2-3-1969


National Aeronastics and Space Administration (NASA)

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5.2.1 GUIDANCE, NAVIGATION, & CONTROL SUBSYSTEM

The Guidance, Navigation, and Control Subsystem (GN&CS) consists of a primary guidance and navigation section (PGNS), abort guidance section (AGS), control electronics section (CES), and radar section. GN&CS malfunction procedures are divided as follows:

- Integrated GN&CS flight displays (paragraph 5.2.2)
- Primary guidance and navigation section (paragraph 5.2.3)
- Abort guidance section (paragraph 5.2.4)
- Control electronics section (paragraph 5.2.5)

Radar section malfunctions are manifested by abnormal flight display readings or improper LGC operation. Therefore, these malfunctions are included in the malfunction procedures for the integrated GN&CS flight displays and the primary guidance and navigation section.

Major GN&CS malfunction symptoms A and B serve as entry points for GN&CS malfunction procedure paragraphs 5.2.2 through 5.2.5.

5.2.1.2 Assumptions

The GN&CS malfunction procedures assume that if the LM is in a critical maneuver, the crew performs only those steps required to save the LM. The crew can continue the diagnostic procedures at their convenience.

<table>
<thead>
<tr>
<th>Table 5-1. GN&amp;CS Procedure Entry Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom</td>
</tr>
<tr>
<td>Total attitude abnormal</td>
</tr>
<tr>
<td>FDAI error needles abnormal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5-2. GN&amp;CS Failure/Symptom Cross-Reference Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure</td>
</tr>
<tr>
<td>Abnormal vehicle dynamics</td>
</tr>
<tr>
<td>ORDEAL failure</td>
</tr>
</tbody>
</table>

Basic Date 3 February 1969  Change Date ____________  Page 5.2-3/5.2-4
<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total attitude abnormal</td>
<td>FDAI OFF flag visible?</td>
<td>Integrated ON/CIS FLT DISP 4 1</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ORDEAL FAIL URE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Both FDAI's agree?</td>
<td>Integrated ON/CIS FLT DISP 5 1</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manual maneuver commanded when symptom appeared?</td>
<td>Direct FALSE, PROPORTIONAL</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrective action to regain vehicle control been necessary?</td>
<td>FDAI OFF flag visible?</td>
<td>Integrated ON/CIS FLT DISP 4 1</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Error needles oscillating at high rate?</td>
<td>CES 14 1</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vehicle drifting in all three axes?</td>
<td>CES 13 1</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Symptom in one or more axes?</td>
<td>Integrated ON/CIS FLT DISP 1 1</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Error needles failed at zero?</td>
<td>AGS 6 1</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td></td>
</tr>
</tbody>
</table>

**GUIDANCE, NAVIGATION, & CONTROL SUBSYSTEM**

**Basic Date**: 3 February 1969

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### 5.2.2 INTEGRATED GUIDANCE, NAVIGATION, & CONTROL SUBSYSTEM FLIGHT DISPLAYS

Table 5-3. INTEGRATED GN&CS FLT DISP Procedure Entry Sheet

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude error is zero in one axis (remains zero) while other axes display actual attitude errors</td>
<td>1</td>
<td>5.2-11</td>
</tr>
<tr>
<td>AGS in follow-up, attitude error is not zero in one axis while other axes are held at zero</td>
<td>1a</td>
<td>5.2-11</td>
</tr>
<tr>
<td>RANGE ind pwr/sig fail lt</td>
<td>2</td>
<td>5.2-12</td>
</tr>
<tr>
<td>X pointer ind pwr fail lt goes on when X pointer is in use</td>
<td>3</td>
<td>5.2-13</td>
</tr>
<tr>
<td>FDAI pwr tb appears while FDAI is in use</td>
<td>4</td>
<td>5.2-13</td>
</tr>
<tr>
<td>One FDAI total attitude display goes to (and remains at) specific attitude</td>
<td>5</td>
<td>5.2-13</td>
</tr>
<tr>
<td>One FDAI total attitude display erratic or inaccurate</td>
<td>5a</td>
<td>5.2-13</td>
</tr>
<tr>
<td>FDAI rate needles abnormal</td>
<td>6</td>
<td>5.2-14</td>
</tr>
<tr>
<td>Tuning fork Indicator displayed on MSN TMR ind</td>
<td>7</td>
<td>5.2-14</td>
</tr>
</tbody>
</table>

Table 5-4. INTEGRATED GN&CS FLT DISP Failure/Symptom Cross-Reference Index

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEA - FDAI interface failure</td>
<td>One FDAI total attitude display goes to (and remains at) specific attitude</td>
<td>5</td>
<td>5.2-13</td>
</tr>
<tr>
<td></td>
<td>One FDAI total attitude display erratic or inaccurate</td>
<td>5a</td>
<td>5.2-13</td>
</tr>
<tr>
<td>ATCA/rate gyro interface failed open, Rates in affected axis cannot be displayed, Needle movement possibly due to vibration</td>
<td>FDAI rate needles abnormal</td>
<td>6</td>
<td>5.2-14</td>
</tr>
<tr>
<td>D-c power to FDAI failed or FDAI shorted</td>
<td>FDAI pwr tb appears while FDAI is in use</td>
<td>4</td>
<td>5.2-13</td>
</tr>
<tr>
<td>Failure from MODE SEL sw to RANGE ind</td>
<td>RANGE ind pwr/sig fail lt</td>
<td>2</td>
<td>5.2-12</td>
</tr>
<tr>
<td>Failure of LR or AGS output to RANGE ind or failure of one deck of S/C: AGS sw</td>
<td>RANGE ind pwr/sig fail lt</td>
<td>2</td>
<td>5.2-12</td>
</tr>
<tr>
<td>Failure of RR output or line to RANGE indicator</td>
<td>RANGE ind pwr/sig fail lt</td>
<td>2</td>
<td>5.2-12</td>
</tr>
<tr>
<td>FDAI attitude error display failed</td>
<td>Attitude error is zero in one axis (remains zero) while other axes display actual attitude errors</td>
<td>1</td>
<td>5.2-11</td>
</tr>
</tbody>
</table>

Basic Date 3 February 1969 Change Date Page 5.2-7
<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGS in follow-up, attitude error is not zero in one axis while other axes are held at zero</td>
<td>1a</td>
<td>5.2-11</td>
<td></td>
</tr>
<tr>
<td>FDAI pwr tb failed on</td>
<td>FDAI pwr tb appears while FDAI is in use</td>
<td>4</td>
<td>5.2-13</td>
</tr>
<tr>
<td>FDAI rate needle failure</td>
<td>FDAI rate needles abnormal</td>
<td>6</td>
<td>5.2-14</td>
</tr>
<tr>
<td>IMU - FDAI interface failure</td>
<td>One FDAI total attitude display goes to (and remains at) specific attitude</td>
<td>5</td>
<td>5.2-13</td>
</tr>
<tr>
<td>Loss of TE of PCMTEA</td>
<td>One FDAI total attitude display goes to (and remains at) specific attitude</td>
<td>5a</td>
<td>5.2-13</td>
</tr>
<tr>
<td>Loss of 10 cps in TE of PCMTEA</td>
<td>One FDAI total attitude display goes to (and remains at) specific attitude</td>
<td>5</td>
<td>5.2-13</td>
</tr>
<tr>
<td>Loss of 10 cps in TE of PCMTEA</td>
<td>One FDAI total attitude display goes to (and remains at) specific attitude</td>
<td>5a</td>
<td>5.2-13</td>
</tr>
<tr>
<td>One FDAI total attitude display interconnect failure from AGS</td>
<td>One FDAI total attitude display erratic or inaccurate</td>
<td>5</td>
<td>5.2-13</td>
</tr>
<tr>
<td>One FDAI total attitude display interconnect failure from PGNS</td>
<td>One FDAI total attitude display erratic or inaccurate</td>
<td>5a</td>
<td>5.2-13</td>
</tr>
<tr>
<td>One or three AEA attitude error channels failed biased</td>
<td>Attitude error is zero in one axis (remains zero) while other axes display actual attitude errors</td>
<td>1</td>
<td>5.2-11</td>
</tr>
<tr>
<td>One of three AEA attitude error channels failed open</td>
<td>Attitude error is zero in one axis (remains zero) while other axes display actual attitude errors</td>
<td>1</td>
<td>5.2-11</td>
</tr>
<tr>
<td>AGS in follow-up, attitude error is not zero in one axis while other axes are held at zero</td>
<td>1a</td>
<td>5.2-11</td>
<td></td>
</tr>
<tr>
<td>AGS in follow-up, attitude error is not zero in one axis while other axes are held at zero</td>
<td>1a</td>
<td>5.2-11</td>
<td></td>
</tr>
<tr>
<td>Failure</td>
<td>Symptom</td>
<td>Sym No.</td>
<td>Page No.</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>One of three LGC attitude error signals failed open or failed biased</td>
<td>Attitude error is zero in one axis (remains zero) while other axes display actual attitude errors</td>
<td>1</td>
<td>5.2-11</td>
</tr>
<tr>
<td></td>
<td>AGS in follow-up, attitude error is not zero in one axis while other axes are held at zero</td>
<td>1a</td>
<td>5.2-11</td>
</tr>
<tr>
<td>Open condition downstream of CB</td>
<td>RANGE ind pwr/sig fail lt</td>
<td>2</td>
<td>5.2-12</td>
</tr>
<tr>
<td>Power to X pointer ind failed or X pointer ind shorted</td>
<td>X pointer ind pwr fail lt goes on when X pointer is in use</td>
<td>3</td>
<td>5.2-13</td>
</tr>
<tr>
<td>RANGE indicator shorted</td>
<td>RANGE ind pwr/sig fail lt</td>
<td>2</td>
<td>5.2-13</td>
</tr>
<tr>
<td>Rate gyro failed on</td>
<td>FDAI rate needles abnormal</td>
<td>6</td>
<td>5.2-14</td>
</tr>
<tr>
<td>RATE SCALE sw failed open. Max rate displayed = 5°/sec</td>
<td>FDAI rate needles abnormal</td>
<td>6</td>
<td>5.2-14</td>
</tr>
<tr>
<td>S/C: DEAD BAND sw failed open in previous position</td>
<td>Attitude error is zero in one axis (remains zero) while other axes display actual attitude errors</td>
<td>1</td>
<td>5.2-11</td>
</tr>
<tr>
<td></td>
<td>AGS in follow-up, attitude error is not zero in one axis while other axes are held at zero</td>
<td>1a</td>
<td>5.2-11</td>
</tr>
<tr>
<td>Signal path from AGS to one FDAI attitude error display failed</td>
<td>Attitude error is zero in one axis (remains zero) while other axes display actual attitude errors</td>
<td>1</td>
<td>5.2-11</td>
</tr>
<tr>
<td></td>
<td>AGS in follow-up, attitude error is not zero in one axis while other axes are held at zero</td>
<td>1a</td>
<td>5.2-11</td>
</tr>
<tr>
<td>Signal path from PGNCS to one FDAI attitude error display failed</td>
<td>Attitude error is zero in one axis (remains zero) while other axes display actual attitude errors</td>
<td>1</td>
<td>5.2-11</td>
</tr>
<tr>
<td></td>
<td>AGS in follow-up, attitude error is not zero in one axis while other axes are held at zero</td>
<td>1a</td>
<td>5.2-11</td>
</tr>
<tr>
<td>Total attitude display failure</td>
<td>One FDAI total attitude display goes to (and remains at) specific attitude</td>
<td>5</td>
<td>5.2-13</td>
</tr>
<tr>
<td></td>
<td>One FDAI total attitude display erratic or inaccurate</td>
<td>5a</td>
<td>5.2-13</td>
</tr>
<tr>
<td>X pointer ind pwr fail lt failed on</td>
<td>X pointer ind pwr fail lt goes on when X pointer is in use</td>
<td>3</td>
<td>5.2-13</td>
</tr>
</tbody>
</table>
## ATTITUDE MON sw - AGS

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Procedure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom remains?</td>
<td>Switch input to FDI</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ATTITUDE MON sw - PGNS

| Symptom appears? | Switch same input to other FDI | |
| Yes |  | |
| No |  | |

### CAUTION

GUID CONT sw - AGS will result in abnormal vehicle dynamics.

### SIGNAL PATH FROM AGS TO ONE FDI ATTITUDE ERROR DISPLAY FAILED

- When GUID CONT & ATTITUDE MON sw - AGS, attitude error signals go to FDI & CES. Failure affects control of LM & display.

### ONE OF THREE AEA ATTITUDE ERROR CHANNELS FAILED BASED

- One FDI attitude error display is lost in one axis.

### S/C DEAD BAND sw - MAX or MIN capability is lost in one axis.

### When ATTITUDE MON sw - PGNS, LGC attitude error signals go to FDM & CES. Failure affects display only.

### Switch same input to other FDI

- One of three AEA attitude error channels failed open or failed biased.

### Switch same input to other FDI

- Needle failed at zero?

### ONE OF THREE LGC ATTITUDE ERROR SIGNALS FAILED OPEN OR FAILED BASED

- When ATTITUDE MON sw - AGS (CMD and LMP).

### Switch input to FDI

- Attitude error is zero in one axis remains zero while other axes display actual attitude errors.

### SIGNAL PATH FROM PGNS TO ONE FDI ATTITUDE ERROR DISPLAY FAILED

- S/C AGS sw - ATT HOLD or S/C AGS sw - PGNs.

### Switch same input to other FDI

- Attitude errors are normally held at zero in AGS follow-up when GUID CONT sw - PGNs.

### ATTITUDE MON sw - PGNS (other FDI)

- Attitude errors are normally held at zero in AGS follow-up when GUID CONT sw - PGNs. S/C AGS sw - ATT HOLD or S/C AGS sw - PGNs.

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**SYMPTOM**
- RANGE ind pow/sig fail II

**PROCEDURE**
1. RNG/ALT MON sw - RNG/RT, RNG RADAR: NO TRACK on?  
   **YES**
   - Normal condition when tracking lock-on is lost.
   **NO**
   - Check for short:
     - Either CB FLT DISP, RNG/RT open or CB/AC BUS A, RNG/RT open and cannot be reset?
     **YES**
     - RANGE INDICATOR SHORTED
     **NO**
     - Check for open:
       - CB FLT DISP, RNG/RT - open
       - CB/AC BUS A, RNG/RT - open
       **YES**
       - RANGE ind pow/sig fail II - off
     **NO**
     - Check alternate path for open:
       - Open other circuit breaker
       **YES**
       - RANGE ind pow/sig fail II - off
     **NO**
     - Verify status of indicator - driving source (radar or AEA):
       - Radar: Check transmitter power of source system (Radar, SIGNAL STRENGTH int).
       - AEA: Observe normal operation of DEHA displays
       **YES**
       - SOURCE operating normally!
     **NO**
     - Select alternate display source (when operating):
       - LR or AOS
       **YES**
       - RANGE ind pow/sig fail II due to new signal source?
         **YES**
         - RR ONLY
         **NO**
         - RR or LR or AOS
       **NO**
       - SOURCE operating normally!
     **NO**
     - SELECT alternate display source (when operating):
       - RR or LR
       **YES**
       - RR ONLY
     **NO**
     - RR or LR or AOS
   **YES**
   - FAILURE OF RR OUTPUT OR LINE TO RANGE INDICATOR
   **NO**
   - FAILURE OF LR OR AOS OUTPUT TO RANGE IND
   **YES**
   - FAILURE FROM MODE SEL SW TO RANGE IND

**REMARKS**
- If light will normally be on when power is supplied and indicator is not used by AGS, LR, or RR. If either input signal goes to zero, light goes on. Light may flash randomly when range rate is below 10 fps. Neither condition indicates malfunction.

**INTEGRATED ON&CS FLIGHT DISPLAYS**

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**Page:** S.2-12
Symptom 1: X pointer and/or fail in place when X pointer is in use

Procedure:
1. Select zero signal
   - Rate ERR MON sw- LCS FOR/MOD
   - X pointer and/or fail?

2. Power to X pointer IND failed or X pointer IND shorted?
3. Power to X pointer IND failed or X pointer IND shorted?

Remark:
- Assumption: Orbit is operating

Symptom 2: One FODA total attitude display erratic or unacceptible

Procedure:
1. Switch input source to FODA
   - Attitude MON sw-FODA
2. Switch input source to FODA
   - Attitude MON sw-AEA
   - Symptom remains?
3. Switch input source to other FODA
   - Attitude MON sw-FODA
   - Symptom remains?
4. Switch input source to other FODA
   - Attitude MON sw-AEA
   - Symptom remains?
5. IMU-FODA interface failure
   - Symptom remains?
6. Attitude MON sw-FODA
   - Symptom remains?

Remark:
- Failure includes the following:
  - One of six AEA output channels failed (complete loss, or magnitude/polarity error) or three AEA return lines failed.
**SYMPTOM**

FDI rate needles abnormal

**PROCEDURE**

1. **WARNING**
   - Do not switch to AGS until troubleshooting is complete.

2. **FDI RATE NEEDLE FAILURE**
   - Both FDI rate needles agree?
     - YES
     - NO

3. **RATE NEEDLES AT ZERO WHEN MANEUVER WAS COMMANDED?**
   - YES
   - NO

4. **RATE SCALE SW FAILED OPEN. MAX RATE DISPLAYED = 5°/SEC**

**REMARKS**

- Rate needles are not abnormal if they are following vehicle dynamics.
- Switching to AGS might result in large vehicle rates. Being in LOO beam might imply activity.
- Roll, pitch, or yaw rate needles read same as both FDI's.
- Automatic maneuvering, rate command, and attitude hold have been lost in affected axis when AGS is in control.

---

**SYMPTOM**

Tuning fork indicator displayed on DSN TMR ind

**PROCEDURE**

1. **GREEN EL**
   - Light on if: loss of 10 cps from PCMTEA and MSM TMR ind is using internal clock

2. **ATCA RATE CYRO INTERFACE FAILED OPEN. RATES IN AFFECTED AXES CANNOT BE DISPLAYED. NEEDLE MOVEMENT POSSIBLY DUE TO VIBRATION**

3. **LOSS OF TE OF PCMTEA**

**REMARKS**

- The failure is due to a power/signal failure light that will flash for the following:
  - a. Range/altitude or rate digital word signal not being updated at specified rate.
  - b. Range rates below 10 fps.

- In LOS, MSN can confirm loss of TE of PCMTEA by confirming loss of emergency key, voice, ENG, and DMI data.

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**SYMPTOM**

**INTEGRATED GN&CS FLIGHT DISPLAYS**

**PROCEDURE**

**REMARKS**

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### Table 5-5. PGNS Procedure Entry Sheet

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISS warn lt</td>
<td>1</td>
<td>5.2-19</td>
</tr>
<tr>
<td>ISS warn lt &amp; TRACKER lt</td>
<td>2</td>
<td>5.2-20</td>
</tr>
<tr>
<td>ISS warn lt &amp; PROG lt</td>
<td>3</td>
<td>5.2-20</td>
</tr>
<tr>
<td>LGC warn lt</td>
<td>4</td>
<td>5.2-21</td>
</tr>
<tr>
<td>LGC warn lt &amp; RESTART lt</td>
<td>5</td>
<td>5.2-21</td>
</tr>
<tr>
<td>RNDZ RDR caut lt</td>
<td>6</td>
<td>5.2-22</td>
</tr>
<tr>
<td>RNDZ RDR caut lt &amp; RNDZ RADAR: NO TRACK lt</td>
<td>7</td>
<td>5.2-22</td>
</tr>
<tr>
<td>LDG RDR caut lt</td>
<td>8</td>
<td>5.2-23</td>
</tr>
<tr>
<td>TRACKER lt</td>
<td>9</td>
<td>5.2-23</td>
</tr>
<tr>
<td>PROG lt &amp; TRACKER lt</td>
<td>10</td>
<td>5.2-23</td>
</tr>
<tr>
<td>TEMP lt</td>
<td>11</td>
<td>5.2-24</td>
</tr>
<tr>
<td>GIMBAL LOCK lt</td>
<td>12</td>
<td>5.2-24</td>
</tr>
<tr>
<td>Abnormal DSKY response</td>
<td>13</td>
<td>5.2-25</td>
</tr>
<tr>
<td>Missing numerics or EL segments appear in PROG ind, VERB ind, NOUN ind, or registers</td>
<td>13a</td>
<td>5.2-25</td>
</tr>
<tr>
<td>Mark verb continues flashing after crew response</td>
<td>13b</td>
<td>5.2-26</td>
</tr>
<tr>
<td>V50 N25 continues flashing after crew response</td>
<td>13c</td>
<td>5.2-26</td>
</tr>
</tbody>
</table>

### Table 5-6. PGNS Failure/Symptom Cross-Reference Index

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOT pb (CDR) or LGC logic failed</td>
<td>Mark verb continues flashing after crew response</td>
<td>13b</td>
<td>5.2-26</td>
</tr>
<tr>
<td>CDU +14-vdc power failure</td>
<td>ISS warn lt and TRACKER lt</td>
<td>2</td>
<td>5.2-20</td>
</tr>
<tr>
<td>CWEA failure</td>
<td>ISS warn lt</td>
<td>1</td>
<td>5.2-19</td>
</tr>
<tr>
<td></td>
<td>LDG RDR caut lt</td>
<td>8</td>
<td>5.2-23</td>
</tr>
<tr>
<td></td>
<td>LGC warn lt</td>
<td>4</td>
<td>5.2-21</td>
</tr>
<tr>
<td></td>
<td>RNDZ RDR caut lt</td>
<td>6</td>
<td>5.2-22</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSKY ENTR or PRO pb failed (depending on pb used)</td>
<td>Abnormal DSKY response</td>
<td>13</td>
<td>5.2-25</td>
</tr>
<tr>
<td>DSKY power supply failed (275 V, 800 cps)</td>
<td>Abnormal DSKY response</td>
<td>13</td>
<td>5.2-25</td>
</tr>
<tr>
<td>DSKY relay(s) failed</td>
<td>Missing numerics or EL segments appear in PROG ind, VERB ind, NOUN ind, or registers</td>
<td>13a</td>
<td>5.2-25</td>
</tr>
<tr>
<td>EL light failed</td>
<td>Missing numerics or EL segments appear in PROG ind, VERB ind, NOUN ind, or registers</td>
<td>13a</td>
<td>5.2-25</td>
</tr>
<tr>
<td>ENG THR CONT: THR CONT sw AUTO position failed open or LGC inbit failed open</td>
<td>V50 N25 continues flashing after crew response</td>
<td>13c</td>
<td>5.2-26</td>
</tr>
<tr>
<td>Gimbal lock detection circuit failure</td>
<td>GIMBAL LOCK lt</td>
<td>12</td>
<td>5.2-24</td>
</tr>
<tr>
<td>GUID CONT sw PGNS position failed open or LGC inbit failed open</td>
<td>V50 N25 continues flashing after crew response</td>
<td>13c</td>
<td>5.2-26</td>
</tr>
<tr>
<td>ICU A/D section failure</td>
<td>ISS warn lt</td>
<td>1</td>
<td>5.2-19</td>
</tr>
<tr>
<td>ICU D/A section failure</td>
<td>ISS warn lt</td>
<td>1</td>
<td>5.2-19</td>
</tr>
<tr>
<td>IMU failure</td>
<td>ISS warn lt</td>
<td>1</td>
<td>5.2-19</td>
</tr>
<tr>
<td>IMU has entered gimbal lock. Inertial reference is lost</td>
<td>GIMBAL LOCK lt</td>
<td>12</td>
<td>5.2-24</td>
</tr>
<tr>
<td>IMU temp control failure</td>
<td>TEMP lt</td>
<td>11</td>
<td>5.2-24</td>
</tr>
<tr>
<td>Integral lighting failed</td>
<td>Abnormal DSKY response</td>
<td>13</td>
<td>5.2-25</td>
</tr>
<tr>
<td>ISS transient condition or false indication</td>
<td>ISS warn lt</td>
<td>1</td>
<td>5.2-19</td>
</tr>
<tr>
<td>LGC failure</td>
<td>LGC warn lt</td>
<td>4</td>
<td>5.2-21</td>
</tr>
<tr>
<td>LGC output channel failure</td>
<td>LGC warn lt and RESTART lt</td>
<td>5</td>
<td>5.2-21</td>
</tr>
<tr>
<td>LGC power failure</td>
<td>TEMP lt</td>
<td>11</td>
<td>5.2-24</td>
</tr>
<tr>
<td>LR data-good logic failure causing absence of data-good signal to LGC</td>
<td>TEMP lt</td>
<td>4</td>
<td>5.2-21</td>
</tr>
<tr>
<td>Numeric pb failed open</td>
<td>LDG RDR caut lt</td>
<td>8</td>
<td>5.2-23</td>
</tr>
<tr>
<td>One DSKY pb failed closed</td>
<td>Missing numerics or EL segments appear in PROG ind, VERB ind, NOUN ind, or registers</td>
<td>13a</td>
<td>5.2-25</td>
</tr>
<tr>
<td>PIPA failure</td>
<td>ISS warn lt and PROG lt</td>
<td>3</td>
<td>5.2-20</td>
</tr>
<tr>
<td>Failure</td>
<td>Symptom</td>
<td>Sym No.</td>
<td>Page No.</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>Possible LGC failure not detected by self-test, or failed LGC warn lt circuitry</td>
<td>LGC warn lt</td>
<td>4</td>
<td>5.2-21</td>
</tr>
<tr>
<td></td>
<td>LGC warn lt and RESTART lt</td>
<td>5</td>
<td>5.2-21</td>
</tr>
<tr>
<td>Possible RR failure or transponder failure not detected by self-tests</td>
<td>RNDZ RDR caut lt and RNDZ RADAR:</td>
<td>7</td>
<td>5.2-22</td>
</tr>
<tr>
<td></td>
<td>NO TRACK lt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRO pb failed open</td>
<td>V50 N25 continues flashing after crew response</td>
<td>13c</td>
<td>5.2-26</td>
</tr>
<tr>
<td>RNDZ RADAR: NO TRACK lt failed off</td>
<td>RNDZ RDR caut lt</td>
<td>6</td>
<td>5.2-22</td>
</tr>
<tr>
<td>RNDZ RADAR: NO TRACK lt failed on</td>
<td>RNDZ RDR caut lt and RNDZ RADAR:</td>
<td>7</td>
<td>5.2-22</td>
</tr>
<tr>
<td></td>
<td>NO TRACK lt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNDZ RADAR sel LGC position failed open or LGC inhibit failed open</td>
<td>V50 N25 continues flashing after crew response</td>
<td>13c</td>
<td>5.2-26</td>
</tr>
<tr>
<td>RNDZ RDR caut lt failed on</td>
<td>RNDZ RDR caut lt and RNDZ RADAR:</td>
<td>7</td>
<td>5.2-22</td>
</tr>
<tr>
<td></td>
<td>NO TRACK lt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RR CDU failure</td>
<td>TRACKER lt</td>
<td>9</td>
<td>5.2-23</td>
</tr>
<tr>
<td>RR frequency tracker failure</td>
<td>RNDZ RDR caut lt and RNDZ RADAR:</td>
<td>7</td>
<td>5.2-22</td>
</tr>
<tr>
<td></td>
<td>NO TRACK lt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RR range tracker failure</td>
<td>RNDZ RDR caut lt and RNDZ RADAR:</td>
<td>7</td>
<td>5.2-22</td>
</tr>
<tr>
<td></td>
<td>NO TRACK lt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RR transmitter failure</td>
<td>RNDZ RDR caut lt and RNDZ RADAR:</td>
<td>7</td>
<td>5.2-22</td>
</tr>
<tr>
<td></td>
<td>NO TRACK lt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S/C: PGNS sw - AUTO position failed open or LGC inhibit failed open</td>
<td>V50 N25 continues flashing after crew response</td>
<td>13c</td>
<td>5.2-26</td>
</tr>
<tr>
<td>Temporary loss of track corrected by AGS acquisition</td>
<td>RNDZ RDR caut lt and RNDZ RADAR:</td>
<td>7</td>
<td>5.2-22</td>
</tr>
<tr>
<td></td>
<td>NO TRACK lt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temporary loss of track corrected by P20</td>
<td>RNDZ RDR caut lt and RNDZ RADAR:</td>
<td>7</td>
<td>5.2-22</td>
</tr>
<tr>
<td></td>
<td>NO TRACK lt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temp relay in DSKY failed closed</td>
<td>TEMP lt</td>
<td>11</td>
<td>5.2-24</td>
</tr>
<tr>
<td>TRACKER lt logic or CDU fail discrete circuit failure</td>
<td>TRACKER lt</td>
<td>9</td>
<td>5.2-23</td>
</tr>
<tr>
<td>Transient condition</td>
<td>PROG lt and TRACKER lt</td>
<td>10</td>
<td>5.2-23</td>
</tr>
<tr>
<td>Transient condition at time of symptom</td>
<td>Mark verb continues flashing after crew response</td>
<td>13b</td>
<td>5.2-26</td>
</tr>
<tr>
<td>Transient condition in gimbal lock detection circuit</td>
<td>GIMBAL LOCK lt</td>
<td>12</td>
<td>5.2-24</td>
</tr>
<tr>
<td>Transient condition in IMU temp control circuit</td>
<td>TEMP lt</td>
<td>11</td>
<td>5.2-24</td>
</tr>
<tr>
<td>Transient condition in LGC, PGNCS operative</td>
<td>LGC warn lt and RESTART lt</td>
<td>5</td>
<td>5.2-21</td>
</tr>
</tbody>
</table>
### Table 5-6. PGNS Failure/Symptom Cross-Reference Index (cont)

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transient condition in PIPA loop, PGNCS is operative</td>
<td>ISS warn lt and PROG lt</td>
<td>3</td>
<td>5.2-20</td>
</tr>
<tr>
<td>Transient condition in RR CDU circuit</td>
<td>PROG lt and TRACKER lt</td>
<td>10</td>
<td>5.2-23</td>
</tr>
<tr>
<td>Transient condition in RR or fail detect circuit, or double failure</td>
<td>TRACKER lt</td>
<td>9</td>
<td>5.2-23</td>
</tr>
<tr>
<td>Transient condition in RR or failure detection circuit</td>
<td>RNDZ RDR caut lt</td>
<td>6</td>
<td>5.2-22</td>
</tr>
<tr>
<td>Transponder failure</td>
<td>RNDZ RDR caut lt and RNDZ RADAR: NO TRACK lt</td>
<td>7</td>
<td>5.2-22</td>
</tr>
<tr>
<td></td>
<td>RNDZ RDR caut lt and RNDZ RADAR: NO TRACK lt</td>
<td>7</td>
<td>5.2-22</td>
</tr>
</tbody>
</table>
**ISS**

**RED**
Light on if:
- IMU fails
- CDU fails
- PPA fails during thrust

**SYMPTOM**

1. ISS warn lit-off?
   - **NO**
   - **YES**

2. Check failure?
   - **NO**
   - **YES**

3. Tracker lit-on?
   - **NO**
   - **YES**

4. Progress lit-on?
   - **NO**
   - **YES**

5. IMU Check
   - **YES**
   - **NO**

6. ISS power-down?
   - **YES**
   - **NO**

7. ICDU A/D/S section check
   - **YES**
   - **NO**

8. ICDU D/A section check
   - **YES**
   - **NO**

9. ICDU D/A section failure
   - **NO**

**PROCEDURE**

1. Switch to AGS control
   - **GUID CONT sw-AGS**
   - **MPS triggering?**

2. ISS warn lit-off?
   - **NO**
   - **YES**

3. Tracker lit-on?
   - **YES**

4. Progress lit-on?
   - **YES**

5. IMU Check
   - **Compare CDR (PGNC S) & LMP (AGS) FOAi to total attitude**

6. ISS power-down?
   - **CB PGN S: IMU OPR - open**
   - **Select desired program not requiring IMU**

7. ICDU A/D/S section check
   - **Performs Crew Defined Maneuver Routine (R62), ref para 4.6.1.9, to where NIB is displayed**
   - **Compare CDR FOAi total attitude with NIB display**

8. ICDU D/A section check
   - **Performs Crew Defined Maneuver Routine (R62), ref para 4.6.1.9, to where NIB is displayed**
   - **Monitor IMU fail inbit**

9. ICDU D/A section failure
   - **NO**

**REMARKS**

- **ICDU is incapable of supplying data from LGC.** (Refer to ICDU Functions Table.)
- **ICDU is incapable of supplying data to LGC.** (Refer to ICDU Functions Table.)
- **ICDU is incapable of supplying data to LGC.** (Refer to ICDU Functions Table.)
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**ICDU Functions Table**

<table>
<thead>
<tr>
<th>Function</th>
<th>A/D Failure</th>
<th>D/A Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine alignment</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Coarse alignment</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Attitude error signals</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Total attitude to FOAi</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Gimbal angles to LGC</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>IMU stabilization loop</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Cage mode</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>IMU fail detect circuit</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Coarse align in gimbal lock mode</td>
<td>NO</td>
<td>YES</td>
</tr>
</tbody>
</table>

**Remarks**

- **ICDU is incapable of supplying data from LGC.** (Refer to ICDU Functions Table.)
- **ICDU is incapable of supplying data from LGC.** (Refer to ICDU Functions Table.)
- **ICDU is incapable of supplying data from LGC.** (Refer to ICDU Functions Table.)
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- **ICDU is incapable of supplying data from LGC.** (Refer to ICDU Functions Table.)
- **ICDU is incapable of supplying data from LGC.** (Refer to ICDU Functions Table.)
- **ICDU is incapable of supplying data from LGC.** (Refer to ICDU Functions Table.)
SYMPTOM: RED TRACKER
Lights on if CDU + 1 -4 VDC power supply is lost

SYMPTOM: PROG
Lights on if PIPA fails during thread

CAUTION
Enable automatic eng-off command:
- ABORT pb-push (APS thrust) or
- ABORT STAGE pb-push (APS thread)
When engine shutdown complete:
- Take THRU CONT. ENG ARM sw-off
- ABORT pb or ABORT STAGE pb-reinit

PROCEDURE
1. Switch to AGS control
   - GUID CONT sw-AGS
   - MPS thrusting?

2. Key RESET
   - PROG it-off?

3. Monitor PIPA's as desired
   - Key V15 V27
   - RL X XXXX pulses
   - RL Y XXXX pulses
   - RL 2 XXXX pulses
   - MSGN monitor ISS performance

REMARKS
1. RR CDU and ICDU are incapable of supplying data to A from the LGC:
   a. Attitude error signals are not available.
   b. Normal IMU alignment is disabled.
   c. RR use under LGC control is disabled (RR can be used in automatic track & slew modes).

2. LGC can perform following:
   a. Functions requiring IMU or RR inputs.
   b. Receive state vector updates via P27.
   c. Update AAS state vectors via RR.

3. Not applicable to docked DPS burn.
   If this failure occurs, terminate burn and transfer attitude control to CSM. AGS is not programmed for docked burn.

4. Not applicable to docked DPS burn.
   If this failure occurs, terminate burn and transfer altitude control to CSM. AGS is not programmed for docked burn.

5. Monitor registers for erratic pulse counts. It is assumed that if PIPA failed during thrust maneuver, PIPA will still exhibit erratic behavior during coast.

Primary Guidance & Navigation Section

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APOLLO OPERATIONS HANDBOOK
Light on
LGCC prime power failure
Scaler fails
Counter fails
These failures can occur when the LGCC is in operate or standby mode.

**SYMPTOM**

<table>
<thead>
<tr>
<th>RED</th>
<th>LIGHT ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>LGCC</td>
<td>PRIME POWER FAILS</td>
</tr>
<tr>
<td>SCALER FAILS</td>
<td></td>
</tr>
<tr>
<td>COUNTER FAILS</td>
<td></td>
</tr>
</tbody>
</table>

**PROCEDURE**

1. **RESTART IT-ON?**
   - YES: **PONS 3.2.3**
   - NO: **1**

2. **SWITCH TO AGS CONTROL**
   - YES: **PONS 3.2.3**
   - NO: **2**

3. **LGCC WARN IT-OFF?**
   - YES: **CMEA FAILURE**
   - NO: **1**

4. **LGCC IN STANDBY AT TIME OF SYMPTOM?**
   - YES: **YES**
   - NO: **3**

5. **ATTEMPT LGCC OPERATE**
   - YES: **LGCC POWER FAILURE**
   - NO: **5**

6. **MONITOR LGCC CLOCK TIME**
   - YES: **LGCC Failure**
   - NO: **12**

7. **PERFORM LGCC SELF-TEST (PARA 4.6.6)**
   - YES: **POSSIBLE LGCC FAILURE NOT DETECTED BY SELF-TEST, OR FAILED LGCC WARN LT CIRCUITRY**
   - NO: **4**

8. **LGCC WARN IT & RESTART IT-OFF?**
   - YES: **RESTART IT REMAINS OFF AS LONG AS RSET IS KEPT**
   - NO: **2**

**REMARKS**

1. **OUT APPlicable to docked DPS burn**
   - If this failure occurs, terminate burn and transfer attitude control to CSM. AGS is not programmed for docked burn.

2. **LGCC WARN IT is not usable for failure detection.**
   - If power can be restored, perform normal system operation.

3. **LGCC performance may be unreliable.**
   - This can be a scaler, counter, or a +4-vdc or +14-vdc failure. If +4-vdc or +14-vdc failure occurs, RESTART IT may also go on. See symptom 5. If LGCC is not functional, IMU can be used as backup for attitude reference.

4. **LGCC performance may be unreliable.**
   - Not applicable to docked DPS burn. If this failure occurs, terminate burn and transfer attitude control to CSM. AGS is not programmed for docked burn.
### Primary Guidance & Navigation Section

**Symptom** | **Procedure** | **Remarks**
--- | --- | ---

**RNDZ RDR**
- Yellow

**SYMPTOM**
- Light on when RR is in automatic track mode if RR loses CSM lock on.

**PROCEDURE**
- If this failure occurs, it is assumed automatic track mode if RR loses CSM lock on.
- It is not usable for monitoring.

**REMARKS**
- RNDZ RDR failure detection.
- Use RNDZ RDR.

---

**RNDZ RDR**
- Yellow

**SYMPTOM**
- Light on when RR is in automatic track mode if RR loses CSM lock on.

**PROCEDURE**
- Attempt automatic LGC acquisition and manual lock-on.
- Agc peak reached?
- Target acquired?
- Transponder self-test performed.
- Transponder self-test successful?
- Range rate data display good?
- TRAJECTORY CORRECTED BY AGC ACQUISITION.
- TEMPORARY LOSS OF TRACK CORRECTED BY AGC ACQUISITION.

**REMARKS**
- RNDZ RDR, NO TRACK II cannot be used for monitoring.

---

**RNDZ RDR**
- Yellow

**SYMPTOM**
- Light on when RR is in automatic track mode if RR loses CSM lock on.

**PROCEDURE**
- Possible IR failure or transponder failure not detected by self-tests.
- Transponder failure.

**REMARKS**
- Rendezvous radar will maintain tracking and provide good range data, good drift & turnon angles to FDV error needles, & good second & elevation rates to X-potter ad.
- Possible data good logic failure. Continue using IR & monitor performance.

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**A. SOL4 M4 070**
SYMPTOM

1. TRACKER

2. COEA FAILURE

3. TRACKER IT goes on if LR velocity or range data are no good. Discrete is present during LGC data-read sequence. In LM, this implies a failure of the data-good logic.

4. LR 4 is wired such that velocity & range data-good signals are always present 20 seconds after power is turned on.

5. LR data are transmitted to MSFN regardless of status of data-good discretes.

PROCEDURE

1. Tracklr IT—off?

2. TRACKER IT—off?

3. CI CIRCUIT

4. DSSY check

5. RR CDU failure

6. RR CDU failure

7. PERFORM manual RR acquisition

8. IF LM under AGS control:

9. RR GOU FAILURE

10. TRANSIENT CONDITION

11. Key REL & RSET

12. CDP

13. CDU performance satisfactory?

14. TRANSIENT CONDITION IN RR CDU CIRCUIT

15. Continue P20

16. PRIMARY GUIDANCE & NAVIGATION SECTION

Change Date

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**SYMPTOM**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TEMP</strong></td>
<td>Light on if IMU temperature is not within 126.3° to 134.3°F.</td>
</tr>
<tr>
<td><strong>IMU TEMP CONTROL FAILURE</strong></td>
<td></td>
</tr>
<tr>
<td><strong>MSFN evaluate ISS performance if MSFN not available or if MSFN confirms ISS not usable, switch to AGS control.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>IMU HAS ENTERED GIMBAL LOCK</strong></td>
<td></td>
</tr>
<tr>
<td><strong>IMU angles will be held at present attitudes.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Check FDD and/or ISS displayed angles to avoid gimbal lock</strong></td>
<td></td>
</tr>
</tbody>
</table>

**PROBLEM**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>YELLOW</strong></td>
<td>Light on if MGA &gt; ±70° from zero position.</td>
</tr>
<tr>
<td><strong>IMU TEMP CONTROL FAILURE</strong></td>
<td></td>
</tr>
<tr>
<td><strong>MSFN evaluate ISS performance if MSFN not available or if MSFN confirms ISS not usable, switch to AGS control.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>IMU HAS ENTERED GIMBAL LOCK</strong></td>
<td></td>
</tr>
<tr>
<td><strong>IMU angles will be held at present attitudes.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Check FDD and/or ISS displayed angles to avoid gimbal lock</strong></td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS**

- CD G&N system performance will be unaffected by IMU temperature out of limits for at least 15 minutes. Critical maneuvers can be continued within this time.
- IMU stabilization loop and velocity measurement accuracy is degraded after 15 minutes depending on temperature excursion from nominal range.
- To prevent gimbal oscillations, LGC commands coarse alignment when MGA > ±85°.
## LMA790-3-LM 4
### APOLLO OPERATIONS HANDBOOK

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
</table>
| 13 Abnormal DSKY response | 1. Yes | YES
| 2. Missing EL segments or numerics | YES | DSKY POWER SUPPLY FAILED (275 V, 800 CPS).
| 3. DSKY keyboard integral lighting off? | YES | INTEGRAL LIGHTING FAILED.
| 4. Work verb/noun flashing? | YES | YES
| 5. VSO N25 flashing? | YES | YES
| 6. DSKY continues to flash some other verb/noun | YES | YES

### 13a Missing numerics or EL segments appear in PROG, NOUN, IND, or registers | 1. Attempt DSKY relay & light test. | YES
| 2. Key V35E | NO | ONE DSKY PB FAILED.
| 3. DSKY relay & light test successful? | NO | Segment or entire digit missing?
| 4. Attempt pb test. | NO | YES
| 5. Key EXIT RXX (Do not enter) | NO | YES
| 6. Key CLR | NO | YES
| 7. Pb test successful? | NO | NUMERIC PB FAILED OPEN.
| 8. Transient condition; continue using DSKY. | YES | YES

### PRIMARY GUIDANCE & NAVIGATION SECTION

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### 13b

**Mark verb continues flashing after crew response**

1. Input verification
   - Key V11 NIUE 31E
   - Push & hold appropriate AOT pb (COORD)
   - R1 XXXXX
   - D = Neither MARK Y nor REJECT inbit present
   - D = MARK Y inbit present
   - D = REJECT inbit present
   - E = MARK X inbit not present
   - E = MARK X inbit present
   - RT displays inbit corresponding to AOT pb being pushed?

   **Remarks:**
   - Perform LGC selftest, if desired, to confirm LGC capability. PGNS star sightings are no longer possible. Normal IMU alignment procedures are not usable. Extended V4I N25 may be performed, but should not be used for PGNS thrust control.

### 13c

**VSO N25 continues flashing after crew response**

1. R1 code?
   - 00062
   - 00203

2. Input channel verification
   - To call RNDZ RADAR set inbit:
     - Key V11 NIUE 31E
     - R1 XXXXX
     - E = 1 or 5 rendezvous auto discrete present
     - V50 RADAR set-LGC

3. Input channel verification
   - B = 6

4. Input channel verification
   - To call G1U1 CONT sw and ENG THR CONT sw inbit:
     - Key V11 NIUE 31E
     - R1 XXXXX
     - B = G1U1 CONT discrete present
     - D = 0 or 5 ENG THR CONT THR CONT sw-AUTO discrete present (DPS only)

5. Input channel verification
   - A = 1 or 51

6. Input channel verification
   - S/C PGNS sw inbit:
     - Key V11 NIUE 31E
     - R1 XXXXX
     - A = 1 or 5 AUTO discrete present

7. Input channel verification
   - S/C PGNS sw-AUTO position failed open or LGC inbit failed open

8. Switch to manual throttling
   - ENG THR CONT THR CONT sw (MAN)

9. Switch to AOS control
   - S/C PGNS sw-AUTO position failed open or LGC inbit failed open

**Remarks:**
- V50 N25 codes:
  - 00062 - Switch LGC power down
  - 00203 - Switch R4 mode to auto
- V50 N25 - Switch to PGNS auto mode
- V50E cannot be used for STBY function as requested by FL-V50 N25
- Automatic rendezvous radar acquisition is not possible under LGC control.
- ENG THR CONT: THR CONT sw automatic discrete register position DI applicable to DPS burns only
- LGC cannot be used for LM control
- Automatic thrust control is lost, manual throttling is required
- PGNS automatic control is lost
### 5.2.4 ABORT GUIDANCE SECTION

**Table 5-7. AGS Procedure Entry Sheet**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGS warn lt</td>
<td>1</td>
<td>5.2-31</td>
</tr>
<tr>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>DEDA and/or FDAI anomaly when AGS STATUS sw position is changed</td>
<td>3</td>
<td>5.2-33</td>
</tr>
<tr>
<td>AGS Initialization complete code is not displayed within 10 seconds after DSKY display flashes</td>
<td>4</td>
<td>5.2-33</td>
</tr>
<tr>
<td>No change in DEDA ΔV display during thrusting</td>
<td>5</td>
<td>5.2-34</td>
</tr>
<tr>
<td>Attitude error needles failed at zero</td>
<td>6</td>
<td>5.2-34</td>
</tr>
<tr>
<td>In deadband, attitude hold error signals are displayed when guidance or Z-body axis steering submodes of operation are commanded</td>
<td>7</td>
<td>5.2-35</td>
</tr>
<tr>
<td>Attitude error signals are non zero when GUID CONT sw - PGNS, S00 = 0 (Attitude Hold Submode)</td>
<td>8</td>
<td>5.2-35</td>
</tr>
<tr>
<td>Attitude error signals are non zero when GUID CONT sw - PGNS, S/C; AGS sw - ATT HOLD S00 = 1 or 2 (Guidance steering or Z-body axis steering)</td>
<td>8a</td>
<td>5.2-35</td>
</tr>
<tr>
<td>Attitude error signals are non zero when S/C; AGS sw - ATT HOLD, ACA - out of detent, S00 = 1 or 2 (Guidance steering or Z-body axis steering)</td>
<td>8b</td>
<td>5.2-35</td>
</tr>
<tr>
<td>PGNCS and AGS total attitude displays disagree in one or more axes immediately following PGNCS/AGS alignment</td>
<td>9</td>
<td>5.2-35</td>
</tr>
<tr>
<td>MASTER ALARM with AGS warn lt temporarily on or without any caution or warning light on (excluding cases when it is known that some other system triggered MASTER ALARM (only) as part of specific sequence)</td>
<td>10</td>
<td>5.2-36</td>
</tr>
</tbody>
</table>

**Table 5-8. AGS Failure/Symptom Cross-Reference Index**

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEA has experienced restart</td>
<td>MASTER ALARM with AGS warn lt temporarily on or without any caution or warning light on (excluding cases when it is known that some other system triggered MASTER ALARM (only) as part of specific sequence)</td>
<td>10</td>
<td>5.2-36</td>
</tr>
<tr>
<td>AEA power supply failure</td>
<td>AGS warn lt</td>
<td>1</td>
<td>5.2-31</td>
</tr>
<tr>
<td>AGS accelerometer failure</td>
<td>No change in DEDA ΔV display during thrusting</td>
<td>5</td>
<td>5.2-34</td>
</tr>
<tr>
<td>AGS self-test detected failure</td>
<td>AGS warn lt</td>
<td>1</td>
<td>5.2-31</td>
</tr>
<tr>
<td>AGS STATUS sw - STAND BY contracts failed open</td>
<td>DEDA and/or FDAI anomaly when AGS STATUS sw position is changed</td>
<td>3</td>
<td>5.2-33</td>
</tr>
<tr>
<td>ASA heater, CWEA, or AEA test mode fail discrete failure</td>
<td>AGS warn lt</td>
<td>1</td>
<td>5.2-31</td>
</tr>
<tr>
<td>ASA heater failure</td>
<td>AGS warn lt</td>
<td>1</td>
<td>5.2-31</td>
</tr>
<tr>
<td>Auto discrete (β₄) failed off</td>
<td>Attitude error needles failed at zero</td>
<td>6</td>
<td>5.2-34</td>
</tr>
</tbody>
</table>

Basic Date: 3 February 1969
<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sum No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic discrete (β 4) failed off</td>
<td>In deadband, attitude hold error signals are displayed when guidance or Z-body axis steering submodes of operation are commanded</td>
<td>7</td>
<td>5.2-35</td>
</tr>
<tr>
<td>Automatic discrete (β 4) failed on</td>
<td>Attitude error signals are non zero when GUID CONT sw - PGNS S/C: AGS sw - ATT HOLD S00 = 1 or 2 (Guidance steering or Z-body axis steering)</td>
<td>8a</td>
<td>5.2-35</td>
</tr>
<tr>
<td>CDU zero from LGC failed</td>
<td>PGNCs and AGS total attitude displays disagree in one or more axes immediately following PGNCs/AGS alignment</td>
<td>9</td>
<td>5.2-35</td>
</tr>
<tr>
<td>CLR pb failed open or OPR ERR lt failed on</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>CWEA or AEA test mode fail discrete failure</td>
<td>AGS warn lt</td>
<td>1</td>
<td>5.2-31</td>
</tr>
<tr>
<td>DEDA failure</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>DEDA failure or DEDA-AEA inter-connection failure</td>
<td>AGS initialization complete code is not displayed within 10 seconds after DSKY display flashes</td>
<td>4</td>
<td>5.2-33</td>
</tr>
<tr>
<td>Digit pb failed closed</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>Digit pb failed closed or +/-pb failed closed</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>Digit pb failed open</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>ENTR pb failed closed</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>Followup discrete (β 3) failed</td>
<td>Attitude error needles failed at zero</td>
<td>6</td>
<td>5.2-34</td>
</tr>
<tr>
<td>Guidance control path of followup discrete (β 3) failed off</td>
<td>Attitude error signals are non zero when GUID CONT sw - PGNS, S00 = 0 (Guidance Hold Submode)</td>
<td>8</td>
<td>5.2-35</td>
</tr>
<tr>
<td></td>
<td>Attitude error signals are non zero when GUID CONT sw - PGNS S/C: AGS sw - ATT HOLD S00 = 1 or 2 (Guidance steering or Z-body axis steering)</td>
<td>8a</td>
<td>5.2-35</td>
</tr>
<tr>
<td>HOLD pb failed closed</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>HOLD pb failed open</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>Intermittent out-of-tolerance condition in nonlatching circuit</td>
<td>MASTER ALARM with AGS warn lt temporarily on or without any caution or warning light on (excluding cases when it is known that some other system triggered MASTER ALARM (only) as part of specific sequence)</td>
<td>10</td>
<td>5.2-36</td>
</tr>
<tr>
<td>One axis out-of-detent path followup failed off</td>
<td>Attitude error signals are non zero when S/C: AGS sw - ATT HOLD ACA - out of detent S00 = 1 or 2 (Guidance steering or Z-body axis steering)</td>
<td>8b</td>
<td>5.2-35</td>
</tr>
<tr>
<td>One EL light segment failed</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>Failure</td>
<td>Symptom</td>
<td>Sym No.</td>
<td>Page No.</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>Out-of-detent path of followup discrete ($\beta_3$) failed off</td>
<td>Attitude error signals are non zero when S/C: AGS sw - ATT HOLD ACA - out of detent $S_00 = 1$ or $2$ (Guidance steering or Z-body axis steering)</td>
<td>8b</td>
<td>5.2-35</td>
</tr>
<tr>
<td>Out-of-detent switch or relay failed closed</td>
<td>Attitude error needles failed at zero</td>
<td>6</td>
<td>5.2-34</td>
</tr>
<tr>
<td>One of six AEA Euler angle inputs failed</td>
<td>PGNCS and AGS total attitude displays disagree in one or more axes immediately following PGNCS/AGS alignment</td>
<td>9</td>
<td>5.2-35</td>
</tr>
<tr>
<td>OPR ERR lt failed off</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>OPR ERR lt failed on</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>+ or - $pb$ failed open</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>+ $pb$ failed open</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>- $pb$ failed open</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>- EL display failed off</td>
<td>DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>READOUT $pb$ failed open</td>
<td>DEDA response is abnormal</td>
<td>5</td>
<td>5.2-34</td>
</tr>
<tr>
<td>Stop pulse from PGNCS not received or PGNCS downlink register failure</td>
<td>No change in DEDA $\Delta V$ display during thrusting DEDA response is abnormal</td>
<td>2</td>
<td>5.2-32</td>
</tr>
<tr>
<td>Transient condition triggering self-test fail discrete</td>
<td>AGS Initialization complete code is not displayed within 10 seconds after DSKY display flashes</td>
<td>4</td>
<td>5.2-33</td>
</tr>
<tr>
<td>Transient malfunction, such as ID word not found during first execution of R47</td>
<td>AGS warn lt AGS Initialization complete code is not displayed within 10 seconds after DSKY display flashes</td>
<td>1</td>
<td>5.2-31</td>
</tr>
</tbody>
</table>

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### APOLLO OPERATIONS HANDBOOK

#### SYMPTOM: AGS

- **Light on if:**
  - $+28$ Vdc out of tolerance by >2.8 Vdc
  - $+12$ Vdc out of tolerance by >1.2 Vdc
  - $29V$, 400cps out of tolerance by >15 cps

- **AGS** test mode discrete signals a fail condition.

- **ASA heater fails on**, (activated at $150^\circ \pm 5^\circ$ F, causing temp sensor to open $+12$-vdc supply to ASA)

- **AEA** fails to complete a minor cycle within 20 milliseconds.

### PROCEDURE

1. **Switch to PONCS control**
   - Key: DEDA: C412 + 00000
   - Key: DEDA: C412R
   - Key: DEDA: C412 + 00000
   - Key: DEDA: C412R

2. **AGS** self-test check
   - Key: DEDA: C412R
   - DEDA responds?

3. **Self-test isolate**
   - Key: DEDA: C412 + 00000
   - + 0000 displayed (within 5 to 30 sec)?

4. **AGS** warn off?

5. **Communicate with MSFN available?**

6. **MSFN verify ASA heater operation**

7. **ASA heater operation satisfactory?**

8. **ASA heater failure may cause PTA to overheat**
   - Key: DEDA: C412R
   - Key: DEDA: C412 + 00000
   - Key: DEDA: C412R

9. **AGS** power supply failure?

10. **Transient condition triggering self-test fail discrete.**

11. **ABA heater, CWA, on test mode fail discrete.**

12. **ASA heater failure**

13. **ASA heater failure may cause PTA to overheat**

14. **AGS** self-test status:
   - 412 + x0000
   - X = 0 — Test not completed
   - X = 1 — Test successful
   - X = 3 — Logic test failure
   - X = 4 — Memory test failure
   - X = 7 — Logic & memory test failure

15. **AGS** operations are not recommended.

16. **AGS** self-test status:
   - + 0000 displayed (within 5 to 30 sec)?

### REMARKS

- **Close MSFN monitoring of ASA heater status is required.**
SYMPTOM

DEDA response is abnormal

DEDA controls freeze, but can be returned to normal via CLR pb

SYMPTOM

DEDA failure may indicate one or more of the following:

a. DEDA power supply failure
b. CLR pb failed closed
c. ENTR pb failed closed
d. Numeric pb power failure
e. CLR pb power failure
f. AGS STATUS sw STANDBY position failed closed

PROCEDURE

Input negative data.

YES

NO

DEDA failed to respond to:

a. DEDA pb push
b. READOUT

NO

YES

DEDA failure may indicate one or more of the following:

a. DEDA pb push
b. READOUT

NO

YES

DEDA failure may indicate one or more of the following:

a. Digit pb push
b. DEDA failure

NO

YES

Digit pb push

Digit pb push

NO

YES

Digit pb push

Digit pb push

NO

YES

Digit pb push

Digit pb push

NO

YES

Digit pb push

Digit pb push

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YES

Digit pb push

Digital pb push

NO

YES


d. ENTR pb failed closed

Remarks

Operator error display is lost.

Operator error display is lost.

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Operator error display is lost.
**Symptom**

- AGS and/or FDI displays when AGS STATUS sw position is changed.

**Procedure**

1. AGS STATUS sw set from OFF to STAND BY, or OPERATE to STAND BY?
   - YES
   - NO

2. AGS STATUS sw - STAND BY CONTACTS FAILED OPEN.
   - YES
   - NO

3. Recycle AGS STATUS sw to attempt to close contacts.

**Remarks**

- One or more of the following aspects of the symptom were indicated:
  - AGS went to operate status immediately, i.e., AGS was accessible via DEOA with AGS STATUS sw - STAND BY
  - Flight displays (e.g., FDI) were driven by AGS.
  - AGS remained operating and accessible via DEOA.
  - Flight displays continued to be driven by AGS.

4. AGS initialization complete code is not displayed within 30 seconds after GSKY display flashes.

**Procedure**

1. Key DEOA READ OUT
   - YES
   - NO

2. DEOA failure or DEOA-AGS interconnection failure.

3. Hold job may have been pushed accidentally.

4. Stop pulse from PNCs not received on PNCs downlink register failure.

5. Perform AGS update manually.

**Remarks**

- System status: DEOA ENTR & READOUT capability is lost. AGS flight display information (FDI, lateral velocity, altitude, and altitude rate) are still available.

- MSPRN can verify abnormal PNCs downlink.

**Symptom**

- AGS initialization complete code is not displayed within 30 seconds after GSKY display flashes.

**Procedure**

1. Key DEOA READ OUT
   - YES
   - NO

2. Call AG again. Ref para 6.6.1.1.
   - YES
   - NO

3. Key DEOA C41R
   - YES
   - NO

4. 00000 displayed within 10 seconds after GSKY changes or blanks?
   - YES
   - NO

5. Transient malfunction. Such as ID word not found during first execution of R47.

**Remarks**

- AGS will operate properly after nominal 2-minute AGS warmup. If AGS powered-down configuration is required, AGS STATUS sw - OFF.
1. INTERMITTENT OUT-OF-TOLERANCE CONDITION IN NON-LATCHING CIRCUIT.

2. AEA HAS EXPERIENCED RESTART.

3. At restart, various parameters (depending upon operation performed at time of restart) must be verified or modified before AEA automatic functions can be considered reliable.

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### 5.2.5 CONTROL ELECTRONICS SECTION

Table 5-9. CES Procedure Entry Sheet

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal vehicle dynamics</td>
<td>1</td>
<td>5.2-44</td>
</tr>
<tr>
<td>PRE AMPS caut lt</td>
<td>2</td>
<td>5.2-46</td>
</tr>
<tr>
<td>CES AC warn lt</td>
<td>3</td>
<td>5.2-46</td>
</tr>
<tr>
<td>CES AC warn lt &amp; PRE AMPS caut lt</td>
<td>4</td>
<td>5.2-46</td>
</tr>
<tr>
<td>CES DC warn lt</td>
<td>5</td>
<td>5.2-47</td>
</tr>
<tr>
<td>MPS thrusts as soon as eng is armed via ENG THR CONT: ENG ARM sw</td>
<td>6</td>
<td>5.2-48</td>
</tr>
<tr>
<td>MPS does not thrust when EVNT TMR ind - 00:00</td>
<td>7</td>
<td>5.2-49</td>
</tr>
<tr>
<td>DPS does not respond to thrust increase or decrease command</td>
<td>8</td>
<td>5.2-50</td>
</tr>
<tr>
<td>ENG THRUST &amp; CMD THRUST ind do not agree during DPS burn</td>
<td>9</td>
<td>5.2-51</td>
</tr>
<tr>
<td>No auto MPS shutdown</td>
<td>10</td>
<td>5.2-52</td>
</tr>
<tr>
<td>Unsuccessful manual APS shutdown</td>
<td>11</td>
<td>5.2-52</td>
</tr>
<tr>
<td>Rate Gyro Check fails</td>
<td>12</td>
<td>5.2-53</td>
</tr>
<tr>
<td>LM drifts</td>
<td>13</td>
<td>5.2-54</td>
</tr>
<tr>
<td>Single RCS jet failed on</td>
<td>14</td>
<td>5.2-55</td>
</tr>
<tr>
<td>CDR (LMP) ACA jammed out of detent. Proportional signals always present</td>
<td>15</td>
<td>5.2-55</td>
</tr>
<tr>
<td>Abnormal response to CDR (LMP) ACA commands</td>
<td>16</td>
<td>5.2-56</td>
</tr>
<tr>
<td>Abnormal proportional mode response</td>
<td>16a</td>
<td>5.2-56</td>
</tr>
<tr>
<td>Abnormal response to CDR (LMP) ACA pulse mode commands</td>
<td>17</td>
<td>5.2-57</td>
</tr>
<tr>
<td>Abnormal response to CDR (LMP) ACA direct mode commands</td>
<td>18</td>
<td>5.2-58</td>
</tr>
<tr>
<td>Absence of normal translation via CDR (LMP) TTCA</td>
<td>19</td>
<td>5.2-59</td>
</tr>
</tbody>
</table>

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Change Date: ________________  
Page: 5.2-37
Table 5-10. CES Failure/Symptom Cross-Reference Index

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACA jammed</td>
<td>Abnormal vehicle dynamics</td>
<td>1</td>
<td>5.2-44</td>
</tr>
<tr>
<td>ACA out-of-detent sw (internal) failed closed</td>
<td>LM drifts</td>
<td>13</td>
<td>5.2-54</td>
</tr>
<tr>
<td>AEA did not issue eng-off command or remove eng-on command, or AELD failure</td>
<td>No auto MPS shutdown</td>
<td>10</td>
<td>5.2-52</td>
</tr>
<tr>
<td>AELD failure</td>
<td>No auto MPS shutdown</td>
<td>10</td>
<td>5.2-52</td>
</tr>
<tr>
<td>Affected axis rate gyro failed</td>
<td>Rate Gyro Check fails</td>
<td>12</td>
<td>5.2-53</td>
</tr>
<tr>
<td>Affected axis S/C: ROLL, PITCH, or YAW sw deck No. 1 failed in DIR, if neg rotation is lost; deck No. 4, if pos rotation is lost</td>
<td>Abnormal response to CDR (LMP) ACA pulse mode commands</td>
<td>17</td>
<td>5.2-57</td>
</tr>
<tr>
<td>Affected axis S/C: ROLL, PITCH, or YAW sw deck No. 2 failed in PULSE position</td>
<td>Abnormal response to CDR (LMP) ACA direct mode commands</td>
<td>18</td>
<td>5.2-58</td>
</tr>
<tr>
<td>Affected axis S/C: ROLL, PITCH, or YAW sw deck No. 2 failed open or in MODE CONT position</td>
<td>Abnormal response to CDR (LMP) ACA pulse mode commands</td>
<td>17</td>
<td>5.2-57</td>
</tr>
<tr>
<td>Affected axis S/C: ROLL, PITCH, or YAW sw deck No. 2 failed in DIR position</td>
<td>Abnormal response to CDR (LMP) ACA pulse mode commands</td>
<td>17</td>
<td>5.2-57</td>
</tr>
<tr>
<td>Affected axis S/C: ROLL, PITCH, or YAW sw deck No. 2 failed open or in MODE CONT position</td>
<td>Abnormal response to CDR (LMP) ACA direct mode commands</td>
<td>18</td>
<td>5.2-58</td>
</tr>
<tr>
<td>Affected axis S/C: ROLL, PITCH, or YAW sw deck No. 3 failed open or in MODE CONT or PULSE position</td>
<td>Abnormal response to CDR (LMP) ACA pulse mode commands</td>
<td>17</td>
<td>5.2-57</td>
</tr>
<tr>
<td>Affected axis S/C: ROLL, PITCH, or YAW sw deck No. 1 failed open or 28-volt line to TTCA failed</td>
<td>Abnormal response to CDR (LMP) ACA direct mode commands</td>
<td>18</td>
<td>5.2-58</td>
</tr>
<tr>
<td>Affected TTCA enable sw deck No. 1 failed open or 28-volt line to TTCA failed</td>
<td>Absence of normal translation via CDR (LMP) TTCA</td>
<td>19</td>
<td>5.2-59</td>
</tr>
<tr>
<td>AGS did not issue eng-on command or did not remove eng-off command, or relay K8 of S &amp; C control assy No. 2 failed open</td>
<td>MPS does not thrust when EVNT TMR ind - 00:00</td>
<td>7</td>
<td>5.2-59</td>
</tr>
<tr>
<td>ATCA failure</td>
<td>Abnormal vehicle dynamics</td>
<td>1</td>
<td>5.2-44</td>
</tr>
</tbody>
</table>

Basic Date: 3 February 1969
Change Date: 
Page: 5.2-38
<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto throttle circuit failure</td>
<td>DPS does not respond to thrust increase or decrease command</td>
<td>8</td>
<td>5.2-50.</td>
</tr>
<tr>
<td>( \beta_1 ) internal to AGS failed on or relay driver in AELD failed on</td>
<td>MPS thrusts as soon as eng is armed via ENG THR CONT; ENG ARM sw</td>
<td>6</td>
<td>5.2-48.</td>
</tr>
<tr>
<td>( \beta_2 ) internal to AGS failed on or relay driver in AELD failed on</td>
<td>MPS thrusts as soon as eng is armed via ENG THR CONT; ENG ARM sw</td>
<td>6</td>
<td>5.2-48.</td>
</tr>
<tr>
<td>( \beta_3 ) followup discrete to AGS failed on</td>
<td>No auto MPS shutdown</td>
<td>10</td>
<td>5.2-52.</td>
</tr>
<tr>
<td>CDR ACA hardover (single contact) sw failed closed</td>
<td>Single RCS jet failed on</td>
<td>14</td>
<td>5.2-55.</td>
</tr>
<tr>
<td>CDR (LMP) ACA 800-cps fuse blown or CDR (LMP) ACA PROP sw failed open</td>
<td>Abnormal response to CDR (LMP) ACA commands</td>
<td>16</td>
<td>5.2-56.</td>
</tr>
<tr>
<td>CDR (LMP) ACA jammed out of detent, Proportional signals always present</td>
<td>Abnormal proportional mode response</td>
<td>16a</td>
<td>5.2-56.</td>
</tr>
<tr>
<td>CDR (LMP) ACA out-of-detent sw (internal) failed open in affected axis</td>
<td>Abnormal response to CDR (LMP) ACA commands</td>
<td>16</td>
<td>5.2-56.</td>
</tr>
<tr>
<td>CDR (LMP) ACA single axis moveable xducer coil (internal) hung up in other than detent position</td>
<td>Abnormal proportional mode response</td>
<td>16a</td>
<td>5.2-56.</td>
</tr>
<tr>
<td>CDR (LMP) ACA 2.5° sw (internal) failed closed</td>
<td>Abnormal response to CDR (LMP) ACA commands</td>
<td>16</td>
<td>5.2-56.</td>
</tr>
<tr>
<td>CDR (LMP) ACA 2.5° sw (internal) failed open</td>
<td>Abnormal response to CDR (LMP) ACA direct mode commands</td>
<td>18</td>
<td>5.2-58.</td>
</tr>
<tr>
<td>CDR (LMP) ACA xducer sw (internal) or xducer coil (internal) failed open</td>
<td>Abnormal response to CDR (LMP) ACA pulse mode commands</td>
<td>17</td>
<td>5.2-57.</td>
</tr>
<tr>
<td>CDR (LMP) eng STOP sw failure</td>
<td>Abnormal response to CDR (LMP) ACA pulse mode commands</td>
<td>17</td>
<td>5.2-57.</td>
</tr>
<tr>
<td>CDR (LMP) TTCA failure or ENG THR CONT: MAIN THROT sw deck No. 1 or 2 failed to LMP (CDR), or (LMP) TTCA fuse blown</td>
<td>Unsuccessful manual APS shutdown</td>
<td>11</td>
<td>5.2-52.</td>
</tr>
<tr>
<td>CDR or LMP ACA hardover sw (single contact) failed closed</td>
<td>DPS does not respond to thrust increase or decrease command</td>
<td>8</td>
<td>5.2-50.</td>
</tr>
<tr>
<td>CDR or LMP ACA pulse/direct sw (internal) failed closed</td>
<td>Abnormal vehicle dynamics</td>
<td>1</td>
<td>5.2-44.</td>
</tr>
<tr>
<td>CES d-c power supply failure</td>
<td>CES DC warn lt</td>
<td>5</td>
<td>5.2-47.</td>
</tr>
<tr>
<td>Failure</td>
<td>Symptom</td>
<td></td>
<td></td>
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<tr>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMD THRUST ind failure or ENG THR CONT: THR CONT sw deck No. 3 failed to auto</td>
<td>ENG THRUST &amp; CMD THRUST ind do not agree during DPS burn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMD THRUST ind failure or ENG THR CONT: THR CONT sw deck No. 3 failed to manual</td>
<td>ENG THRUST &amp; CMD THRUST ind do not agree during DPS burn</td>
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<td></td>
</tr>
<tr>
<td>CWEA failure</td>
<td>CES AC warn lt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DPS eng pressure transducer failure</td>
<td>ENG THRUST &amp; CMD THRUST ind do not agree during DPS burn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DPS experienced excessive throat erosion</td>
<td>ENG THRUST &amp; CMD THRUST ind do not agree during DPS burn</td>
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<td></td>
</tr>
<tr>
<td>ENG ARM sw failure</td>
<td>MPS does not thrust when EVNT TMR ind - 00:00</td>
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<td></td>
</tr>
<tr>
<td>ENG START sw failure</td>
<td>MPS does not thrust when EVNT TMR ind - 00:00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENG THR CONT: MAIN THROT sw deck No. 2 failed open or manual throttle circuit failure</td>
<td>DPS does not respond to thrust increase or decrease command</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENG THRUST ind failure</td>
<td>ENG THRUST &amp; CMD THRUST ind do not agree during DPS burn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jet on-off command line is shorted</td>
<td>Abnormal vehicle dynamics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LGC did not issue eng-off command or remove eng-on command</td>
<td>No auto MPS shutdown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LGC did not issue eng-on command or did not remove eng-off command</td>
<td>MPS does not thrust when EVNT TMR ind - 00:00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LGC did not issue translation command</td>
<td>Absence of normal translation via CDR (LMP) TTCA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LMP ACA hardover (single contact) sw failed closed</td>
<td>Single RCS jet failed on</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No enable voltage to primary preamps. S/C: PGNS sw deck No. 2 failed open</td>
<td>Absence of normal translation via CDR (LMP) TTCA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out of-detent relay K7 failed closed</td>
<td>LM drifts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-of-detent relay K8 failed closed</td>
<td>LM drifts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre amp power supply failure</td>
<td>PRE AMPS caul it</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate gyro failed on or solenoid driver failed on</td>
<td>Abnormal vehicle dynamics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate needle failure</td>
<td>Rate Gyro Check fails</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RATE SCALE sw failed open</td>
<td>Rate Gyro Check fails</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCS oxid valve &amp; fuel valve failed open (double failure) or solenoid driver shorted to ground</td>
<td>Single RCS jet failed on</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 5-10. CES Failure/Symptom Cross-Reference Index (cont)

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay driver in AEID failed closed</td>
<td>MPS thrusts as soon as eng is armed via ENG THR CONT: ENG ARM sw</td>
<td>6</td>
<td>5.2-48</td>
</tr>
<tr>
<td>Relay K2, K3, or K4 in S &amp; C control assy No. 2 failed open</td>
<td>Abnormal response to CDR (LMP) ACA commands</td>
<td>16</td>
<td>5.2-56</td>
</tr>
<tr>
<td>Relay K2, K3, or K4 in S &amp; C control assy No. 2 failed open or ATT CONT sw deck 3 failed to pulse or direct</td>
<td>Abnormal proportional mode response</td>
<td>16a</td>
<td>5.2-56</td>
</tr>
<tr>
<td>Relay K3 in S &amp; C control assy No. 2 or PGNCS relay K8 failed open</td>
<td>Abnormal proportional mode response</td>
<td>16</td>
<td>5.2-56</td>
</tr>
<tr>
<td>Relay K4 in S &amp; C control assy No. 2 failed closed</td>
<td>Abnormal proportional mode response</td>
<td>16a</td>
<td>5.2-56</td>
</tr>
<tr>
<td>Relay K14 in S &amp; C control assy No. 2 failed closed</td>
<td>Unsuccessful manual APS shutdown</td>
<td>11</td>
<td>5.2-52</td>
</tr>
<tr>
<td>Relay K14, K16 or K19 II in S &amp; C control assy No. 2 failed closed</td>
<td>MPS thrusts as soon as eng is armed via ENG THR CONT: ENG ARM sw</td>
<td>6</td>
<td>5.2-48</td>
</tr>
<tr>
<td>Relay K14 or K19 II in S &amp; C control assy No. 2 failed closed</td>
<td>MPS thrusts as soon as eng is armed via ENG THR CONT: ENG ARM sw</td>
<td>6</td>
<td>5.2-48</td>
</tr>
<tr>
<td>Relay K19 II in S &amp; C control assy failed closed</td>
<td>MPS thrusts as soon as eng is armed via ENG THR CONT: ENG ARM sw</td>
<td>6</td>
<td>5.2-48</td>
</tr>
<tr>
<td>Relay K19 II or K16A in S &amp; C control assy No. 2 failed closed</td>
<td>LM drifts</td>
<td>13</td>
<td>5.2-54</td>
</tr>
<tr>
<td>Relay K19 (yaw), K20 (pitch) or K21 (roll) in ATCA filed open</td>
<td>LM drifts</td>
<td>13</td>
<td>5.2-54</td>
</tr>
<tr>
<td>S/C: AGS sw deck No. 2 failed open, No enable voltage to abort pre amps</td>
<td>LM drifts</td>
<td>13</td>
<td>5.2-54</td>
</tr>
<tr>
<td>S/C: AGS sw deck No. 3 failed open, No enable voltage to primary pre amps</td>
<td>Absence of normal translation via CDR (LMP) TTCA</td>
<td>19</td>
<td>5.2-59</td>
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<tr>
<td>S/C: AGS sw deck No. 3 failed open, No enable voltage to abort pre amps</td>
<td>Rate Gyro Check fails</td>
<td>12</td>
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</tr>
<tr>
<td>S/C: GYRO TEST ROLL sw failed into unaffected axis, or double gyro failure</td>
<td>Rate Gyro Check fails</td>
<td>12</td>
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<tr>
<td>S/C: GYRO REST POS RT sw failed into unaffected rate (pos or neg)</td>
<td>Rate Gyro Check fails</td>
<td>12</td>
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<tr>
<td>S/C: GYRO TEST ROLL sw failed open in affected axis</td>
<td>Rate Gyro Check fails</td>
<td>12</td>
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<tr>
<td>S/C: GYRO TEST ROLL sw or GYRO TEST POS RT sw failed open or less of test voltage</td>
<td>Rate Gyro Check fails</td>
<td>12</td>
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<tr>
<td>Failure</td>
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<tr>
<td>S/C: PGNS sw deck 2 or S/C: AGS sw deck 3 failed open</td>
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<td></td>
<td>Abnormal proportional mode response</td>
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<tr>
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<td>LM drifts</td>
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<tr>
<td>S/C: PGNS sw deck No. 5 failed open, No attitude hold inhibit supplied to LGC</td>
<td>Absence of normal translation via CDR (LMP) TTCA</td>
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<td>Solenoid driver failed off</td>
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<td>Throttle valve actuator failure or DPS failure</td>
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<td>Transient out-of-limit condition triggered it</td>
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<td>Voltage out of limits</td>
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<td>26 V, 800-cps, three-phase failure</td>
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<td>ACA pulse mode commands</td>
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<tr>
<td>28 V, 800-cps, single-phase failure</td>
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<td>+X TRANSL pb (single deck) failed closed</td>
<td>Single RCS jet failed on</td>
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<tr>
<td></td>
<td>ACA pulse mode commands</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Date: 3 February 1969

Change Date: __________

Page: 5.2-42
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### Symptom
- Abnormal vehicle dynamics

### Procedure

1. **Terminate burn if engine is firing**
   - RCS, SYS A (B) ASC FEED 1 & 2 SW CLOSE
   - Eng STOP pb/tb - push
   - ENG THR CONT ENG ARM SW OFF
   - ASC (ABORT STAGE) pb - reset
   - Key Owen, ICAE

2. **Ascent interconnect closed?**
   - RCS, SYS A (B) QUAD 1, 2, 3, 4 SW CLOSE
   - RCS, SYS A (B) MAIN SOV SW - OPEN

3. **Configure for troubleshooting**
   - RCS, ROLL, PITCH, & YAW SW PULSE
   - RCS CRSHD SW - CLOSE
   - RATE ERR MON SW - LOW VIB/NEUT
   - TCA VALVE SW (CMD & LMP) - DISABLE
   - GUID CONT SW - AGS
   - ACA PROP SW (CMD & LMP) - DISABLE

4. **Failing rate indicators excessive in any axis?**
   - RATE Gyro FAILED OR SOL ENCLOSE DRIVER FAILED ON

5. **Failure recurs?**
   - RCS, SYS A (B) QUAD 1, 2, 3, 4 SW - OPEN (individually)

6. **Failure recurs?**
   - CB S/C ATT DIR CONT - close

7. **Failure recurs?**
   - 0.5 ROLL, PITCH, & YAW SW - DIR (individually)

### Remarks
- RCS TCA valve failed open & numerous RCS, SYS A (B) QUAD 18s will show red until reset by closing RCS, SYS A (B) QUAD SW.

### Procedure

1. **Steps listed are suggested as order of priority. If situation is time-critical, sys may be reset as follows:**
   - SIC: AGS SW - OFF
   - SIC: PGNS SW - OFF
   - CB S/C ATT DIR CONT - open
   - RCS, SYS A & B MAIN SOV SW - CLOSE
   - Perform step 5
   - RCS: SYS A & B MAIN SOV SW - OPEN

2. **Alternate failure isolation procedure is to open CB S/C ATT DIR CONT. This results in loss of 0.5 X TRANS. pb & hardover & direct modes for all jets.**

3. **Noise & direct modes in affected axes are lost.**
### Symptom: Abnormal Vehicle Dynamics (cont)

#### Procedure:

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. ACA/JET sw (CDR &amp; LMP) - ENABLE (individual)</td>
<td>Failure recur?</td>
</tr>
<tr>
<td>19. COB OR LMP ACA HARDOVER SW (SINGLE CONTACT) FAILED CLOSED</td>
<td>Affected ACA/JET sw (CDR or LMP) - DISABLE</td>
</tr>
<tr>
<td>20. NO AC/AJAMS sw (CDR or LMP) - ATT HOLD</td>
<td>Failures recur?</td>
</tr>
<tr>
<td>21. ACA sw - ATT HOLD</td>
<td>ACA FAILURE</td>
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<tr>
<td>22. ATCA FAILURE</td>
<td>23. ACC/AGS sw - ATT HOLD</td>
</tr>
<tr>
<td>24. ACC/AGS sw - ATT HOLD</td>
<td>ACC/AGS sw - ATT HOLD</td>
</tr>
<tr>
<td>25. NO ACC/AGS sw - ATT HOLD</td>
<td>ACC/AGS sw - ATT HOLD</td>
</tr>
<tr>
<td>26. ACC/AGS sw - ATT HOLD</td>
<td>ACC/AGS sw - ATT HOLD</td>
</tr>
<tr>
<td>27. ACC/AGS sw - ATTC (individual)</td>
<td>ACC/AGS sw - ATTC (individual)</td>
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<tr>
<td>28. ACC/AGS sw - ATT HOLD</td>
<td>ACC/AGS sw - ATT HOLD</td>
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<tr>
<td>29. ACC/AGS sw - ATT HOLD</td>
<td>ACC/AGS sw - ATT HOLD</td>
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<tr>
<td>30. ACC/AGS sw - ATTC (individual)</td>
<td>ACC/AGS sw - ATTC (individual)</td>
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<tr>
<td>31. JET ON-OFF COMMAND LINE IS SHORTED</td>
<td>JET ON-OFF COMMAND LINE IS SHORTED</td>
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<tr>
<td>32. AFFECTED JET</td>
<td>AFFECTED JET</td>
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<tr>
<td>33. TGCA/TRANSL sw (CDR &amp; LMP) - ENABLE (individual)</td>
<td>Failure recur?</td>
</tr>
<tr>
<td>34. Affected TGCA/TRANSL sw (CDR or LMP) - DISABLE</td>
<td>Affected TGCA/TRANSL sw (CDR or LMP) - DISABLE</td>
</tr>
<tr>
<td>35. Consult MSPN for additional real-time troubleshooting.</td>
<td>Consult MSPN for additional real-time troubleshooting.</td>
</tr>
</tbody>
</table>

### Remarks:

- ACS automatic and attitude hold modes are lost.
- Attitude hold mode is lost.

**Control Electronics Section**

**Basic Date:** 3 February 1969

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**Page:** 5, 3-45
### Symptom: PRE AMPS

#### Procedure
- **WARNING**
  - If AGS is in control, a true CES AC failure causes loss of damping.

#### Procedure
1. **CES AC PRE AMPS**
   - **YELLOW**
   - Light on if 28 vac, single phase goes out of limits. Limit is 26 to 30 vac.

#### Symptom: PROCEDURE

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<thead>
<tr>
<th>Symptom</th>
<th>Procedure</th>
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</thead>
<tbody>
<tr>
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<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

#### Remarks
- This fault is inhibited after staging.
- It is impossible to determine whether one or both bias voltages are out of limit or whether CES AC failed. If both bias voltages are out of limit, noise in ATV may cause intermittent operation, single RCS jet firings. RCS jet firing via ATV will not be degraded otherwise.

#### Symptom: CONTROL ELECTRONICS SECTION

<table>
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</tr>
</thead>
<tbody>
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<td>WARNING</td>
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<td>NO</td>
</tr>
<tr>
<td>NO</td>
<td>YES</td>
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</tbody>
</table>

#### Remarks
- Proper response to proportional commands is now 30% rotation with damping.
- AGS can no longer maintain attitude or control "Cone" rotation. Manual throttle control of DPS is also lost in AGS.
- Gyro testing in AGS causes RCS jets to fire as long as S/C GYRO TEST POS RT switch is not set to OFF.
- General capability of monitoring CES AC is lost.
- AGS can no longer maintain attitude or control vehicle rotation. Manual throttle control of DPS is also lost in AGS.
- This fault is inhibited after staging.

---

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**Change Date:**

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Depending on which power supply failed or is degraded, one or more of the following symptoms may appear:

- Jets come on at full thrust rather than 50% duty cycle when maneuver is commanded.
- Deadband is inoperative.
- Jet select logic is non-operational.
- Pulse ratio modulators are not operational.
- If DPS goes to 100% thrust, thrusting capability of DPS is lost in either AGS or PGNCS.

If CES d-c failure may cause DPS to go to 100% thrust level if indicated then:

1. CeS d-c failure may cause d-c failure
2. Shut down MPS
3. Complete maneuver
4. Verify CES d-c failure
5. CES d-c power supply failure
6. CMR failure
7. CBEA failure
8. Voltage out of limits

Remarks

- Power supplies have an interlocking feature: if one supply output is shorted, other d-c supplies also fail. If short eliminates itself, all supplies return to normal operation. If one supply is degraded other supplies are not degraded.
- AGS control is lost.
- Onboard capability of controlling CES d-c is lost.
**SYMPTOM**

1. NPS threats as soon as eng is armed via ENG THR CONT. ENG ARM sw

**PROCEDURE**

1. **Continue burn?**
   - NO
   - YES

2. **Reject eng on enabling request**
   - FL V99 AXX
   - FL V99 AXX
   - FL V99 AXX

3. **Accept eng on enabling request**
   - FL V99 AXX
   - FL V99 AXX
   - FL V99 AXX

**REMARKS**

The possibility of this failure (undetectable via displays) implies a requirement not to arm NPS until voltage criteria is reached.

**SYMPTOM**

1. MPS section

**PROCEDURE**

1. **Monitor eng shut down criteria**

2. **Shut down eng**
   - ENG STOP pb/push

3. **Disarm eng**
   - ENG THR CONT ENG ARM sw-OFF
   - ENG THR CONT ENG ARM sw-OFF
   - ENG THR CONT ENG ARM sw-OFF

**REMARKS**

If the possibility of this failure (undetectable via displays) implies a requirement not to arm NPS until voltage criteria is reached.

**SYMPTOM**

1. MPS section

**PROCEDURE**

1. **Which NPS section?**
   - MPS
   - MPS
   - MPS

**REMARKS**

Step 5 & 12 are to be accomplished almost simultaneously. Crew can detect which action results in NPS shutdown.

**SYMPTOM**

1. S & C CONTROL ASSY NO. 2 FAILED CLOSED

**PROCEDURE**

1. **RELAY K16 OR K19 II IN S & C CONTROL ASSY NO. 2 FAILED CLOSED**

**REMARKS**

The crew can detect which action results in NPS shutdown.

---

*Note: The diagram and text are from the Apollo Operations Handbook, LMA790-3-LM 4, and are not transcribed. The image contains a handwritten note in the margin.*
**APOLLO OPERATIONS HANDBOOK**

**SYMPTOM**

MPD does not thrust after EVNT TRM rd - 0000

**PROCEDURE**

1. Attempt automatic start
   - Key DSKY-PRO
   - Eng start?
     - YES
     - NO
2. Attempt manual start
   - Key DSKY-PRO
   - Eng start?
     - YES
     - NO
3. Apply redundant arming signal
   - ABORT pb - push (DPS only)
   - ABORT STAGE pb - push (IPS)
4. ENG ARM SW FAILURE

**REMARKS**

Successful eng ignition is only way of isolating this failure. There are no other onboard capabilities for detecting this failure.

This procedure assumes PCNS is in control with appropriate program running, but manual start & throttle control are desired.

It is unrealistic to postulate an AGS automatic burn with manual start.

Automatic shutdown is expected. Regain manual throttle control within 20 seconds of eng ignition.

Change Date __________

Assumption: GUID CONT sw - PCNS. When AGS is in control, redundant arming signal is present.

**SYMPTOM**

CONTROL ELECTRONICS SECTION

**PROCEDURE**

**REMARKS**

Basic Date 3 February 1969

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Page 5.2–69
SYMPTOM

1. DPS does not respond to thrust (increase or decrease) command.

PROCEDURE

1. Select manual control.
   - Eng THRCNT: THR CONT sw - MAN
   - TTCA: adjust as required

   Eng responds?
   YES
   2. AUTO THROTTLE CIRCUIT FAILURE
   NO

   3. THROTTLE VALVE ACTUATOR FAILURE OR DPS FAILURE

   CMD THR and follow TTCA INCREASE?
   YES
   NO

   Select other TTCA
   - ENG THR CONT: MAN THROT sw - SE (C0RM)
   - LMP (C0RM) THROTTLE/JETS cont - THROTTLE
   - TTCA: INCREASE
   DPS responds?
   YES
   NO

   4. COR (LMP) TTCA FAILURE OR ENG THR CONT: MAN THROT SW DECK NO. 2 FAILED OPEN OR MANUAL THROTTLE CIRCUIT FAILURE

   5. Can burn be completed at 10% thrust?
   YES
   NO

   6. Switch to automatic throttle
   - GUID CONT sw - PGNs
   - S/C PGNs sw - AUTO
   - ENG THR CONT, THR CONT sw - AUTO

   7. Continue burn?
   YES
   NO

   8. Monitor displays for shutdown criteria

   9. Shut down eng
   - STOP thr - push
   - ALL THR CONT, THR CONT sw - OFF
   - ABORT pb - reset

REMARKS

1. In automatic control, symptom means eng did not follow time line.

2. Auto shutdown is still enabled.

3. Ability to throttle DPS is lost.

4. Assumption P40 is in progress.

5. Option exists at this time to shut down DPS & set up for automatic DPS burn. Throttle profile may prevent switching to automatic throttle while DPS burn is in progress due to nature of this failure.

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**SYMPTOM**

1. **ENG THRUST & CMD THRUST ind do not agree during DPS burn**

**PROCEDURE**

1. **ENG THRUST ind: THR CONT sw?**
   - YES
   - NO

2. **Indicated thrust follows TTCA?**
   - YES
   - NO

3. **CMD THRUST ind FAILURE or ENG THR CONT: THR CONT sw?**
   - NO
   - YES

4. **Auto**
   - NO
   - YES

5. **CMD THRUST ind follows time line?**
   - YES
   - NO

6. **ENG THRUST ind FAILURE**
   - CONTINUE mission using ENG THRUST ind to derive DPS eng performance data

7. **Check eng thrust with MSFN**
   - YES
   - NO

8. **MSFN confirms thrust normal?**
   - YES
   - NO

9. **MSFN confirms abnormality due to excessive ablation?**
   - YES
   - NO

10. **DPS ENG PRESSURE TRANSDUCER FAILURE**
    - CONTINUE mission using CMD THRUST ind to derive DPS eng performance data

11. **DPS EXPERIENCED EXCESSIVE THRUST EROSION**
    - DPS thrust erosion is expected to decrease CMD thrust m/s² below time line and ENG THRUST m/s² below time line. Thus a 4% difference could be nominal.

**REMARKS**

1. "NO" branch assumes ENG THRUST ind is following time line.

---

**SYMPTOM**

**PROCEDURE**

**REMARKS**

---

**Control Electronics Section**

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Page: s.2-51
**SYMPTOM**

1. No auto MPS shutdown

**PROCEDURE**

1. Shut down MPS manually
   - Eng STOP pb/lt - push
   - ENG THR CONT ENG ARM sw - OFF
   - ABORT pb - reset (DPS)
   - ABORT STAGE pb - reset (APS)

2. GUID CONT sw?
   - ACS

3. Check eng on/off orbits from LGC
   - Key SSKY - VOS NIDE, L1E
   - R1 - XXXX
   - A displays?
   - A = 0, 1, or 2

4. LGD DID NOT ISSUE ENG-OFF COMMAND OR REMOVE ENG-ON COMMAND

5. GUID CONT sw?
6. ABD STAGE pb - reset (APS)
7. ENG THR CONT ENG ARM sw - OFF

**REMARKS**

- AGS attitude hold cannot be used, because AGS is not outputting zero attitude error signals. AGS will not issue eng on or off commands.
- AGS attitude hold cannot be used, because AGS is not outputting zero attitude error signals. AGS will not issue eng on or off commands.

---

**SYMPTOM**

1. Unsuccessful manual APS shutdown

**PROCEDURE**

1. Attempt shutdown, using other eng STOP pb/lt
   - LMP(COR) Eng STOP pb/lt - push

2. COM ENG STOP SW FAILURE

3. Decr. eng
   - ENG THR CONT ENG ARM sw - OFF
   - ABORT STAGE pb - reset

4. RELAY K14 IN S & C CONTROL XDD NO 2 FAILED CLOSED

**REMARKS**

- Unsuccessful manual DPS shutdown was not considered, because it involves double failure.
- Use ENG THR CONT. ENG ARM sw as on-off control for subsequent APS burns.
SYMPTOM
Rate Gyro Check

PROCEDURE
1. Rate needles on both FOA's agree?
   - NO
   - YES

2. Any rate needle remain at 0°?
   - NO
   - YES

3. All rate needles deflect in one direction only?
   - NO
   - YES

4. All rate needles peg in both directions?
   - NO
   - YES

5. S/C Gyro Test POS RT SW FAILED INTO UNAFFECTED RATE (POS OR NEG)
   - YES
   - NO

6. How many rate needles remain at 0°?
   - ONE
   - TWO

7. S/C Gyro Test Roll SW FAIled OPEN or LOSS of TEST VOLTAGE?
   - YES
   - NO

8. Perform dynamic check:
   - GUID CONT sw - AGS
   - S/C AGS sw - ATT HOLD
   - S/C ROLL, PITCH, & YAW sw - MODE CONT
   - AOA - command rate is affected axis
   - Monitor vehicle for smooth rate with damping
   - Vehicle response normal?
   - YES
   - NO

9. Affected Axis Rate Gyro Failed
   - YES
   - NO

10. S/C Gyro Test Roll SW FAILED OPEN IN Affected Axis

REMARKS
Before entering procedure, test all three axes in both directions & note discrepancies, ref para 4.6.2.10

Dynamic check step B may be desired at this point

Assumption: RATE SCALE sw is set to 25°/SEC but switch failed open when test was run. Failure results in selection of 5°/SEC scale.
Symptom: LM drifts

LM drift is characterized by absence of RCS firing in one or more axes, increasing error of FOAi total attitude and/or error needles in one or more axes.

**Procedure:**

1. Control vehicle via hardwar (if necessary) to avoid gantry lock

2. Prepare for troubleshooting
   - GUID CONT sw - AGS
   - S/C AGS sw - ATT HOLD
   - S/C PGNS sw - ATT HOLD
   - S/C ROLL, PITCH, & YAW sw - MODE CONT
   - Select FOAi's on alternate sources

3. ACA - command single-axis proportional rate (all three axes + or -)
   - No
   - All axes respond vehicle motion?
     - Yes
     - One axis did not respond
   - Error needles on both FOAi's establish new reference when ACA returned to detent?
     - Yes
     - S/C AGS sw deck no. 2 failed open, no enable voltage to abort pre amps
   - No
     - S/C AGS sw deck no. 3 failed open, no enable voltage to primary pre amps

4. Establish attitude hold via DEDA
   - Key DEDA C 400 + 00000
   - S/C AGS sw - AUTO
   - To establish new reference and maneuver
   - S/C AGS sw - ATT HOLD
   - S/C ROLL, PITCH, & YAW sw - as desired
   - ACA - maneuver
   - When maneuver complete:
     - S/C AGS sw - AUTO
     - S/C ROLL, PITCH, & YAW sw - MODE CONT

5. Out of detent relay K failed closed
   - Yes
   - S/C PGNS sw deck no. 5 failed open, no attitude hold input supplied to LGC
   - No

6. **Remarks:**
   - AGS proportional mode, pulse mode, attitude hold, guidance steering & translation are lost.
   - AGS proportional mode, attitude hold, & guidance steering in affected axes are lost.
   - If both FOAi's establish new reference, PGNS attitude hold discrete in verified. PGNS proportional mode, attitude hold, guidance steering & translation are lost.
   - Use PGNS for computational purposes only.
   - Neither PGNS nor AGS can display attitude error.
   - If PGNS guidance is desired:
     - GUID CONT sw - PGNS
     - S/C PGNS sw - OFF (momentarily)
     - S/C PGNS sw - AUTO
     - Lock out exists override.
   - ACA - maneuver
   - When maneuver is complete:
     - S/C PGNS sw - ATT HOLD
     - ACA - maneuver
     - As rotation maneuvers are required:
     - S/C PGNS sw - ATT HOLD
   - SIC, PGNS sw is momentarily set to OFF to allow CDU's to be driven to existing vehicle orientation. If sw is not set to OFF, vehicle will be driven to attitude previously stored in CDU's.

7. AGS cannot display attitude errors.

---

**Symptom**

- 3 February 1969

**Change Date**

**Page** 5.2-54
### Symptom

1. Single RCS jet failed on  
   - Detected by:  
     - Increased RCS propellant consumption  
     - Continuous RCS jet firing  
   - Attitude error needle oscillating at high rates within deadband

### Procedure

#### Procedure 1

1. Attempt to stop jet firing  
   - CB/S/C ATT DIR CONT: open
   - Jet fires?
     - Yes
     - CB/S/C ATT DIR CONT: close

2. Regain control of vehicle  
   - CB/S/C PGNS (AGS) sw - ATT HOLD
   - CB/S/C ROLL, PITCH, & YAW sw - MOD CONT
   - ACA - null rates via proportional mode

3. Isolate failure  
   - ACA 4 JET sw (CDR) - DISABLE
   - ACA 4 JET sw (LMP) - DISABLE
   - CB/S/C ATT DIR CONT - close

4. Attempt to stop jet firing

#### Procedure 2

5. Isolate failed quad sys A  
   - RCS SYS A MAIN SOV sw - OPEN
   - RCS SYS A QUAD 1, 2, 3 & 4 sw - CLOSE until jet firing stops
   - Jet firing stops?
     - Yes
     - No

6. Isolate failed quad sys B  
   - RCS SYS B QUAD 1, 2, 3 & 4 sw - CLOSE until jet firing stops
   - RCS SYS B QUAD sw - OPEN (not associated with failures)
   - CB/S/C ATT DIR CONT - close

#### Procedure 3

7. Determine affected jets  
   - CB/S/C ATT DIR CONT: open
   - RCS SYS A QUAD 2 & 4 sw - CLOSE
   - RCS SYS B QUAD 1 & 3 sw - CLOSE
   - CB/S/C ATT DIR CONT - close
   - RCS SYS A QUAD 2 & 4 sw - OPEN
   - RCS SYS B QUAD 1 & 3 sw - OPEN
   - Affected quad RCS SYS A or B sw - CLOSE
   - Reclose affected S/C switches in desired mode

#### Procedure 4

8. Alternate failure isolation procedure is to open CB/S/C ATT DIR CONT. This results in loss of X TRANS PLB.  

#### Procedure 5

9. Set X TRANS PLB (SINGLE DECK) FAILED CLOSED

#### Procedure 6

10. Isolate failed quad sys B  
    - RCS NON VALVE & FUEL VALVE FAILED OPEN (DUAL FAILURE) OF SOLENOID DRIVER SHORTED TO GROUND

11. Isolate failed quad sys A  
    - RCS SYS A MAIN SOV sw - OPEN
    - RCS SYS A QUAD 1, 2, 3 & 4 sw - CLOSED until jet firing stops

#### Procedure 7

12. Determine if ACA jammed 2.5° or more out of detent  
    - ACA is jammed so it cannot be used in any axis

#### Procedure 8

13. Determine if ACA jammed 2.5° or more out of detent  
    - If ACA is jammed 2.5° or more out of detent, do not select S/C ROLL, PITCH, YAW sw - DIRECT or PULSE

### REMARKS

- **WARNING:**  
  A single RCS jet failed on when compensated for by opposing jets firing will consume 0.12% sec of total RCS propellant.

- **NOTE:**  
  S/C PGNS (AGS) sw associated with controlling guidance section is affected only.

- **REMARKS:**  
  - A single RCS jet failed on when compensated for by opposing jets firing will consume 0.12% sec of total RCS propellant.
### APOLLO OPERATIONS HANDBOOK

**SYMPTOM**

16 Abnormal response to CDR LMP ACA commands
16a Abnormal proportional mode response

**PROCEDURE**

1. Control rates, using handover, as required
2. Establish troubleshooting configuration
   - S/C PNS sw - ATT HOLD
   - S/C ACS sw - ATT HOLD
   - CDR PNS sw - ATT HOLD
   - CDR ACS sw - ATT HOLD
   - MODE CONT
3. CDR LMP ACA - Introduce single axis commands in at least three axes (+, -, 0)
   - Coupled motion resulted in any axis?
     - NO
     - YES
4. SOLENOID DRIVER FAILED OFF
   - Close affected thruster pair isolation valves
   - RCS SYS A or B QUAD sw - CLOSE FAULT ALRT
5. All axes responded properly?
   - NO
   - YES
   - Excessive rates resulted?
     - NO
     - YES
8. GUID CONT sw?
   - PNS?
   - AGS?
9. GUID CONT sw - PNS?
   - Successful?
   - ALL?
   - NO
   - YES
10. GUID CONT sw - AGS?
11. How many axes did not respond properly?
    - NO
    - YES
12. LM responds?
    - NO
    - YES
13. CDR LMP ACA OUT-OF-DETENT SW INTERNAL FAILED OPEN IN AFFECTED AX
14. CDR LMP ACA sw - INTERNAL FAILED OPEN IN AFFECTED AX
15. How many axes did not respond properly?
    - NO
    - YES
16. GUID CONT sw?
    - PNS?
    - AGS?
17. RELAY K2, K3, OR K4 IN S & C CONTROL ASSY NO. 2 FAILED OPEN
18. Change guidance control

**REMARKS**

Under PNSC control, LM will not rotate. Under ACS control, vehicle will rotate, but will be driven back to original altitude when ACA is released.

CDF LMP ACA proportional mode is lost in all axes (PNSC & ACS). PNSC minimum impulse mode is also lost.

CDF LMP ACA proportional mode is lost in affected axes (PNSC & ACS). PNSC minimum impulse mode is also lost in affected axis.

Proportional mode and manual throttle capability in controlling guidance section is lost.

Proportional mode in failed axis, in controlling guidance section, is lost.

**CONTROL ELECTRONICS SECTION**

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## APOLLO OPERATIONS HANDBOOK

### SYMPTOM

**17** Abnormal response to CDR (LM/AC) ACS pulse mode commands

### PROCEDURE

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1    | - CHECK CONT sw - AGS  
      - S/C ROLL, PITCH, & YAW sw - PULS  
      Jets fire immediately when pulse mode is selected?  
      YES  
      NO  
| 2    | - CDR (LM/AC) ACA 2.5° SW (INTERNAL) FAILED CLOSED  
| 3    | - CDR (LM/AC) ACA-rotate in + & - direction in all axes  
      Jets fire?  
      YES  
      NO  
| 4    | Coupled motion in any axis?  
      YES  
      NO  
| 5    | SOLENOID DRIVER FAILED OFF  
| 6    | Response test in both directions (+ & -)?  
      YES  
      NO  
| 7    | - AFFECTED AXES S/C ROLL, PITCH,  
      or YAW sw- DIR  
      - ACA - command ± or - rotation  
      Jets fire?  
      YES  
      NO  
| 8    | BALANCED COUPLE (SINGLE AXIS MOTION)?  
      YES  
      NO  
| 9    | AFFECTED AXES S/C ROLL, PITCH,  
      or YAW sw DECK NO. 2 FAILED IN SW POSITION  
| 10   | AFFECTED AXES S/C ROLL, PITCH,  
      or YAW sw DECK NO. 2 FAILED OPEN OR IN MODE CONT POSITION  
| 11   | AFFECTED AXES S/C ROLL, PITCH,  
      or YAW sw DECK NO. 2 FAILED OPEN OR IN MODE CONT POSITION  
| 12   | AFFECTED AXES S/C ROLL, PITCH,  
      or YAW sw DECK NO. 2 FAILED IN SW POSITION  
| 13   | AFFECTED AXES S/C ROLL, PITCH,  
      or YAW sw DECK NO. 2 FAILED IN SW POSITION  
| 14   | AFFECTED AXES S/C ROLL, PITCH,  
      or YAW sw DECK NO. 2 FAILED OPEN OR IN MODE CONT POSITION  
| 15   | AFFECTED AXES S/C ROLL, PITCH,  
      or YAW sw DECK NO. 2 FAILED IN SW POSITION  
| 16   | AFFECTED AXES S/C ROLL, PITCH,  
      or YAW sw DECK NO. 2 FAILED IN SW POSITION  

### REMARKS

1. Failures to be considered affect one axis only. Procedures apply to affected axis only and are applicable to any axis.
2. Pulse and direct mode control is lost in affected axis.

---

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<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Abnormal response to COR (LMP) ACA direct mode commands</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. DUR CONT on - AGS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. S/C ROLL, PITCH, &amp; YAW sw - DIR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jets fire immediately when DIR is selected? NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. DUR S/C ACA - rotate + &amp; - in all axes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One jet fires? NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Affected axis S/C ROLL, PITCH, or YAW sw - PULSE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACA - rotate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proper jets fire? YES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Affected axis S/C ROLL, PITCH, or YAW sw - PULSE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACA - rotate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Affected axis S/C ROLL, PITCH, or YAW sw - PULSE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACA - rotate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. Affected axis S/C ROLL, PITCH, or YAW sw - PULSE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACA - rotate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8. Affected axis S/C ROLL, PITCH, or YAW sw - PULSE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACA - rotate</td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**
1. Failures to be considered affect one axis only. Procedures apply to affected axis only and are applicable to any axis.
2. Do not set affected axis S/C ROLL, PITCH, or YAW sw in PULSE or DIR.
3. Direct mode control in affected axis is lost.
4. Pulse & direct mode control in lost in affected axis.
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#### SYMPTOM

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Procedure</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| Absence of normal translation via COR (LMP TCCA) | - Isolate driver<br>- Affected TTCA cannot command translation maneuver in PGNCS. | - Absence of normal translation will be indicated by:<br>  
  a. High oscillation rate or error in one RCS jet fires.<br>  
  b. Reading on RANGE RATE ind is constant.<br>  
  c. Lack of, or degraded acceleration.<br>  
  d. Reading on RCS A & B QUANTITY ind is constant.<br>  |
| Change guidance systems<br>- GUID CONT sw - AGS (PGNS)<br>- S/C: AGS sw - ATT HOLD<br>- Using alternative TTCA<br>- LMP (CLR): TTCA - translate if needed<br>- AGS (CDR): rotate as required to allow +X translation<br>- +X TRANSL pb - push & rel | - Complete maneuver<br>- Isolate failure<br>- Affected TTCA - translate +&- in all axes | |
| Any jets fire in any axes? | NO | |
| Balanced couples fired in all three axes? | YES | |
| Affected TTCA - translate +&- in all axes | YES | |
| How many directions do not respond? | ONE | |
| Single axis in single direction failure of COR (LMP TCCA) | YES | |
| TTCA ENABLE SW DECK NO. 3 FAILED OPEN | NO | |
| LGC DID NOT ISSUE TRANSLATION COMMAND | NO | |
| GUID CONT sw-PGNS | | |
| GUID CONT sw-AGS | | |

#### REMARKS

- AOS cannot cause RCS jets to fire for proportional & minimum impulse mode rotation, translation, attitude hold, and guidance steering.
- LGC DID NOT ISSUE TRANSLATION COMMAND.

#### BASIC DATA

- Basic Date: 3 February 1969
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#### CONTROL ELECTRONICS SECTION

- LGC DID NOT ISSUE TRANSLATION COMMAND.
- REQUIRED VOLTAGE TO PRIMARY PREAMPS. S/C: AGS SW DECK NO. 2 FAILED OPEN

#### PROCEDURE

- Isolate driver<br>- Affected TTCA cannot command translation maneuver in AGS.
5.2.6 DESCENT PROPULSION SECTION

5.2.6.1 General
- Double failures are not considered.
- During descent engine burns, continue the burn unless it becomes apparent that an explosion could occur.
- The DPS is loaded with helium and propellants according to prescribed values.
- The DPS has been checked before use.
- The status of all tb's has been checked and verified before entering the tb malfunction procedures.

5.2.6.2 Assumptions

5.2.6.2.1 Off-Nominal Helium Pressure, or Propellant Temperature or Pressure, Indication
- Large leaks are not considered.
- These are troubleshooting procedures intended to locate, identify, and isolate off-nominal conditions that do not trigger the CWEA or provide discrete malfunction indications.
- The crew does not enter into this symptom unless they have had an obvious off-nominal condition.
- Cold-soak is not a malfunction.

5.2.6.2.2 DES REG Warning Light
- The descent engine arming signal is present.

5.2.6.2.3 DES QTY Warning Light
- If the light goes on when the engine is firing, shut down the engine when propellant quantity remaining reaches 6%, to avoid possible engine explosion.

5.2.6.2.4 ENG GMBL Caution Light
- Excessive RCS propellants will be consumed if this light goes on while the descent engine is firing.

5.2.6.2.5 MPS: PRESS Indicator Power Fail Light On
- The status of the light is verified by cross-checking with APS propellant pressures.

5.2.6.2.6 Abnormal PQGS Indication
- Quantity indications are not reliable until after ullage settling.
### Table 5-11. DPS Procedure Entry Sheet

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
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</thead>
<tbody>
<tr>
<td>Off-nominal helium pressure or propellant temp or pressure indication</td>
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<td>5.2-66</td>
</tr>
<tr>
<td>DES REG warn lt</td>
<td>2</td>
<td>5.2-68</td>
</tr>
<tr>
<td>DES QTY warn lt</td>
<td>3</td>
<td>5.2-69</td>
</tr>
<tr>
<td>ENG GMBL caut lt</td>
<td>4</td>
<td>5.2-69</td>
</tr>
<tr>
<td>MPS: PRESS ind pwr fail lt on</td>
<td>5</td>
<td>5.2-69</td>
</tr>
<tr>
<td>DES He REG 1 (2) tb - bp</td>
<td>6</td>
<td>5.2-70</td>
</tr>
<tr>
<td>DES He REG 2 (1) tb - gray</td>
<td>7</td>
<td>5.2-70</td>
</tr>
<tr>
<td>Before venting: DES PROPUL: FUEL (OXID) VENT tb - gray</td>
<td>8</td>
<td>5.2-70</td>
</tr>
<tr>
<td>After venting: DES PROPUL: FUEL (OXID) VENT tb - bp</td>
<td>9</td>
<td>5.2-70</td>
</tr>
<tr>
<td>Abnormal PQGS indication</td>
<td>10</td>
<td>5.2-71</td>
</tr>
</tbody>
</table>

### Table 5-12. DPS Failure/Symptom Cross-Reference Index

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient helium leak upstream of quad check vlvz</td>
<td>Off-nominal helium pressure of propellant temp or pressure indication</td>
<td>1</td>
<td>5.2-66</td>
</tr>
<tr>
<td>Cold soak or slow leak. Verify with MSFN</td>
<td>Off-nominal helium pressure or propellant temp or pressure indication</td>
<td>1</td>
<td>5.2-66</td>
</tr>
<tr>
<td>C/W circuitry failure</td>
<td>DES QTY warn lt</td>
<td>3</td>
<td>5.2-69</td>
</tr>
<tr>
<td>C/W circuitry failure or liquid low-level sensor in propellant tank</td>
<td>DES QTY warn lt</td>
<td>3</td>
<td>5.2-69</td>
</tr>
<tr>
<td>CWEA failure</td>
<td>DES REG warn lt</td>
<td>2</td>
<td>5.2-68</td>
</tr>
<tr>
<td>ENG GMBL caut lt</td>
<td></td>
<td>4</td>
<td>5.2-69</td>
</tr>
<tr>
<td>Descent helium reg 1 failed closed</td>
<td>Descent helium reg 1 failed closed</td>
<td>2</td>
<td>5.2-68</td>
</tr>
<tr>
<td>Descent helium reg 1 failed open</td>
<td>Descent helium reg 1 failed open</td>
<td>2</td>
<td>5.2-68</td>
</tr>
<tr>
<td>Descent helium reg 1 failure</td>
<td>Descent helium reg 1 failure</td>
<td>2</td>
<td>5.2-68</td>
</tr>
<tr>
<td>Fuel (oxid) vent SOV failed closed</td>
<td>After venting: DES PROPUL: FUEL (OXID) VENT tb - bp</td>
<td>9</td>
<td>5.2-70</td>
</tr>
<tr>
<td>Fuel (oxid) vent SOV failed open</td>
<td>Before venting: DES PROPUL: FUEL (OXID) VENT tb - gray</td>
<td>8</td>
<td>5.2-70</td>
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</table>

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### Table 5-12. DPS Failure/Symptom Cross-Reference Index (cont)

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
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<tr>
<td>Fuel (oxid) vent SOV transient failure</td>
<td>Before venting: DES PROPUL: FUEL (OXID) VENT tb - gray</td>
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<td>5.2-70</td>
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<tr>
<td>GDA failure</td>
<td>ENG GMBL caut lt</td>
<td>4</td>
<td>5.2-69</td>
</tr>
<tr>
<td>Heat soak</td>
<td>Off-nominal helium pressure or propellant temp or pressure indication</td>
<td>1</td>
<td>5.2-66</td>
</tr>
<tr>
<td>Helium leak</td>
<td>DES REG warn lt</td>
<td>2</td>
<td>5.2-68</td>
</tr>
<tr>
<td>Helium leak downstream of quad check vlvs</td>
<td>Off-nominal helium pressure or propellant temp or pressure indication</td>
<td>1</td>
<td>5.2-66</td>
</tr>
<tr>
<td>Helium leak downstream of quad check valves in affected leg.</td>
<td>DES REG warn lt</td>
<td>2</td>
<td>5.2-68</td>
</tr>
<tr>
<td>Helium leak in ambient tank</td>
<td>Off-nominal helium pressure or propellant temp or pressure indication</td>
<td>1</td>
<td>5.2-66</td>
</tr>
<tr>
<td>Helium leak upstream of quad check valves in affected leg.</td>
<td>DES REG warn lt</td>
<td>2</td>
<td>5.2-68</td>
</tr>
<tr>
<td>Helium pressure xducer failure</td>
<td>Off-nominal helium pressure or propellant temp or pressure indication</td>
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<tr>
<td>Helium reg 1 (2) SOV failed closed</td>
<td>DES He REG 1 (2) tb - bp</td>
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<tr>
<td>Helium reg 1 (2) SOV inadvertently unlatched</td>
<td>DES He REG 1 (2) tb - bp</td>
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<tr>
<td>Helium reg 2 (1) SOV failed open</td>
<td>DES He REG 2 (1) tb - gray</td>
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<tr>
<td>Helium reg 2 (1) SOV inadvertently opened</td>
<td>DES He REG 2 (1) tb - gray</td>
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<td>Ind failure</td>
<td>Off-nominal helium pressure or propellant temp or pressure indication</td>
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<td>Instrumentation failure</td>
<td>DES REG warn lt</td>
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<td>5.2-68</td>
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<tr>
<td>MPS: FUEL &amp; OXID QUANTITY ind failure</td>
<td>Abnormal PQGS indication</td>
<td>10</td>
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<tr>
<td>MPS: PRESS ind pwr fail lt failed on</td>
<td>Abnormal PQGS indication</td>
<td>10</td>
<td>5.2-71</td>
</tr>
<tr>
<td>Possible propellant leak</td>
<td>Abnormal PQGS indication</td>
<td>10</td>
<td>5.2-71</td>
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<tr>
<td>Power to MPS: FUEL &amp; OXID PRESS ind is lost</td>
<td>Abnormal PQGS indication</td>
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<td>5.2-71</td>
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<tr>
<td>PQGS failure</td>
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<td>PQGS failure in propellant tanks No. 1 (2)</td>
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<td>PQGS power failure</td>
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<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
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<tbody>
<tr>
<td>Primary descent helium reg failed high or low</td>
<td>Off-nominal helium pressure or propellant temp or pressure indication</td>
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<td>Primary descent helium reg is leaking or regulating high</td>
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<tr>
<td>Primary descent helium reg regulating low</td>
<td>Off-nominal helium pressure or propellant temp or pressure indication</td>
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<tr>
<td>Probable heat or cold soak</td>
<td>Off-nominal helium pressure or propellant temp or pressure indication</td>
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<td>5.2-66</td>
</tr>
<tr>
<td>Probable xducer failure. Verify with MSFN</td>
<td>Off-nominal helium pressure or propellant temp or pressure indication</td>
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<tr>
<td>Propellant leak in off-nominal propellant section</td>
<td>DES REG warn lt</td>
<td>2</td>
<td>5.2-68</td>
</tr>
<tr>
<td>Propellant leak or degraded eng performance</td>
<td>DES QTY warn lt</td>
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<tr>
<td>Propellant leak, verify interface pressure with MSFN</td>
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<td>Quantity-sensing probe failure</td>
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<td>Tb or instrumentation failure &amp; inadvertently stuck valve</td>
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<tr>
<td>Tb or instrumentation failure</td>
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<td>Transient drive signal</td>
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<tr>
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<td>1</td>
<td>5.2-66</td>
</tr>
</tbody>
</table>
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SYMPTOM

Shee t I o l 2 I

O ff -nominal helium

Select alternati v e so ur ce pres s ur e or propellant
temp or pressure .-----------,

ASSOCIATED RESPONSE

Cycle HELIUM MON se l or
PRPLNT TEMP / PRESS MON sw

ASSOCIATED FAILURE?

NO

MSFN ver ifies pressure reading
anomal y with interface pres s ure
reading?

NO

XDU CER FAILURE

MSFN mu st moni t or affected
helium pressures or prop e llant
temp or pressure

YE S

Propellant tank pressures normal?

NO

Switch to secondary reg

YE S

NO

YES Off -nomi nal in high direction?

YES

YES

PROCEDURE

DESCENT PROPULSION SECTION

11

Primary DES He REG I sw · CLOSE

• DES He REG I sw · OPEN

• DES He REG 2 sw · OPEN

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REMARKS

Possibility exists that, upon initial
power-up, completely depleted am-

bient helium tank will have ef-

cfect of open xducer. This cannot be de-

cermined onboard without MSFN

assistance

MSFN has alternative pressure

Telemetry point.

REMARKS

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<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
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<tbody>
<tr>
<td>Off-nominal helium pressure or propellant temp. or pressure indication</td>
<td>Off-nominal helium pressure or propellant temp. or pressure indication</td>
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<td>DPS pressurized?</td>
<td>Propellant pressure?</td>
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<td>NO</td>
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<td>HIGH</td>
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<td>Do not fire ambient helium isolation valve</td>
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</tr>
<tr>
<td>WARNING</td>
<td>WARNING</td>
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</tr>
<tr>
<td>DES REG warn it - as when ambient helium pressure decays to &lt;=220 psia.</td>
<td>DES REG warn it - as when ambient helium pressure decays to &lt;=220 psia.</td>
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<tr>
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</tbody>
</table>

**APOLLO OPERATIONS HANDBOOK**

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**SYMPTOM**

1. DES REG

**PROCEDURE**

1. **CAUTION**
   - Expedite closing of reg vlv.

2. **WARNING**
   - If ambient pressure continues to decay after opening re-pressurant helium thru and must be shut down immediately.

3. If DES He REG sw - OPEN
   -Helium pressure downstream of regulator may indicate regulator failed open. Expenditure closing of regulator valve to prevent freeze up due to abnormally high helium flow and low helium temperature.

4. Depending on ullage volume, pressure may slowly return to normal.

5. Setting ENG ARM sw to OFF removes arming signal to throttle actuator, causing throttle to move to fully open position. To avoid possible transient thrust surge, pause 3 seconds after pushing Eng STOP pb. This ensures that all engine valves have time to close.

6. Burst disk will probably rupture & leak ullage pressure to <225 psia, at which point DES REG warn it will go off.

**REMARKS**

- Note fuel & oxid quantities for immediate use.
- Setting ENG ARM sw to OFF removes arming signal to throttle actuator, causing throttle to move to fully open position. To avoid possible transient thrust surge, pause 3 seconds after pushing Eng STOP pb. This ensures that all engine valves have time to close.
- Burst disk will probably rupture & leak ullage pressure to <225 psia, at which point DES REG warn it will go off.
# SYMPTOM

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<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESC QTY RED</td>
<td>(1) Monitor propellant quantity deficits</td>
<td>DESC QTY warn if burn time remaining to propellant depletion &gt; 2 minutes or &gt;20% thrust level.</td>
</tr>
<tr>
<td>C/W CIRCUITY FAILURE</td>
<td>(2) Shut down eng at &lt;0.5% propellant remaining.</td>
<td></td>
</tr>
<tr>
<td>ENG GMBL</td>
<td>(3) ENG GMBL II-off; delay is 3 seconds for sw action.</td>
<td></td>
</tr>
<tr>
<td>MPS PRESS ind pressur fall it on RED</td>
<td>(5) Determine status of MPS: FUEL &amp; GRID PRESS ind by checking ascent fuel &amp; exust pressures.</td>
<td></td>
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## PROCEDURE

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<thead>
<tr>
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<tr>
<td>Pointers of MPS: FUEL &amp; GRID PRESS ind - both move?</td>
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<tr>
<td><strong>POWER TO MPS: FUEL &amp; GRID PRESS ind IS LOST</strong></td>
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<td>(6)</td>
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</table>

**REMARCH**

1. **DES QTY warn if burn time remaining to propellant depletion > 2 minutes or >20% thrust level.**
2. **C/W CIRCUITY FAILURE**
3. **ENG GMBL**
4. **ENG GMBL II-off; delay is 3 seconds for sw action.**
5. **MPS PRESS ind pressur fall it on RED**

**SYMPTOM**

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**REMARCH**

1. **DES QTY warn if burn time remaining to propellant depletion > 2 minutes or >20% thrust level.**
2. **C/W CIRCUITY FAILURE**
3. **ENG GMBL**
4. **ENG GMBL II-off; delay is 3 seconds for sw action.**
5. **MPS PRESS ind pressur fall it on RED**

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<td>(6)</td>
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**REMARCH**

1. **DES QTY warn if burn time remaining to propellant depletion > 2 minutes or >20% thrust level.**
2. **C/W CIRCUITY FAILURE**
3. **ENG GMBL**
4. **ENG GMBL II-off; delay is 3 seconds for sw action.**
5. **MPS PRESS ind pressur fall it on RED**

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<td>DESC QTY warn if burn time remaining to propellant depletion &gt; 2 minutes or &gt;20% thrust level.</td>
</tr>
<tr>
<td>C/W CIRCUITY FAILURE</td>
<td>(2) Shut down eng at &lt;0.5% propellant remaining.</td>
<td></td>
</tr>
<tr>
<td>ENG GMBL</td>
<td>(3) ENG GMBL II-off; delay is 3 seconds for sw action.</td>
<td></td>
</tr>
<tr>
<td>MPS PRESS ind pressur fall it on RED</td>
<td>(5) Determine status of MPS: FUEL &amp; GRID PRESS ind by checking ascent fuel &amp; exust pressures.</td>
<td></td>
</tr>
</tbody>
</table>

## PROCEDURE

### DESCENT PROPULSION SECTION

**Basic Date**: 3 February 1969

**Change Date**

**Page**: 5, 2-69

<table>
<thead>
<tr>
<th>MPS PRESS ind pressur fall it on RED</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine status of MPS: FUEL &amp; GRID PRESS ind by checking ascent fuel &amp; exust pressures.</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
</tr>
<tr>
<td>Pointers of MPS: FUEL &amp; GRID PRESS ind - both move?</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
</tr>
<tr>
<td><strong>POWER TO MPS: FUEL &amp; GRID PRESS ind IS LOST</strong></td>
<td>(5)</td>
<td>(6)</td>
</tr>
</tbody>
</table>

**REMARCH**

1. **DES QTY warn if burn time remaining to propellant depletion > 2 minutes or >20% thrust level.**
2. **C/W CIRCUITY FAILURE**
3. **ENG GMBL**
4. **ENG GMBL II-off; delay is 3 seconds for sw action.**
5. **MPS PRESS ind pressur fall it on RED**

**SYMPTOM**

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESC QTY RED</td>
<td>(1) Monitor propellant quantity deficits</td>
<td>DESC QTY warn if burn time remaining to propellant depletion &gt; 2 minutes or &gt;20% thrust level.</td>
</tr>
<tr>
<td>C/W CIRCUITY FAILURE</td>
<td>(2) Shut down eng at &lt;0.5% propellant remaining.</td>
<td></td>
</tr>
<tr>
<td>ENG GMBL</td>
<td>(3) ENG GMBL II-off; delay is 3 seconds for sw action.</td>
<td></td>
</tr>
<tr>
<td>MPS PRESS ind pressur fall it on RED</td>
<td>(5) Determine status of MPS: FUEL &amp; GRID PRESS ind by checking ascent fuel &amp; exust pressures.</td>
<td></td>
</tr>
</tbody>
</table>
**SYMPTOM**

1. DES He REG 1 (2) lb-gray

### PROCEDURE

1. Cycle primary (secondary) SOV
   - DES He REG 1 (2) sw-CLOSE, then OPEN
   - TB remains bp?

   **YES**

2. DES He REG 1 (2) SOV FAILED CLOSED

   **YES**

3. TB OR INSTRUMENTATION FAILURE

   **NO**

4. DES He REG 2 (2) sw-CLOSE

   **NO**

5. HELIUM REG 2 (3) SOV FAILED OPEN

6. FUEL (OXIO) VENT SOV FAILED OPEN

### REMARKS

1. DEScent helium reg 'SOV's are normally set as follows:
   - DES He REG 1 sw-OPEN, tb-gray
   - DES He REG 2 sw-CLOSE, tb-bp

   It is preferable to verify SOV positions with MSFN before cycling.

2. HELIUM REG 1 (2) SOV FAILED OPEN

3. FUEL (OXIO) VENT SOV FAILED OPEN

---

### SYMPTOM

2. DES He REG 2 (2) lb-gray

### PROCEDURE

1. Determine status of secondary (primary) SOV
   - DES He REG 2 (2) sw-CLOSE
   - TB remains gray?

   **YES**

2. TB OR INSTRUMENTATION FAILURE & INADVERTENTLY STUCK

### REMARKS

1. DEScent helium reg 'SOV's are normally set as follows:
   - DES He REG 1 sw-OPEN, tb-gray
   - DES He REG 2 sw-CLOSE, tb-bp

### SYMPTOM

3. Before venting: DES PROPUL: FUEL (OXIO) VENT lb-gray

### PROCEDURE

1. Close fuel (oxid) vent SOV
   - DES PROPUL: FUEL (OXIO) VENT sw-CLOSE
   - TB remains gray?

   **YES**

2. MSFN verifies associated SOV open?

   **NO**

3. FUEL (OXIO) VENT SOV FAILED OPEN

### REMARKS

1. If this failure occurs before venting, associated explosive valves isolate fuel or oxid.

---

### SYMPTOM

4. After venting: DES PROPUL: FUEL (OXIO) VENT lb-bp

### PROCEDURE

1. PREPARE TEMP/PRESS MON & DES 1
   - MPS: FUEL (OXIO) PRESS in-decreasing?

   **NO**

2. FUEL (OXIO) VENT SOV FAILED CLOSED

### REMARKS

1. PREPARE TEMP/PRESS MON & DES 1

---

**Basic Date:** 3 February 1969

**Page:** 5.2-70
**SYMPTOM** | **PROCEDURE** | **REMARKS**
---|---|---
1. **Descent eng firing?**  | 2. **Select alternative source by switching to other QUANTITY ind.**  
- **MPS: FUEL & OXID QUANTITY ind. normal?**
- **Consult MSFN**  | **NOTE:** Descent propulsion section.

3. **Both ind changing & diverging?**  | 4. **Possible propellant leak.**
| 5. **Shut down descent eng.**
- **Eng. STOP pb/lt. push**
- **ONE THR CONT. ENG. ARM sw - OFF**
- **ABORT pb - reset**  | **WARNING:** Descent eng must be shut down as soon as possible to prevent possible eng explosion.

6. **MPS: FUEL & OXID QUANTITY ind. blank?**  | 7. **MSN receiving PGGS telemetry?**
| 8. **MPS: FUEL & OXID QUANTITY ind. failure.**
- **PGGS failure**
- **Propellant quantity is available from MSFN.**
- **One propellant tank can still be monitored onboard.**

---

**SYMPTOM** | **PROCEDURE** | **REMARKS**
---|---|---
**Removal PGGS indication.**  |  | **NOTE:** Descent propulsion section.

**Descent PROPULSION SECTION.**

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**Page:** 5.2-71/5.2-72
5.2.7 ASCENT PROPULSION SECTION

5.2.7.1 General

- Double failures are not considered, except that in the ASC HI REG caut lt malfunction procedure a double failure (series-parallel regulators) causes the ASC HI REG caut lt to go on.
- During ascent engine burns, continue the burn unless it becomes apparent that an explosion could occur.
- The APS is loaded with helium and propellants according to prescribed values.
- The APS has been checked before use.
- The status of all tb's has been checked and verified before entering the tb malfunction procedures.

5.2.7.2 Assumptions

5.2.7.2.1 Off-Nominal Helium, or Propellant Temperature or Pressure, Indication

- Large leaks are not considered.
- These are troubleshooting procedures that cover off-nominal and anomalous conditions that do not trigger the CWEA or provide discrete malfunction indications.
- The crew does not enter into this symptom unless they have had an obvious off-nominal condition.
- Cold-soak is not a malfunction.

5.2.7.2.2 ASC PRESS Warning Light

- If this light goes on during a burn, immediately shut down the engine.

5.2.7.2.3 ASC QTY Caution Light

- A malfunction does not exist if this light goes on at the nominal time.
- If a propellant leak occurs while the ascent engine is firing, complete the maneuver with RCS propellants.

5.2.7.2.4 MPS: PRESS Indicator Power Fail Light On

- The status of the light is verified by cross-checking with the DPS propellant pressures.
Table 5-13. APS Procedure Entry Sheet

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-nominal helium or propellant temp or pressure indication</td>
<td>1</td>
<td>5,2-77</td>
</tr>
<tr>
<td>ASC PRESS warn lt</td>
<td>2</td>
<td>5,2-78</td>
</tr>
<tr>
<td>ASC HI REG caut lt</td>
<td>3</td>
<td>5,2-79</td>
</tr>
<tr>
<td>ASC QTY caut lt</td>
<td>4</td>
<td>5,2-80</td>
</tr>
<tr>
<td>MPS: PRESS ind pwr fail lt on</td>
<td>5</td>
<td>5,2-81</td>
</tr>
<tr>
<td>ASC He REG 1 (2) tb - bp</td>
<td>6</td>
<td>5,2-81</td>
</tr>
</tbody>
</table>

Table 5-14. APS Failure/Symptom Cross-Reference Index

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascent He reg failed open in leg determined by MSFN</td>
<td>ASC HI REG caut lt</td>
<td>3</td>
<td>5,2-79</td>
</tr>
<tr>
<td>Ascent He reg 1 (2) failed open</td>
<td>ASC HI REG caut lt</td>
<td>3</td>
<td>5,2-79</td>
</tr>
<tr>
<td>Cold soak</td>
<td>ASC PRESS warn lt</td>
<td>2</td>
<td>5,2-78</td>
</tr>
<tr>
<td>CWEA failure</td>
<td>ASC PRESS warn lt</td>
<td>2</td>
<td>5,2-78</td>
</tr>
<tr>
<td>CWEA or instrumentation failure</td>
<td>ASC HI REG caut lt</td>
<td>3</td>
<td>5,2-79</td>
</tr>
<tr>
<td>Fuel or oxid leak</td>
<td>ASC QTY caut lt</td>
<td>4</td>
<td>5,2-80</td>
</tr>
<tr>
<td>Heat or cold soak</td>
<td>Off-nominal helium or propellant temp or pressure indication</td>
<td>1</td>
<td>5,2-77</td>
</tr>
<tr>
<td>Helium leak between reg 1 or 2 SOV &amp; quad check valves</td>
<td>ASC PRESS warn lt</td>
<td>2</td>
<td>5,2-78</td>
</tr>
<tr>
<td>Helium leak downstream of compatibility explosive valves</td>
<td>ASC PRESS warn lt</td>
<td>2</td>
<td>5,2-78</td>
</tr>
<tr>
<td>Helium leak downstream of quad check valves in affected line</td>
<td>ASC PRESS warn lt</td>
<td>2</td>
<td>5,2-78</td>
</tr>
<tr>
<td>Helium leak upstream of reg 1 or 2 SOV</td>
<td>ASC PRESS warn lt</td>
<td>2</td>
<td>5,2-78</td>
</tr>
<tr>
<td>Helium pressure xducer failure</td>
<td>ASC PRESS warn lt</td>
<td>2</td>
<td>5,2-78</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helium reg 1 (2) SOV failed closed</td>
<td>ASC He REG 1 (2) tb - bp</td>
<td>6</td>
<td>5.2-81</td>
</tr>
<tr>
<td>Helium reg 1 (2) SOV inadvertently unlatched</td>
<td>ASC He REG 1 (2) tb - bp</td>
<td>6</td>
<td>5.2-81</td>
</tr>
<tr>
<td>Helium tank leak</td>
<td>Off-nominal helium or propellant temp or pressure indication</td>
<td>1</td>
<td>5.2-77</td>
</tr>
<tr>
<td>Inadvertently unlatched</td>
<td>ASC PRESS warn lt</td>
<td>2</td>
<td>5.2-78</td>
</tr>
<tr>
<td>Ind failure</td>
<td>Off-nominal helium or propellant temp or pressure indication</td>
<td>1</td>
<td>5.2-77</td>
</tr>
<tr>
<td>Instrumentation failure</td>
<td>ASC QTY caut lt</td>
<td>4</td>
<td>5.2-80</td>
</tr>
<tr>
<td>Loss of power to MPS: FUEL &amp; OXID PRESS ind</td>
<td>MPS: PRESS ind pwr fail lt on</td>
<td>5</td>
<td>5.2-81</td>
</tr>
<tr>
<td>MPS: PRESS ind pwr fail lt failed on</td>
<td>MPS: PRESS ind pwr fail lt on</td>
<td>5</td>
<td>5.2-81</td>
</tr>
<tr>
<td>Probable heat or cold soak. Confirm with MSFN</td>
<td>Off-nominal helium or propellant temp or pressure indication</td>
<td>1</td>
<td>5.2-77</td>
</tr>
<tr>
<td>Propellant leak</td>
<td>ASC PRESS warn lt</td>
<td>2</td>
<td>5.2-78</td>
</tr>
<tr>
<td>Propellant leak downstream of compatibility explosive vlvs</td>
<td>Off-nominal helium or propellant temp or pressure indication</td>
<td>1</td>
<td>5.2-77</td>
</tr>
<tr>
<td>Tb failure, or instrumentation failure and inadvertent stuck valve</td>
<td>ASC He REG 1 (2) tb - bp</td>
<td>6</td>
<td>5.2-81</td>
</tr>
<tr>
<td>Xducer failure</td>
<td>Off-nominal helium or propellant temp or pressure indication</td>
<td>1</td>
<td>5.2-77</td>
</tr>
<tr>
<td>Xducer failure in affected sys</td>
<td>Off-nominal helium or propellant temp or pressure indication</td>
<td>1</td>
<td>5.2-77</td>
</tr>
</tbody>
</table>
**SYMPTOM**

- Non-nominal helium or propellant temperature or pressure indication

**PROCEDURE**

1. **SYMPTOM:** Non-nominal helium or propellant temperature or pressure indication
   - **PROCEDURE:** Select alternative source.
   - **If:** NO
     - **PROCEDURE:** Yes
     - **PROCEDURE:** No reading remains same for all other sw positions?
     - **PROCEDURE:** YES
     - **PROCEDURE:** NO
     - **PROCEDURE:** Verify condition with MSFN, troubleshoot after burn.
   - **PROCEDURE:** NO
     - **PROCEDURE:** During MPS burn?
     - **PROCEDURE:** YES
     - **PROCEDURE:** NO
     - **PROCEDURE:** Off-nominal indication in helium or propellant sys?
     - **PROCEDURE:** YES
     - **PROCEDURE:** NO
     - **PROCEDURE:** Propellant pressure decreasing?
     - **PROCEDURE:** YES
     - **PROCEDURE:** NO
     - **PROCEDURE:** Other propellant pressure (temperature) off-nominal in same direction?
     - **PROCEDURE:** YES
     - **PROCEDURE:** NO
     - **PROCEDURE:** Instrumentation failure
     - **PROCEDURE:** YES
     - **PROCEDURE:** NO
     - **PROCEDURE:** Propane heat or cold soak, confirm with MSFN
   - **PROCEDURE:** NO
     - **PROCEDURE:** Alternative helium source pressure (temperature) indication off-nominal?
     - **PROCEDURE:** YES
     - **PROCEDURE:** NO
     - **PROCEDURE:** Instrumentation failure
     - **PROCEDURE:** YES
     - **PROCEDURE:** NO
     - **PROCEDURE:** Propane heat or cold soak, confirm with MSFN
   - **PROCEDURE:** NO
     - **PROCEDURE:** Helium pressure decreasing?
     - **PROCEDURE:** YES
     - **PROCEDURE:** NO
     - **PROCEDURE:** Other helium pressure (temperature) indication off-normal?
     - **PROCEDURE:** YES
     - **PROCEDURE:** NO
     - **PROCEDURE:** Instrumentation failure
     - **PROCEDURE:** YES
     - **PROCEDURE:** NO
     - **PROCEDURE:** Propane heat or cold soak, confirm with MSFN
   - **PROCEDURE:** NO
     - **PROCEDURE:** Helium pressure decreasing?
     - **PROCEDURE:** YES
     - **PROCEDURE:** NO
     - **PROCEDURE:** Helium tank leak
   - **PROCEDURE:** YES
     - **PROCEDURE:** Instrumentation failure
   - **PROCEDURE:** YES
     - **PROCEDURE:** Propane heat or cold soak, confirm with MSFN
   - **PROCEDURE:** NO
     - **PROCEDURE:** Helium tank leak
   - **PROCEDURE:** YES
     - **PROCEDURE:** Instrumentation failure
   - **PROCEDURE:** YES
     - **PROCEDURE:** Propane heat or cold soak, confirm with MSFN
   - **PROCEDURE:** NO
     - **PROCEDURE:** Helium tank leak
   - **PROCEDURE:** YES
     - **PROCEDURE:** Instrumentation failure
   - **PROCEDURE:** YES
     - **PROCEDURE:** Propane heat or cold soak, confirm with MSFN
   - **PROCEDURE:** NO
     - **PROCEDURE:** Helium tank leak
   - **PROCEDURE:** YES
     - **PROCEDURE:** Instrumentation failure
   - **PROCEDURE:** YES
     - **PROCEDURE:** Propane heat or cold soak, confirm with MSFN
   - **PROCEDURE:** NO
     - **PROCEDURE:** Helium tank leak
   - **PROCEDURE:** YES
     - **PROCEDURE:** Instrumentation failure
   - **PROCEDURE:** YES
     - **PROCEDURE:** Propane heat or cold soak, confirm with MSFN
   - **PROCEDURE:** NO
     - **PROCEDURE:** Helium tank leak
   - **PROCEDURE:** YES
     - **PROCEDURE:** Instrumentation failure
   - **PROCEDURE:** YES
     - **PROCEDURE:** Propane heat or cold soak, confirm with MSFN
   - **PROCEDURE:** NO
     - **PROCEDURE:** Helium tank leak
   - **PROCEDURE:** YES
     - **PROCEDURE:** Instrumentation failure
   - **PROCEDURE:** YES
     - **PROCEDURE:** Propane heat or cold soak, confirm with MSFN
   - **PROCEDURE:** NO
     - **PROCEDURE:** Helium tank leak
   - **PROCEDURE:** YES
     - **PROCEDURE:** Instrumentation failure
   - **PROCEDURE:** YES
     - **PROCEDURE:** Propane heat or cold soak, confirm with MSFN

**REMARKS**

- If descent source is selected after staging, indicator will ping low.
- Ensure failure in affected sys.
- Open transducer results in low indication; shorted transducer, in high indication.

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- Page: 5.2-77

**ASCENT PROPULSION SECTION**

Basic Date: 3 February 1969
### Symptom: ASC PRESS

#### Procedure:

1. **WARNING**
   - Eng must be shut down immediately to prevent possible explosion.

2. **PROCEDURE**
   - Eng STOP pb/it-renew
   - ENG Tur CONT/ENG ARM sw-OFF
   - ABOERT STAGE pb-reset
   - LM staged?

3. **PROCEDURE**
   - ASC He REG 1 & 2 sw-CLOSE
   - MFSN TEMP/PRESS MON sw-ASC
   - MPS: FUEL or OXID PRESS ind-decreasing?

4. **PROCEDURE**
   - MFSN verifies helium manifold pressure low?
   - NO

5. **PROCEDURE**
   - HELIUM LEAK DOWNSTREAM OF QUAD CHECK VALVES IN AFFECTED LINE
     - YES

6. **PROCEDURE**
   - HELIUM LEAK BETWEEN REG 1 OR 2 SOV & QUAD CHECK VALVES
     - NO

7. **PROCEDURE**
   - CWA FAILURE

8. **PROCEDURE**
   - HELENIUM MON sel-PRESS 1, PRESS 2
   - MPS: HELIUM ind-monitor
   - Either helium tank pressure < 2775 psia?

9. **PROCEDURE**
   - PROPELLANT LEAK

10. **PROCEDURE**
    - CWA FAILURE

11. **PROCEDURE**
    - Inhibit faulty system.
    - ASC He REG 1 & 2 sw-CLOSE
    - MPS: HELIUM ind-monitor
    - HELIUM MON sel-TEMP 1 & TEMP 2

12. **PROCEDURE**
    - Monitor temp of helium in affected tank
    - NO

13. **PROCEDURE**
    - Monitor fuel & oxid tank inlet pressure
    - MPS: FUEL & OXID PRESS ind-decreasing?

14. **PROCEDURE**
    - HELIUM LEAK UPSTREAM OF REG 1 OR 2 SOV

15. **PROCEDURE**
    - CAUTION
    - Depression of ascent helium tanks is imminent

16. **PROCEDURE**
    - HELIUM LEAK DOWNSTREAM OF QUAD CHECK VALVES IN AFFECTED LINE

17. **PROCEDURE**
    - HELIUM LEAK BETWEEN REG 1 OR 2 SOV & QUAD CHECK VALVES

18. **PROCEDURE**
    - CWA FAILURE

19. **PROCEDURE**
    - HELIUM LEAK DOWNSTREAM OF QUAD CHECK VALVES IN AFFECTED LINE

#### Remarks:

- ASC PRESS warn is inhibited by stage deadface switch.
- ASC PRESS warn is not indicative of low propellant pressure.
- Propellant tank stage pressure can be read on MPS.
- MPS: FUEL & OXID PRESS ind.

---

**LMA790-3-LM 4 APOLLO OPERATIONS HANDBOOK**

**Symptom**

**Procedure**

**Remarks**

---

**Basic Date:** 3 February 1969

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**Page:** 5.2-79
**SYMPTOM**

ASC H REG

YELLOW

Light on if helium manifold pressure > 220 psia

---

**SYMPTOM**

If eng is firing, continue firing.

---

**PROCEDURE**

2

ASC He REG 1 & 2 sw - CLOSE

- PRPL NT TEMP/ PRESS MON sw - ASC
- MPS, FUEL & OXID PRESS amd - monitor

Eng firing?

Y

- 3

ASC He REG 1 & 2 sw - OPEN

Maintain fuel & oxid tank inlet pressure until completion of firing

When fuel & oxid pressure < 220 psia or ASC H REG can't go off
- ASC He REG 1 sw - OPEN
- ASC He REG 1 sw - CLOSE

ASC He REG 2 sw - OPEN

4

ASC He REG can't go off?

Y

- 5

CMSA or INSTRUMENTATION FAILURE

N

- 6

ASC He Reg 1 (D) FAILED OPEN

Do not reopen failed helium reg SOV

---

**REMARKS**

- If propellant tank pressure drops below 120 psia, ASC PRESS warn it goes off.
- Possibility exists of approaching maximum design operating pressure if leg with failed-open reg is pressurized and propellant tanks are locked up at greater than normal operating pressure.
- ASC He REG can’t indicate high helium manifold pressure. However, MSFN can monitor redundant helium manifold pressure to provide real-time data on helium manifold status.
- Post will continue to burn in blowdown mode.
- Helium reg redundancy is lost.
### Apollo Operations Handbook

**Symptom**: ASC QTY

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td><strong>Caution</strong>&lt;br&gt;Loss of ASC QTY cautions to close ascent feed interconnect valves during APS firing.</td>
</tr>
<tr>
<td><strong>WARNING</strong>&lt;br&gt; Fuel &amp; oxid ascent feed interconnect valves must be closed before determining of flooding occurrence to prevent feed ingress into RCS thrusters.</td>
<td></td>
</tr>
</tbody>
</table>

#### Procedure

1. **Check CVL** for CVL to go on if CVL is required.
2. **Monitor** TEMP/PRESS MON sw --ASC.
3. **Monitor** fuel & oxid pressure with MSPN.
4. **Compare** status of fuel & oxid pressure with MSPN.
5. Loss of ASC QTY cautions to close ascent feed interconnect valves during subsequent APS firing.

#### Caution

- **Loss of ASC QTY caution**: When ASC ENG is not firing.

#### Basic Date

- **3 February 1969**

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- **_______**

#### Page

- **5.2-80**
## Symptom

**MPS, PRESS ind PIN 1, red**

- Light on if 28-vdc power to MPS, FUEL, & OXID PRESS ind is lost.

## Procedure

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1    | Determine status of MPS, FUEL, & OXID PRESS ind by checking descent fuel & oxid pressure. **DES** 1.  
If both pointers on MPS, FUEL & OXID PRESS ind - zero or normal? **YES**.  
- MPS PRESS IND PIN FAIL LT FAILED ON.  
- LOSS OF POWER TO MPS, FUEL & OXID PRESS IND.  
**NO**.  
- **DES** 2.  
- HELIUM REG 1 (O2) SOV FAILED CLOSED.  
| 2    | **HELIO REG 1 (O2) SOV INADVERTENTLY UNLATCHED**.  
| 3    | **HELIO REG 1 (O2) SOV FAILED CLOSED**.  
| 4    | TB FAILURE OR INSTRUMENTATION FAILURE AND INADVERTENT STUCK VALVE.  
| 5    | MSFN verifies associated SOV open? **YES**.  
| 6    | **HELIO REG 1 (O2) SOV FAILED CLOSED**.  
| 7    | TB remains bp? **YES**.  
| 8    | **HELIO REG 1 (O2) SOV FAILED CLOSED**.  

## Remarks

1. **DES** 1 position of PRPLNT TEMP/PRESS MON sw is used to provide different signal input to determine status of ind. Provided ind has not failed, it will read descent propellant pressures if unstaged, zero if staged. If ind has failed, pointers will remain in position indicated when power was lost.

2. Ind is operable. There will be no indication if 28 vdc to ind is lost.

3. MSFN will have to monitor propellant pressures.

4. APS helium reg 1 & 2 SOV's are normally open at all times.

5. Helium reg redundancy is lost.

### Ascent Propulsion Section

**Basic Date**: 3 February 1969

**Change Date**: 

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5.2.8 REACTION CONTROL SUBSYSTEM

5.2.8.1 General

- The integrity of the RCS is verified before entering the off-nominal condition indicated in the "symptom" column of each RCS malfunction procedure.

5.2.8.2 Assumptions

5.2.8.2.1 RCS Caution Light

- An RCS propellant leak can cause the RCS caution light to go on, but this will only happen if a leak occurs when the propellant quantity is very low or if the propellant tanks rupture. (The probability of the propellant tanks rupturing is very remote.)

5.2.8.2.2 RCS TCA Warning Light

- A translation maneuver must be completed before any action is taken regarding the RCS TCA warning light, except if two or more red tube's appear for the same RCS system (A or B). Appearance of the red tube's would indicate that the main SOV's or ascent feed valves are unlatched or failed closed.

- Crossfeed valves are not open.

- Ascent feed valves are not open, except during +X-translation.

5.2.8.2.3 Talkback Anomaly

- The status of all tube's is checked and verified before entering the tube anomaly malfunction procedure.

5.2.8.2.4 PQMD Off Nominal

- Temp compensation of the PQMD pressure xducer has considerable time lag. During periods of high propellant use, the PQMD may indicate 5% to 10% low for several minutes.

- The PQMD malfunction procedure is primarily for detection of leaks and xducer failures. It is not applicable to off-nominal performance of the thrusters or digital autopilot.

5.2.8.2.5 Off-Nominal RCS Propellant or Helium Indication

- A helium reg failure is not considered in this malfunction procedure because the RCS: A & B PRESS ind are not sensitive enough to reflect regulated helium pressure changes less than 20 psia. However, the RCS A & B REG warn it alerts the crew to high and low regulated helium pressure.

Table 5-15. RCS Procedure Entry Sheet

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCS caut lt</td>
<td>1</td>
<td>5.2-87</td>
</tr>
<tr>
<td>RCS A REG warn lt &amp; RCS B REG warn lt</td>
<td>2</td>
<td>5.2-88</td>
</tr>
<tr>
<td>RCS TCA warn lt</td>
<td>3</td>
<td>5.2-89</td>
</tr>
<tr>
<td>RCS isolation vlvs, main SOV, crossfeed vlvs, ascent feed vlvs tube anomaly</td>
<td>4</td>
<td>5.2-89</td>
</tr>
<tr>
<td>PQMD off-nominal</td>
<td>5</td>
<td>5.2-90</td>
</tr>
</tbody>
</table>

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### Table 5-15. RCS Procedure Entry Sheet (cont)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-nominal RCS propellant or helium indication</td>
<td>6</td>
<td>5.2-91</td>
</tr>
<tr>
<td>RCS: PRESS ind pwr fail lt on</td>
<td>7</td>
<td>5.2-91</td>
</tr>
<tr>
<td>RCS: QUANTITY ind pwr fail lt on</td>
<td>8</td>
<td>5.2-91</td>
</tr>
</tbody>
</table>

### Table 5-16. RCS Failure/Symptom Cross-Reference Index

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C/W circuit failure</td>
<td>RCS TCA warn lt</td>
<td>3</td>
<td>5.2-89</td>
</tr>
<tr>
<td>CWEA failure</td>
<td>RCS A REG warn lt &amp; RCS B REG warn lt</td>
<td>2</td>
<td>5.2-88</td>
</tr>
<tr>
<td>Fuel or oxid isolation vlvs unlatched</td>
<td>RCS TCA warn lt</td>
<td>3</td>
<td>5.2-89</td>
</tr>
<tr>
<td>Helium leak</td>
<td>RCS caut lt</td>
<td>1</td>
<td>5.2-87</td>
</tr>
<tr>
<td>Helium p/t sensor failure</td>
<td>PQMD off-nominal</td>
<td>5</td>
<td>5.2-90</td>
</tr>
<tr>
<td>Instrumentation failure</td>
<td>RCS caut lt</td>
<td>1</td>
<td>5.2-87</td>
</tr>
<tr>
<td>Jet failed off</td>
<td>RCS TCA warn lt</td>
<td>3</td>
<td>5.2-89</td>
</tr>
<tr>
<td>Jet failed on</td>
<td>RCS TCA warn lt</td>
<td>3</td>
<td>5.2-89</td>
</tr>
<tr>
<td>Leak in lines downstream of thruster pair isolation vlvs or failed-open TCA vlvs</td>
<td>PQMD off-nominal</td>
<td>5</td>
<td>5.2-90</td>
</tr>
<tr>
<td>Measurement indicating abnormality has instrumentation failure</td>
<td>Off-nominal RCS propellant or helium indication</td>
<td>6</td>
<td>5.2-91</td>
</tr>
<tr>
<td>Power to RCS: A &amp; B PRESS ind is lost</td>
<td>RCS: PRESS ind pwr fail lt on</td>
<td>7</td>
<td>5.2-91</td>
</tr>
<tr>
<td>Power to RCS: A &amp; B QUANTITY ind is lost</td>
<td>RCS: QUANTITY ind pwr fail lt on</td>
<td>8</td>
<td>5.2-91</td>
</tr>
<tr>
<td>PQMD failed in affected sys</td>
<td>PQMD off-nominal</td>
<td>5</td>
<td>5.2-90</td>
</tr>
<tr>
<td>Propellant leak upstream of main SOV vlvs or helium tank leak</td>
<td>PQMD off-nominal</td>
<td>5</td>
<td>5.2-90</td>
</tr>
<tr>
<td>Propellant manifold leak in affected sys</td>
<td>PQMD off-nominal</td>
<td>5</td>
<td>5.2-90</td>
</tr>
<tr>
<td>RCS: A &amp; B QUANTITY ind pwr fail lt failed on</td>
<td>RCS: QUANTITY ind pwr fail lt on</td>
<td>8</td>
<td>5.2-91</td>
</tr>
</tbody>
</table>

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Page: 5.2-84
<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCS sys A (B) reg failed closed</td>
<td>RCS A REG warn It &amp; RCS B REG warn lt</td>
<td>2</td>
<td>5.2-88</td>
</tr>
<tr>
<td>RCS sys A (B) reg failed high (dual reg in one sys)</td>
<td>RCS A REG warn lt &amp; RCS B REG warn lt</td>
<td>2</td>
<td>5.2-88</td>
</tr>
<tr>
<td>RCS: A (B) TEMP or PRESS ind failure or RCS: TEMP/PRESS MON sel failure</td>
<td>Off-nominal RCS propellant or helium indication</td>
<td>6</td>
<td>5.2-91</td>
</tr>
<tr>
<td>RCS: PRESS ind pwr fail lt failed on</td>
<td>RCS: PRESS ind pwr fail lt on</td>
<td>7</td>
<td>5.2-91</td>
</tr>
<tr>
<td>Reg outlet pressure xdcer or instrumentation failure</td>
<td>RCS A REG warn lt &amp; RCS B REG warn lt</td>
<td>2</td>
<td>5.2-88</td>
</tr>
<tr>
<td>Sys A (B) fuel or oxid main SOV or sys A (B) ASC feed fuel or oxid vlv hard fall close</td>
<td>RCS TCA warn lt</td>
<td>3</td>
<td>5.2-89</td>
</tr>
<tr>
<td>Sys A (B) fuel or oxid main SOV or sys A (B) ASC feed fuel or oxid vlv unlatched</td>
<td>RCS TCA warn lt</td>
<td>3</td>
<td>5.2-89</td>
</tr>
<tr>
<td>Tb failure</td>
<td>RCS isolation vlv, main SOV, cross-feed vlv, ascent feed vlv tb anomaly</td>
<td>4</td>
<td>5.2-89</td>
</tr>
<tr>
<td>Vlv unlatched</td>
<td>RCS isolation vlv, main SOV, cross-feed vlv, ascent feed vlv tb anomaly</td>
<td>4</td>
<td>5.2-89</td>
</tr>
</tbody>
</table>
### SYMPTOM

**RCS**

**YELLOW**

Light on if helium tank pressure (sys A or B) ≤ 1,700 psia

### PROCEDURE

1. **RCS**
   - Monitor helium tank pressure for affected sys
   - RCS A or B PRESS ind < 1,700 psia
     - NO
     - YES

2. **YELLOW**
   - **SIMPLISMA FAILURE**

3. **RCS**
   - Quantity abnormally low?
     - NO
     - YES

4. **HELIUM LEAK**
   - Helium explosive line blown?
     - YES
     - NO

5. **HELIX LEAK**
   - Do not pressure test unless leakage rate is low enough to permit use of affected sys A or B

6. **YELLOW**
   - **FAILURE**

### REMARKS

- If RCS TEMP/PRESS MON cur is set to the RCS cursor if goes off
- RCS cannot be reset, helium tank pressure should be monitored frequently on RCS A or B PRESS ind
- For subsequent burns:
  - a. Propellant quantity remaining in sys A & B, as indicated on QUANT TEMP ind should be approximately the same for both sys.
  - b. RCS TEMP/PRESS MON not. He
  - c. Sys A & B helium pressures, as indicated on PRESS ind, should be approximately same for both sys.
- Sys redundancy is lost when pressure of affected helium tank drops to between 400 and 500 psia.

---

**APOLLO OPERATIONS HANDBOOK**

**PROCEDURE**

**REACTOR CONTROL SUBSYSTEM**

**INSTRUMENTATION FAILURE**

**SHUT DOWN FAILED SYS WHEN PRESSURE DROPS TO 500 PSI OR PROPELLANT PRESSURE DROPS TO 140 PSI**

- **HELIUM LEAK**
  - Helium explosive line blown?
    - YES
    - NO

- **HELIUM LEAK**
  - Do not pressure test unless leakage rate is low enough to permit use of affected sys A or B

- **FAILURE**

---

**SYMPTOM**

**PROCEDURE**

**REMARKS**

**A-305044-052**

**REMARKS**

**Page 5. 2-87**
**SYMPTOM**

- RCS A REG RED
- RCS B REG RED

Light on if helium regulated pressure of sys A or B is high (>205 psia) or low (<165 psia). Light inhibited when main SOV is closed.

**PROCEDURE**

1. Check helium main pressure of affected sys:
   - RCS: TEMP/PRESS MON PLANT
     - RCS A or B PRESS reed >205 psia:
   - RCS SYS A (B) REG FAILED HIGH (PLANT, REG IN ONE SYS)

2. Check fuel manifold pressure of affected sys:
   - RCS: TEMP/PRESS MON PLANT
     - RCS A or B PRESS reed >160 psia:
   - RCS SYS A (B) REG FAILED HIGH (PLANT, REG IN ONE SYS)

3. Monitor RCS reg pressure; there is no warning of reg malfunction. Light remains on.

4. Some propellant in sys A (B) will not be usable.
   - Helium venting may occur. RCS card it goes on if helium tank pressure drops below 1,700 psia.
   - Rely on affected system A (B) fuel or oxidizer manifold pressure to estimate system A (B) helium regulator pressure. RCS A-REG (B-REG) warn it remains on. Manifold pressure is approximately 3 psi lower than helium regulator pressure.

5. A helium manifold pressure <140 psi may cause TCA failure.
   - Sys redundancy is lost. All propellant remaining in sys A (B) is not usable.

**REMARKS**

- Normal regulator pressure is 178 to 283 psi. Burst disks rupture at 220 psi relief valves crack at 232 psi.
- When manifold pressure <140 psi, unload SYS A (B) or SYS B (A) propellant to feed all 16 thrusters.
- RCS: CRSPL sw - OPEN
## Reaction Control Subsystem

### Symptom: RCS TCA Red

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reset C/W cb</td>
<td></td>
</tr>
<tr>
<td>2. RCS TCA warn II-on?</td>
<td></td>
</tr>
<tr>
<td>3. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>4. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>5. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>6. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>7. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>8. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>9. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>10. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>11. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>12. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>13. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>14. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>15. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
<tr>
<td>16. RCS A/B fuel or oxid main SOV or sys A/B ASC feed fuel or oxid VLV unlatched</td>
<td></td>
</tr>
</tbody>
</table>

### Symptom: RCS Isolation valve fuel or oxid main SOV crossed with VLV unlatched

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Isolation VLV to not?</td>
<td></td>
</tr>
<tr>
<td>2. TB failure</td>
<td></td>
</tr>
</tbody>
</table>

### Symptom: Under two-jet translation condition, failure-detection logic may oppose commanded translation. Monitor ASC readout on SRSKY or DEDA. Terminate translation if this occurs.

### Remark: This failure is only applicable if main SOV is closed.

### Remark: If isolation VLV (fuel or oxid) fails closed, indication could be same. Throttle pair would still be inoperative.

### Remark: Only RCS TCA failure indication will be that of remaining RCS throttle pairs.

### Remark: Unlatching could occur due to vibration or contamination.

---

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### LMA790-3-LM 4
### APOLLO OPERATIONS HANDBOOK

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
</table>
| 5       | Check helium tank pressure of sys showing low quantity | 1. For subsequent burns, monitor RCS, PRESS & QUANTITY ind & determine quantity of propellant remaining in affected sys as follows:  
- Compare helium tank pressure readings for both sys. Readings should be approximately equal.  
- Note quantity of propellant remaining in good sys. Reading represents quantity of propellant remaining in affected sys. |
| Off-nominal POMO | RCS TEMP PRESS MON sel-He  
- RCS A or B PRESS ind-monitor  
- Helium tank pressure | 2. If QUANTITY ind failed internally, MSFN can give indication of quality remaining for affected system. If POMO failed, MSFN will not be able to provide indication of quantity. |

#### SYMPTOM

**POMO off-nominal**

**Check helium tank pressure of sys showing low quantity**

- RCS TEMP PRESS MON sel-He
- RCS A or B PRESS ind-monitor
- Helium tank pressure

#### PROCEDURE

1. **Check POMO in affected sys**
2. **Check with MSFN whether ind or ejector failed**

#### REMARKS

1. **NORMAL**
2. **LOW**

**WARNING**

If during burn, RCS A (or B) POMO approaches 19%, close isolation vlv & main SOV in affected sys to prevent possibility of injection.

---

**Close RCS QUAD switches of affected sys individually & monitor pressures.**

- CB RCS SYS A or B QUAD 4, 3, 2, 1 TCA-open
- RCS SYS A or B QUAD 1, 2, 3, 4 sw-CLOSE; tb-top
- RCS SYS A or B MAIN SOV sw-CLOSE; tb-top
- RCS A or B PRESS ind-note helium tank pressure for subsequent use in diagnostic procedure
- RCS TEMP PRESS MON sel-FUEL MANF
- RCS A or B PRESS ind-monitor pressure of manifold associated with low propellant quantity

**Propellant manifold pressure?**

- ≤ 120 PSIA

3. **Propellant manifold leak in affected sys**

4. **Reconfigure affected system**

---

**RCS CRSFD sw must remain in CLOSE position to avoid loss of propellant from good system.**

- RCS SYS A or B QUAD sw (associated with leak, last one opened)-CLOSE
- RCS SYS A or B QUAD sw (remaining switches in failed sys)-OPEN
- CB RCS SYS A or B QUAD 1, 2, 3, or 4 TCA (all cb’s except cb for failed quad TCA)-CLOSE

5. **Helium P/T sensor failure**

---

**T-300LM4**

**REMARKS**

1. Use this propellant as last alternative.

2. PGNCS capability to translate in +Z, -Z, or -Y directions is lost if RCS system A is isolated via QUAD switches.

3. PGNCS capability to translate in +Z, -Z, or +Y directions is lost if RCS system B is isolated via QUAD switches.

4. Vapor pressure of fuel and oxidizer is a function of their temperature. If fuel manifold pressure reading is < 5 psia and/or oxidizer manifold pressure reading < 30 psia, vapor pressure is displayed.

5. With MSFN coordination, it may be possible to use any amount of RCS residual in leaking sys.
## Symptom: RCS propellant or helium indication

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. RCS TEMP/PRESS MON sel - cycle. Pointers move? NO</td>
<td>Propellant temp is indicated only in PRPLNT position, and pointer pegs to lowest position.</td>
</tr>
<tr>
<td>2. Cross-check RCS SYS A/B helium PRESS &amp; QUANTITY ind. One sys low or decreasing? NO</td>
<td>Use indication in other sys as indication of failed measurement.</td>
</tr>
<tr>
<td>3. Go to abnormal propellant quantity measuring device troubleshooting procedures</td>
<td></td>
</tr>
</tbody>
</table>

---

## Symptom: RCS PRESS ind fail if on

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. RCS TEMP/PRESS MON sel - cycle through all positions. Both pointers move? YES</td>
<td></td>
</tr>
<tr>
<td>2. RCS PRESS IND PWR FAIL LT FAILED ON</td>
<td></td>
</tr>
<tr>
<td>3. POWER TO RCS A &amp; B PRESS IND IS LOST</td>
<td></td>
</tr>
</tbody>
</table>

---

## Symptom: RCS QUANTITY ind fail if on

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CB RCS SYS B POSITIVE - opened? NO</td>
<td>Propellant temp is indicated only in PRPLNT position, and pointer pegs to lowest position.</td>
</tr>
<tr>
<td>2. Attempt to close CB RCS SYS B POSITIVE NO</td>
<td></td>
</tr>
<tr>
<td>3. CB remain closed? NO</td>
<td></td>
</tr>
<tr>
<td>4. POWER TO RCS A &amp; B QUANTITY IND IS LOST</td>
<td></td>
</tr>
<tr>
<td>5. RCS A &amp; B QUANTITY IND PWR FAIL LT FAILED ON</td>
<td></td>
</tr>
</tbody>
</table>

---

**Remarks:**

1. Propellant temp is indicated only in PRPLNT position, and pointer pegs to lowest position.
2. Use indication in other sys as indication of failed measurement.

---

**Procedure:**

**Reaction Control Subsystem**

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**REM 300LM4-LM4**
5.2.9 ELECTRICAL POWER SUBSYSTEM

5.2.9.1 Assumptions

- Troubleshooting will be performed when mission phase and task loading permit. Accordingly, certain malfunction procedures will not be performed until a main engine burn or critical maneuver is completed.
- Malfunction procedures are entered from normal operational modes. Procedures for checkout modes are not included.
- Inverter No. 2 is on line.
- No a-c circuit breaker opened before entering these procedures.
- These malfunction procedures make no distinction as to whether a d-c circuit breaker opened or was initially open.
- In the case of loss of bus, recovery procedures for equipment other than EPS are not included (except for certain critical ECS recovery procedures indicated in symptoms 1 and 2 and for a recovery procedure for regaining EL lighting in symptom 4).
- Symptoms 1 and 2 assume that one or both CB EPS: CROSS TIE BAL LOAD opened.
- A partial short as referred to in these procedures: (1) Affects either CDR or SE bus in such a way as to cause the bus voltage to drop below 26.5 volts; (2) Does not draw current of sufficient magnitude to actuate the associated ECA overcurrent relay (150 to 200 amps per ECA).

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC BUS warn lt (UNSTAGED)</td>
<td>1</td>
<td>5,2-96</td>
</tr>
<tr>
<td>DC BUS warn lt (STAGED)</td>
<td>2</td>
<td>5,2-98</td>
</tr>
<tr>
<td>C/W PWR caut lt (UNSTAGED)</td>
<td>3</td>
<td>5,2-100</td>
</tr>
<tr>
<td>DC BUS FAULT comp caut lt</td>
<td>3a</td>
<td>5,2-100</td>
</tr>
<tr>
<td>EPS tb - bp</td>
<td>3b</td>
<td>5,2-100</td>
</tr>
<tr>
<td>Flood lights lost if on</td>
<td>3c</td>
<td>5,2-100</td>
</tr>
<tr>
<td>EL lighting lost if EPS: INVERTER sw - 2</td>
<td>3d</td>
<td>5,2-100</td>
</tr>
<tr>
<td>C/W PWR caut lt (STAGED)</td>
<td>4</td>
<td>5,2-101</td>
</tr>
<tr>
<td>All EPS tb - bp</td>
<td>4a</td>
<td>5,2-101</td>
</tr>
<tr>
<td>Flood lights lost if on</td>
<td>4b</td>
<td>5,2-101</td>
</tr>
<tr>
<td>EL lighting lost if EPS: INVERTER sw - 2</td>
<td>4c</td>
<td>5,2-101</td>
</tr>
<tr>
<td>BATTERY caut lt (UNSTAGED)</td>
<td>5</td>
<td>5,2-102</td>
</tr>
<tr>
<td>BATTERY caut lt (STAGED)</td>
<td>6</td>
<td>5,2-103</td>
</tr>
<tr>
<td>INVERTER caut lt</td>
<td>7</td>
<td>5,2-104</td>
</tr>
<tr>
<td>Cannot turn descent battery off low tap (UNSTAGED)</td>
<td>8</td>
<td>5,2-105</td>
</tr>
<tr>
<td>Failure</td>
<td>Symptom</td>
<td>Symp No.</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>----------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>A-c bus A short (bus lost, including EPS a-c instrumentation)</td>
<td>INVERTER caut lt</td>
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<td>A-c bus B short</td>
<td>INVERTER caut lt</td>
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<tr>
<td>Bat lost due to reverse current</td>
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</tr>
<tr>
<td>Bat main fed contactor inadvertently opened</td>
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<tr>
<td>Bat overtemperature</td>
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<tr>
<td>Bat overtemperature</td>
<td>C/W PWR caut lt (STAGED)</td>
<td>4</td>
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<td>Battery is lost because of short between battery &amp; ECA</td>
<td>BATTERY caut lt (UNSTAGED)</td>
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<tr>
<td>Battery is lost due to ECA failure</td>
<td>DC BUS warn lt (STAGED)</td>
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<td>Bat 6 (5) overtemperature</td>
<td>C/W PWR caut lt (UNSTAGED)</td>
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<tr>
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<td>Bus short</td>
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<td>CWEA failure</td>
<td>BATTERY caut lt (STAGED)</td>
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<td>CWEA or instrument failure</td>
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<td>EPS: INVERTER sw failed open in all positions (a-c power is lost)</td>
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<td>Feeder short between DFR &amp; bus (bat 3 &amp; 4 lost)</td>
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<tr>
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<td>5</td>
<td>5.2-102</td>
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<tr>
<td>Instrumentation failure</td>
<td>INVERTER caut lt</td>
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<tr>
<td>Inverter 2 failure</td>
<td>INVERTER caut lt</td>
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<td>5.2-104</td>
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<tr>
<td>Open circuit between bat &amp; ECA</td>
<td>C/W PWR caut lt (STAGED)</td>
<td>4</td>
<td>5.2-101</td>
</tr>
<tr>
<td>Open circuit between ECA &amp; bus</td>
<td>C/W PWR caut lt (STAGED)</td>
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<td>Open circuit between switch &amp; reset coil</td>
<td>Cannot turn descent battery off low tap</td>
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<tr>
<td>Overcurrent contact closed without coil action</td>
<td>DC BUS warn lt (STAGED)</td>
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<tr>
<td>Overtemperature or false ECA indication</td>
<td>BATTERY caut lt (STAGED)</td>
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</tr>
<tr>
<td>Partial short between DFR &amp; bus</td>
<td>DC BUS warn lt (UNSTAGED)</td>
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</tr>
<tr>
<td>Partial short between ECA &amp; DFR</td>
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<td>5.2-96</td>
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<tr>
<td>Reverse current</td>
<td>BATTERY caut lt (STAGED)</td>
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<td>5.2-103</td>
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<tr>
<td>SE bus short</td>
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<td>3</td>
<td>5.2-100</td>
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<tr>
<td>Short between bat &amp; current-sensing coil, or bat expended</td>
<td>DC BUS warn lt (STAGED)</td>
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<tr>
<td>Short between current-monitoring coil &amp; main contact</td>
<td>DC BUS warn lt (STAGED)</td>
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<tr>
<td>Short between deadface &amp; bus (Bat 1 &amp; 2 lost)</td>
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<tr>
<td>Short between ECA &amp; bat 6</td>
<td>DC BUS warn lt (STAGED)</td>
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<tr>
<td>Short between ECA &amp; deadface (bat 1 &amp; 2 lost)</td>
<td>C/W PWR caut lt (UNSTAGED)</td>
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<tr>
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<td>DC BUS warn lt (UNSTAGED)</td>
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<tr>
<td>Short between main contact &amp; bus</td>
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<tr>
<td>Short between switch &amp; reset coil</td>
<td>Cannot turn descent battery off low tap</td>
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<td>5.2-105</td>
</tr>
<tr>
<td>Shorted bat 4 (3)</td>
<td>DC BUS warn lt (UNSTAGED)</td>
<td>1</td>
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</tr>
<tr>
<td>Short on feeder line from inverter 2 to buses A &amp; B causing loss of inverter</td>
<td>INVERTER caut lt</td>
<td>7</td>
<td>5.2-104</td>
</tr>
<tr>
<td>Short on inverter 1 path (loss of inverter)</td>
<td>INVERTER caut lt</td>
<td>7</td>
<td>5.2-104</td>
</tr>
</tbody>
</table>
**SYMPTOM**

1 UNSTAGED

**PROCEDURE**

**ELECTRICAL POWER SUBSYSTEM**

**REFERENCES**

1. **Basic Date**: 3 February 1969
2. **Change Date**: 5 January 1969

**SYMPTOM**

**PROCEDURE**

**ELECTRICAL POWER SUBSYSTEM**

**Remarks**
FAILURE PROCEDURE

ELECTRICAL POWER SUBSYSTEM

In case of short between DFR and bus on CDR side, powering LM dc system with ascent batteries only would place both batteries on short circuit.

Panel 11 CB EPS: BAT FEED TIE (2) should be opened to isolate short.

Remarks

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APOLLO OPERATIONS HANDBOOK

Sheet 2 of 2
## Electrical Power Subsystem

### Symptoms

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</tr>
</thead>
<tbody>
<tr>
<td>DC BUS Staged</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Procedure

1. **BATTERY caud fl-?**
   - **YES**
   - **No**

2. **EPS DC BUS FAULT comp caud fl-?**
   - **YES**
   - **No**

3. **EPS POWER/TEMP MON sw-COR, SE BUS**
   - **YES**
   - **No**

### Warning

- Crew can be placed in 3 to 5 minutes if initial flow stops when crew is fully aware.
- Suit Fan: vol-2

### Battery Voltage

- Open all 11 dc bus:
  - CB EPS
  - BAT FEED TIE: close
  - XLIUNAR BUS TIE: close
  - DC BUS Vol: close
  - EPS: BAT 6(5) NORMAL COR FEED sw-OFF/RESET: to-
  - EPS: BAT 6(5) NORMAL COR FEED sw-OFF/RESET: to-
  - Pin (1) CR EPS BAT FEED TIE: close

### Cor Bus Short

- **EPS: BAT 6 (5) BACK UP SE FEED sw-ON: to-gray**
- **EPS: BAT 6 (5) BACK UP SE FEED sw-ON: to-gray**

### Short Between ECA & BUS

- **WATER TANK SELECT sw-ON: SEC**
- **GLYC/PUMP INST (DEC)**
- **EC: C_1+ GLYC/PUMP**
- **SEC: C_1- GLYC/PUMP**
- **SEC: C_1- GLYC/PUMP**

### Secondary Glycol Loop Operation

- **CLOSE PIN 11 DC CHS, AS REQUIRED TO ACTIVATE SUBSYSTEMS**

### Secondary Glycol Loop Operation

- **CLOSE PIN 11 DC CHS, AS REQUIRED TO ACTIVATE SUBSYSTEMS**

### Remarks

- **Bus functions fail**: COR AUDI/BU DATA LINK
- **CABIN FAN**
- **GLYC/PUMP AUTO ThROW**
- **GLYC/PUMP**
- **SUIT FAN**
- **FILE DISP**
- **GAS**
- **MISS NAR**
- **ORING/PUMP THRUST**
- **AFT DOCK WINDOW**
- **NBD ROB**
- **INST**
- **SIG COND 1**
- **PMD**
- **LOG ON**
- **RNZ RDG**
- **SIG STR BDP**
- **S/C**
- **ATA (PSD)**
- **ATT (HRT)**
- **ENG CONT**
- **ENG START**

### Cautions

- **Assumption**: DC BUS FAULT comp caud it remains on when pin 11 dc lead chs are opened.
- **Primary glycol is inoperative. Only secondary glycol loop is operational.**
### SYMPTOM 3 UNSTAGED

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Procedure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C/W PWR FAULT yellow</td>
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<tr>
<td>2</td>
<td>DC BUS FAULT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Flood lights lost if on</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Loss of EL lighting if EPS INVERTER on</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### PROCEDURE

1. Test all 16 ch's, except CB EPS: DC BUS VOLT: close; EPS: DC BUS FAULT comp caut: ON. If the fault is present, proceed to step 2.
2. EPS: DC BUS Fault comp caut: OFF: YES. 
   - EBAT 1 SHORT (BAT LOST) 
3. EPS: DC BUS Fault comp caut: OFF: NO. 
   - EPS: BAT 1 SHORT (BAT LOST) 
4. EPS: BAT 2 SHORT (BAT LOST) 
5. To power SE bus with good descent bat:
   - EPS: GOOD BAT HI VOLT SW: ON
6. To power SE bus with descent and ascent batteries:
   - CB EPS: CROSS THE BUS (2) 
   - CB EPS: CROSS THE BAL LOADS (2) 
7. To power both buses from ascent batteries only:
   - EPS: BAT 2 NORMAL CDR FEED: ON
8. SHORT BETWEEN ECA & DEADFACE (BAT 1 & 2 LOST) 
9. Repower bus as required.
10. To power both buses from descent and ascent batteries:
    - CB EPS: CROSS THE BUS (2) 
    - EPS: BAT 6 NORMAL CDR FEED: ON
11. To avoid feeding into short, do not close PNL 16 CB EPS: BAT FEED Tie (2) 
12. Close PNL 16 load ch's as required, to activate subsystems.
13. To power both buses from ascent batteries only:
    - EPS: BAT 2 NORMAL SE FEED: ON
14. To avoid feeding into short, do not place EPS: DES BATS sw: CONNECT while vehicle is unstaged.
15. EBAT 1 SHORT (BAT LOST) 
16. SE BUS SHORT
17. EPS: BAT 5 BACK UP CDR FEED SW: ON
18. SHORT BETWEEN DEADFACE & BUS (BAT 1 & 2 LOST) 
19. To avoid feeding into short, do not close PNL 16 CB EPS: BAT FEED Tie (2) 
20. Repower bus as required.
21. To power both buses from descent and ascent batteries:
    - CB EPS: CROSS THE BUS (2) 
    - EPS: BAT 6 BACK UP CDR FEED: ON
22. Close PNL 16 load ch's as required, to activate subsystems.
23. To power both buses from ascent batteries only:
    - EPS: BAT 5 BACK UP CDR FEED: ON
24. EPS: BAT 5 BACK UP CDR FEED SW: ON

#### REMARKS

1. SE's bus power failure
2. Assumption: DC BUS FAULT comp caut: 11 remains on when PNL 16 load ch's are open.
3. EPS will indicate tip and cannot be used until power is restored to SE's bus.
4. SE's bus functions lost:
   - COMM: DISP, TV
   - ECS: CABIN FAN CONT, CABIN PRESS, CABIN PRESS, CABIN PRESS
   - IDL: FLOOD ALARM, TRACK, PROPUL
   - ECS: AEA, ASA, ATCA (AGS), ENG ARM, DES ENG ARM
5. C/W PWR caut: 11 remains on. EPS 15's remain nonoperational.

---

**Basic Date**: 3 February 1969

**Change Date**: _______
### 4 STAGED

#### SYMPTOM
- C/W PAR
- YELLOW
  - Light on if ORHA power failure occurs.
  - 4a. All EPS 16 chs.
  - 4b. Open lights test if not
  - 4c. EL lighting lost if EPS INVERTER sw.

#### PROCEDURE
1. **Open all 16 chs. except C/W EPS.**
   - EPS: BAT 5 NORMAL SE FEED sw - OFF/RESET
   - EPS: DC BUS FAULT comp caut it off?

2. **FAULT BETWEEN ECA & BAT 5**
   - EPS: BAT 5 NORMAL SE FEED sw - OFF/RESET

3. **BUS SHORT**
   - EPS: BAT 6 BACK UP SE FEED sw - ON
   - EPS: CROSS TIE BUS sw - close

4. **WARNING**
   - To avoid feeding into short, do not close CB EPS: CROSS TIE BUS (2) and CB EPS: CROSS TIE BAL LOADS (2)

5. **WARNING**
   - To avoid feeding into short, do not close CB EPS: CROSS TIE BUS (2) and CB EPS: CROSS TIE BAL LOADS (2)

6. **BAT MAIN FEED CONTACTOR INADVERTENTLY OPENED**

7. **BAT OVERTEMPERATURE**

8. **REVERSE CURRENT**
   - EPS: BAT 5 BACK UP CDR FEED sw - ON
   - EPS: AMPS int. normal?

9. **OPEN CIRCUIT BETWEEN BAT & ECA**

10. **OPEN CIRCUIT BETWEEN ECA & BUS**

#### REMARKS
- To regain EL lighting:
  - Pre EPS INVERTER sw - 1
  - Pre CB EPS: INV I - close

- CB EPS: CROSS TIE BAL LOADS (2) will only be closed during orbital contingency.

- Except for CB S/C DES ENG (2): SE's bus functions listed are as listed in remark 4 of symptom 3.

- Cause of contact opening is not defined. Monitor for remainder of mission. Closing both CB EPS: CROSS TIE BUS (2) may be desirable to ensure continued power to SE's bus.

- If reverse-current relay in ECA is tripped, faulty battery in VOLTS sw must be held in OFF/RESET position for 1.5 to 4 seconds to reset relay.

---

### ELECTRICAL POWER SUBSYSTEM

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**Page:** 5.2-101
**SYMPTOM**

5 UNSTAGED

**PROCEDURE**

1. **BATTERY**
   - EPS DC BUS FAULT comp cau? h?
   - EPS
   - ON
   - OFF

2. **SYMPTOM**
   - CB EPS: CROSS TIE BUS (2) — close
   - EPS: POWER TEMP MON set — rotate thru descent bat positions
   - EPS: BAT FAULT comp cau? h?
   - OFF

3. **SYMPTOM**
   - CWEA FAILURE

4. **SYMPTOM**
   - Faulty bat tb — bp?
   - NO
   - YES

5. **SYMPTOM**
   - Faulty bat VOLTS ind — normal?
   - NO
   - YES

6. **SYMPTOM**
   - BATTERY IS LOST BECAUSE OF SHORT BETWEEN BATTERY & ECA

7. **SYMPTOM**
   - Faulty bat HI VOL sw — OFF/RESET; then ON
   - EPS: BAT FAULT comp cau? h?
   - OFF
   - BATTERY cau? h — OFF

8. **SYMPTOM**
   - INADVERTENT ACTUATION OF ECA OVERCURRENT RELAY

9. **SYMPTOM**
   - BATTERY IS LOST DUE TO ECA FAILURE.

10. **SYMPTOM**
    - On cb panel associated with faulty bat:
    - CB EPS: BAT FEED TIE (2) — open

11. **SYMPTOM**
    - EPS: BAT FAULT comp cau? h?
    - OFF

12. **SYMPTOM**
    - REVERSE CURRENT

13. **SYMPTOM**
    - Faulty bat HI VOL sw — OFF/RESET until BATTERY cau? h — OFF;
    - TB — BP
    - Good bat (in faulty pair) HI VOL sw — ON; TB — gray

14. **SYMPTOM**
    - On cb panel associated with faulty bat:
    - CB EPS: BAT FEED TIE (2) — close
    - On 11 & 16 CB EPS: CROSS TIE BUS (2) — open

**REMARKS**

1. CB EPS: CROSS TIE BUS (2) must be kept closed to ensure sufficient bus power.
2. Battery monitoring via CWEA is lost.
4. Cause of battery disconnect is not defined. Monitor for remainder of mission.
5. Battery cau? h remains on.
7. One descent battery is lost.
8. If reverse-current relay in ECA has tripped, faulty battery HI VOL sw must be held in OFF/RESET position for 1.5 to 4 seconds to reset relay.
9. Failure of overcurrent, overtemperature, or reverse-current contact may cause fault, in addition to true overtemperature condition. These failures cannot be separated.

**ELECTRICAL POWER SUBSYSTEM**

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**SYMPTOM**

6 STAGED BATTERY

**PROcedure**

1. EPS: POWER/TEMP MON sel -BAT 5 & 6
   - EPS: BAT FAULT comp cau it on?
     - YES: BAT 5 & 6
     - NO:

2. CB EPS: CROSS TIE BUS (2) - close
   - EPS: BAT FAULT comp cau it on?
     - YES: NO
     - NO: REVERSE CURRENT

3. CB EPS: CROSS TIE BAL LOADS (2) - closed?
   - YES - OVERTEMPERATURE OR FALSE ECA INDICATION
   - NO - REVERSE CURRENT

4. EPS: BAT FAULT comp cau it on?
   - YES: NO
   - NO - REVERSE CURRENT

5. EPS: BAT 5 (6) NORMAL SE (COR) FEED sw - OFF/RESET until BAT TERY caut - OFF:
   - EPS: BAT 6 (5) BACK UP SE (COR) FEED sw - ON, th - gray
     - Bat 6 (5) current decreases?
       - YES: NO
       - NO - INCREASES

6. CB EPS: CROSS TIE BAL LOADS (2) - open
   - CB EPS: CROSS TIE BUS (2) - close
     - EPS: POWER/TEMP MON sel -BAT 6 (5)
     - EPS: AMPS ind - monitor
     - ECA sw - OFF (15)
     - EPS: BAT FEED TIE (2) - close
       - CB EPS: CROSS TIE BAL LOADS (2) - open
       - CB EPS: CROSS TIE BUS (2) - open

**Remarks**

1. C/W cannot be used for bat malfunction indications. Maintain close check of bat status.

2. CB EPS: CROSS TIE BAL LOADS (2) will only be closed during orbital contingency.


4. Bat may be placed on line as long as it supplies positive current and DC BUS warn it remains off.

5. Because BATTERY cau it remains on, monitoring capability is lost when faulty bat is on line.

6. If reverse current relay in ECA has tripped, faulty battery HI VOLT sw must be held in OFF/RESET position for 1.5 to 4 seconds to reset relay.

---

**ELECTRICAL POWER SUBSYSTEM**

**Basic Date** 3 February 1969

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**Page** 5.2-103
###SYMPTOM

**7**

**INVERTER**

**YELLOW**

Light on if:

A - C voltage < 112 volts

Frequency < 390 cps

Frequency > 4 cp

###PROCEDURE

1. EPS VOLTS ind-green hand

YES

2. CB EPS INV 1-close

INVERTER cau it off?

NO

3. CB EPS INV 2-open

YES

4. CB EPS INV 2-short

A - C BUS B SHORT (LS 10' BUSES A & B LOSING INVERTER)

5. EPS INVERTER sw-Failed

NO

INVERTER sw in ALL POSITIONS (A - C POWER IS LOST)

6. EPS INVERTER sw -off

NO

7. EPS INVERTER sw off

YES

8. EPS INV 1-open

NO

9. EPS EPS INV 2-open

YES

10. CB EPS INV 1-open

NO

11. CB EPS INV 2-open

YES

12. CB EPS INV 1-short

A - C BUS A SHORT (BUSES A & B LOSING INVERTER)

13. EPS INVERTER sw-Failed

YES

14. EPS EPS INV 1-open

NO

15. EPS EPS INV 2-open

YES

###REMARKS

1. Assumption INV 2 on. Due to lack of grounding, spurious readings will be observed on instruments when monitoring bus voltage.

2. Frequency failure of inverter, inverter No. 2 (or No. 1) is not rendered inoperable due to frequency failure, because it will freerun at 390 to 410 cps whenever PORTA signal line or inverter sync circuit fails. Inverter frequency can be monitored by MSFN.

3. To reestablish inverter configuration:

   * EPS INVERTER sw-2
   * CB EPS INV 1-open
   * EPS INVERTER cau it remains on MSFN will verify loss of SIG COND

4. SHORT ON FEDER LINE FROM INVERTER 2 TO BUSES A & B CAUSING LOSS OF INVERTER

   * CB EPS INV 2-open

5. INVERTER cau it may go off if contact is made.

---

**APOLLO OPERATIONS HANDBOOK**

**PROCEDURE**

**ELECTRICAL POWER SUBSYSTEM**

**SYMPTOM**

**PROCEDURE**

**REMARKS**

Basic Date 3 February 1969

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## APOLLO OPERATIONS HANDBOOK

### ELECTRICAL POWER SUBSYSTEM

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### SYMPTOM: 8 UNSTAGED

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<td>Can't turn descent battery off low tap</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CB EPS: DES ECA CONT (2) popped during attempt to remove battery from low-voltage tap</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Faulty battery HI VOLT sw - OFF/RESET &amp; hold</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>FAULTY BATTERY LOW VOLT SWITCH FAILED ON</td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Open circuit between switch &amp; reset coil</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>EPS: BAT 5 NORMAL SE FEED sw - ON, th - gray</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>EPS: BAT 6 NORMAL COR FEED sw - ON, th - gray</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>EPS: DES BATS sw - DEAD FACE</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Remove descent batteries or faulty pair &amp; power bus as follows</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>- Ascent battery NOT associated with faulty pair</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>- EPS: BAT 5 NORMAL SE FEED sw - ON, th - gray</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
</tr>
<tr>
<td>- EPS: BAT 6 COR FEED sw - ON, th - gray</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
</tr>
<tr>
<td>- EPS: DES BATS sw - DEAD FACE</td>
<td></td>
</tr>
</tbody>
</table>

#### REMARKS

1. Assumption: Removal has been attempted, using both HI and LOW VOLT switches.

2. Faulty battery will be placed on low-voltage tap when HI VOLT sw is set to OFF/RESET and released. Refer to step 4 for removal.

---

This is a page for a case that will occur frequently (during power-up). We hope it happens frequently. If it happens, we'll solve it by real time. If we blow the mission, we'll blame the mission.
5.2.10 COMMUNICATIONS SUBSYSTEM

5.2.10.1 Assumptions

- Troubleshooting procedures such as checking sw's, cb's, redundant PTT pb's, alternative antennas, etc are performed before entering malfunction procedures.
- These malfunction procedures do not assume a particular Communications Subsystem sw configuration other than that required to operate the equipment before entry into the procedures.
- Malfunction procedures are entered from normal operational modes. (Procedures are not included for checkout modes.)

Table 5-19. CS Procedure Entry Sheet

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of intercom</td>
<td>1</td>
<td>5.2-111</td>
</tr>
<tr>
<td>One crewman has abnormal (unselected) hot mike condition</td>
<td>2</td>
<td>5.2-112</td>
</tr>
<tr>
<td>Loss of VHF A simplex voice comm with MSFN or CSM</td>
<td>3</td>
<td>5.2-113</td>
</tr>
<tr>
<td>Loss of VHF A simplex voice comm with CSM, MSFN not available - not within LOS</td>
<td>4</td>
<td>5.2-114</td>
</tr>
<tr>
<td>Cannot acquire S-band f lock</td>
<td>5</td>
<td>5.2-114</td>
</tr>
<tr>
<td>Loss of S-band voice comm</td>
<td>6</td>
<td>5.2-115</td>
</tr>
<tr>
<td>MSFN reports loss of S-band ranging</td>
<td>7</td>
<td>5.2-116</td>
</tr>
<tr>
<td>MSFN reports loss of LM S-band telemetry, S-band voice OK</td>
<td>8</td>
<td>5.2-116</td>
</tr>
<tr>
<td>S-BD RCVR caut lt</td>
<td>9</td>
<td>5.2-116</td>
</tr>
</tbody>
</table>

Table 5-20. CS Failure/Symptom Cross-Reference Index

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio center failure</td>
<td>Loss of intercom</td>
<td>1</td>
<td>5.2-111</td>
</tr>
<tr>
<td>Audio center ICS circuitry failure</td>
<td>Loss of intercom</td>
<td>1</td>
<td>5.2-111</td>
</tr>
<tr>
<td>Audio center mike amplifier continuously keyed</td>
<td>One crewman has abnormal (unselected) hot mike condition</td>
<td>2</td>
<td>5.2-112</td>
</tr>
<tr>
<td>Audio center removing key has abnormal hot mike condition</td>
<td>Loss of VHF A simplex voice comm with MSFN or CSM</td>
<td>3</td>
<td>5.2-113</td>
</tr>
<tr>
<td>Comm carrier or comm cable failure</td>
<td>Loss of intercom</td>
<td>1</td>
<td>5.2-111</td>
</tr>
<tr>
<td>Common S-band rcvr or SPA 30 kc subcarrier output circuit failure</td>
<td>Loss of S-band voice comm</td>
<td>6</td>
<td>5.2-115</td>
</tr>
<tr>
<td>CSM or LM xmtr or rcvr failure</td>
<td>Loss of VHF A simplex voice comm with CSM, MSFN not available (not within LOS)</td>
<td>4</td>
<td>5.2-114</td>
</tr>
</tbody>
</table>

Basic Date: 3 February 1969
<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CWEA failure</td>
<td>S BD RCVR caut lt</td>
<td>9</td>
<td>5.2-116</td>
</tr>
<tr>
<td>Failure in CSM</td>
<td>Loss of VHF A simplex voice comm with CSM. MSFN not available (not within LOS)</td>
<td>4</td>
<td>5.2-114</td>
</tr>
<tr>
<td>Hot mike failure</td>
<td>Loss of intercom</td>
<td>1</td>
<td>5.2-111</td>
</tr>
<tr>
<td>Intermittant PTT switch</td>
<td>One crewman has abnormal (unselected) hot mike condition</td>
<td>2</td>
<td>5.2-112</td>
</tr>
<tr>
<td>Loss of 512 kc from PCMTEA</td>
<td>Loss of S-band voice comm</td>
<td>6</td>
<td>5.2-115</td>
</tr>
<tr>
<td>PCMTEA HBR circuit failure</td>
<td>MSFN reports loss of LM S-band telemetry, S-band voice OK</td>
<td>8</td>
<td>5.2-116</td>
</tr>
<tr>
<td>PMP failure (e.g., high-pass filter, data modulator amplifier) or PCMTEA failure</td>
<td>MSFN reports loss of LM S-band telemetry, S-band voice OK</td>
<td>8</td>
<td>5.2-116</td>
</tr>
<tr>
<td>PMP failure (e.g., PM mixer)</td>
<td>MSFN reports loss of LM S-band telemetry, S-band voice OK</td>
<td>8</td>
<td>5.2-116</td>
</tr>
<tr>
<td>PMP power supply failure</td>
<td>Loss of S-band voice comm</td>
<td>6</td>
<td>5.2-115</td>
</tr>
<tr>
<td>PMP PM circuitry failure (e.g., PM mixer)</td>
<td>Loss of S-band voice comm</td>
<td>6</td>
<td>5.2-115</td>
</tr>
<tr>
<td>PMP S-band voice circuit failure</td>
<td>Loss of S-band voice comm</td>
<td>6</td>
<td>5.2-115</td>
</tr>
<tr>
<td>Primary S-band rcvr failure</td>
<td>Cannot acquire S-band &amp; lock</td>
<td>5</td>
<td>5.2-114</td>
</tr>
<tr>
<td>Primary S-band rcvr 30 kc output circuit failure</td>
<td>Loss of S-band voice comm</td>
<td>6</td>
<td>5.2-115</td>
</tr>
<tr>
<td>Primary S-band xmtr failure</td>
<td>Loss of S-band voice comm</td>
<td>6</td>
<td>5.2-115</td>
</tr>
<tr>
<td>Primary xmtr/rcvr ranging circuit failure</td>
<td>MSFN reports loss of S-band ranging</td>
<td>7</td>
<td>5.2-116</td>
</tr>
<tr>
<td>PTT keying circuit failure</td>
<td>Loss of intercom</td>
<td>1</td>
<td>5.2-111</td>
</tr>
<tr>
<td>PTT switch failed on</td>
<td>One crewman has abnormal (unselected) hot mike condition</td>
<td>2</td>
<td>5.2-112</td>
</tr>
<tr>
<td>PTT switch failure</td>
<td>Loss of intercom</td>
<td>1</td>
<td>5.2-111</td>
</tr>
<tr>
<td>S-band antenna system failure (e.g., RF switch, coax, diplexer, or xcvr RF diode switch)</td>
<td>Cannot acquire S-band &amp; lock</td>
<td>5</td>
<td>5.2-114</td>
</tr>
<tr>
<td>Short in range enable circuit</td>
<td>MSFN reports loss of S-band ranging</td>
<td>7</td>
<td>5.2-116</td>
</tr>
<tr>
<td>Short on VHF A keying line</td>
<td>Loss of VHF A simplex voice comm with MSFN or CSM</td>
<td>3</td>
<td>5.2-113</td>
</tr>
<tr>
<td>VHF A coax cable failure</td>
<td>Loss of VHF A simplex voice comm with MSFN or CSM</td>
<td>3</td>
<td>5.2-113</td>
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</table>

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Table 5-20. CS Failure/Symptom Cross-Reference Index (cont)

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF A rcvr failure</td>
<td>Loss of VHF A simplex voice comm with MSFN or CSM</td>
<td>3</td>
<td>5.2-113</td>
</tr>
<tr>
<td>VHF antenna system failure</td>
<td>Loss of VHF A simplex voice comm with CSM. MSFN not available (not within LOS)</td>
<td>4</td>
<td>5.2-114</td>
</tr>
<tr>
<td>VHF antenna system failure; (e.g., diplexer or RF switch)</td>
<td>Loss of VHF A simplex voice comm with MSFN or CSM</td>
<td>3</td>
<td>5.2-113</td>
</tr>
<tr>
<td>VHF A xmtr or keying circuit failed open</td>
<td>Loss of VHF A simplex voice comm with MSFN or CSM</td>
<td>3</td>
<td>5.2-113</td>
</tr>
<tr>
<td>VHF keying circuitry common to both xmtrs failed open</td>
<td>Loss of VHF A simplex voice comm with MSFN or CSM</td>
<td>3</td>
<td>5.2-113</td>
</tr>
<tr>
<td>VOX circuit failure</td>
<td>Loss of intercom</td>
<td>1</td>
<td>5.2-111</td>
</tr>
<tr>
<td></td>
<td>One crewman has abnormal (unselected) hot mike condition</td>
<td>2</td>
<td>5.2-112</td>
</tr>
</tbody>
</table>

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SYMPTOM

1. Loss of intercom

PROCEDURE

1. Operate intercom
   - AUDIO MODE sw-Alternate positions
   - Intercom OK?

2. VOX
   - VOX mode failed

3. VOX CIRCUIT FAILURE

4. ICS/PTT mode failed

5. PTT mode failed

6. PTT KEYING CIRCUIT FAILURE

7. AUDIO MODE sw-PTT
   - Operate alternative PTT sw
   - Intercom OK?

8. PTT SWITCH FAILURE

9. PTT KEYING CIRCUIT FAILURE

10. Check VHF or S band vswr with COMM or MSFN
    - Voice OK?

11. AUDIO CENTER CIRCUIT FAILURE

12. AUDIO CENTER FAILURE

13. COMM CARRIER OR COMM CABLE FAILURE

REMARKS

1. Relay capability is lost

2. Crewman has option of remaining on his audio center at expense of intercom function. Crewman's audio tone signal cannot be used as a backup to intercom

3. All comms (one crewman) is lost.
2 One crewman has abnormal (unselected) hot mike condition

1. AUDIO MODE sw-PTT
   - Talk without keying
   - Side tone heard?
   - YES
   - VOX CIRCUIT FAILURE
   - NO

2. Individually cycle PTT switches on crew cable and ACA - Talk without keying
   - Side tone heard?
   - YES
   - VOX CIRCUIT FAILURE
   - NO

3. AUDIO CONT sw-BU
   - AUDIO sw (second crewman) - PTT
   - Talk without keying
   - Side tone heard?
   - YES
   - AUDIO CENTER MIKE AMPLIFIER CONTINUOUSLY KEYED
   - NO

4. CONTINUOUSLY KEYED
   - AUDIO sw (BU)
   - VHF CONSTANT KEYED
   - Do not use failed switch

5. PTT SWITCH FAILED ON

6. Hot mike in all modes.
7. VHF comm (one crewman) is lost.

Continuous key on VHF exists precludes use of simplex. Duplex is available for use, but consumes considerable power.
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#### PROCEDURE

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Loss of VHF A simplex voice comm with MSFN or CSM</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
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<td>4</td>
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<td>6</td>
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<td></td>
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<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
</tr>
</tbody>
</table>

#### REMARKS

- Major VHF B simplex voice comm with MSFN.
- No voice transmission or reception.
- No down voice.
- No up voice.
- No voice transmission.
- Each crewman sequentially:
  - AUDIO: VHF A sw-OFF

#### SYMPTOM

<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MSFN available (within LOS)?</td>
</tr>
<tr>
<td>2</td>
<td>Establish S band voice comm with MSFN</td>
</tr>
<tr>
<td>3</td>
<td>MSFN reports VHF voice status</td>
</tr>
<tr>
<td>4</td>
<td>Establish VHF B simplex voice comm with MSFN</td>
</tr>
<tr>
<td>5</td>
<td>VHF B simplex voice OK?</td>
</tr>
<tr>
<td>6</td>
<td>VHF ANTENNA SYSTEM FAILURE (e.g. SUPP LDR OR RF SWITCH)</td>
</tr>
<tr>
<td>7</td>
<td>VHF KEYING CIRCUIT COMMON TO BOTH XMTS FAILED OPEN</td>
</tr>
<tr>
<td>8</td>
<td>VHF A XMT OR KEYING CIRCUIT FAILED OPEN</td>
</tr>
<tr>
<td>9</td>
<td>VHF A RCVR FAILURE</td>
</tr>
<tr>
<td>10</td>
<td>VHF A RCVR FAILURE</td>
</tr>
<tr>
<td>11</td>
<td>Audio center removing key has abnormal HOT MIC condition</td>
</tr>
<tr>
<td>12</td>
<td>Audio center removing key has abnormal HOT MIC condition</td>
</tr>
<tr>
<td>13</td>
<td>Audio center removing key has abnormal HOT MIC condition</td>
</tr>
</tbody>
</table>
# LMA790-3-LM 4
## APOLLO OPERATIONS HANDBOOK

### SYMPTOM 4
- Loss of VHF A simplex voice comm with CSM. MSFN not available (not within LOS)

#### PROCEDURE
1. Flash utility light or docking lights to indicate to CSM that VHF A failed
2. COMM VHF A XMT sw-VOICE
   - COMM VHF B RCV sw-ON
   - AUDIO VHF B sw-T/R
   - VHF voice OK?
3. YES
   - CSM or LM XMT or RCV failure
   - VHF antenna system failure
4. NO
   - Establish VHF A simplex voice comm with MSFN as soon as possible
   - AUDIO S BAND T/R sw-T/R
5. YES
   - VHF antenna system failure
6. NO
   - Failure in CSM

### SYMPTOM 5
- Cannot acquire S-band A-lock.

#### PROCEDURE
1. Use VHF for voice comm
   - COMM S BAND XMTR/RCVR sw-SEC (Reacquire A-lock)
   - A-lock acquired?
2. YES
   - PRIMARY S BAND RCVR FAILURE
   - S-BAND ANTENNA SYSTEM FAILURE
   - PRIM. BAND RCVR RF DIODE SWITCH
3. NO
   - PRIMARY S BAND RCVR FAILURE
   - S-BAND ANTENNA SYSTEM FAILURE
   - PRIM. BAND RCVR RF DIODE SWITCH

### REMARKS
1. Predetermined procedures (TBD)
2. Both spacecraft will configure for VHF A simplex.
3. Exact failure will be determined by VHF A comm check with MSFN as soon as possible.
4. LM/CSM VHF voice comm is lost.
5. All VHF capability is lost.

### REMARKS
1. Reacquisition requires up to 20 seconds.
2. All S-band functions are lost.

---

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**SYMPTOM**

6. Loss of S-band voice capability

**PROCEDURE**

1. Establish VHF voice comm with MSFN
   - AUDIO: VHF A SW: T/R

2. MSFN reports S-band voice status

3. No down voice
   - MSFN reports PCM OK?
     - YES: PNP S-BAND VOICE CIRCUIT FAILURE
     - NO: COMM. S-BAND PCM SW: OFF
   - VOICE & PCM OK?
     - YES: PRIMARY S-BAND XMTR FAILURE
     - NO: COMM. S-BAND DEMODULATE SW: FM

4. COMM. S-BAND MODULATE SW: FM
   - VOICE & PCM OK?
     - YES: PNP POWER SUPPLY FAILURE
     - NO: COMM. S-BAND PCM SW: OFF

5. No up voice

6. COMM. S-BAND XMTR-RECVR SW: SEC
   - VoICE OK?
     - YES: PRIMARY S-BAND XMTR 16 KHZ OUTPUT CIRCUIT FAILURE
     - NO: COMM. S-BAND XMTR-RECVR SW: SEC

7. COMM. S-BAND XMTR-RECVR SW: SEC
   - Output Circuit Failure
   - COMM. S-BAND XMTR-RECVR SW: SEC
   - Output Circuit Failure

8. COMM. S-BAND XMTR-RECVR SW: SEC
   - Up DATA LINK SW: V/VOICE BU

**REMARKS**

1. May require short S-band voice check for complete status.

2. Crew has option of restoring S-band voice at expense of S-band ranging by selecting ON VOICE BU

3. Power-up and recovery requires up to 20 seconds.

4. S-band PCM & ranging is lost

5. Loss of S-band capability except ranging and emergency keying.

6. S-band up voice capability is lost.

7. COMM'S AUDIO CONT sw must be set to NORM.
   - For LMP S-band reception capability, set LMP AUDIO AUDIO CONT sw: BU

---

**SYMPTOM**

COMMUNICATIONS SUBSYSTEM

**PROCEDURE**

**REMARKS**

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#### Symptom: MSFN reports loss of S-band ranging

1. **COMM: S-BAND XMTR/RCVR sw - SEC**
   - Ranging OK?
     - **YES**: Proceed to the next step.
     - **NO**: Finish Step 2.

2. **Primary XMTR/RCVR Ranging Circuit Failure**

3. **Shunt in Range Enable Circuit**

#### Remarks:
- S-band ranging capability is lost.

#### Symptom: MSFN reports loss of LM S-band telemetry, S-band ranging is OK

1. **COMM: S-BAND MODULATE sw - FM**
   - MSFN reports PCM OK?
     - **YES**: Proceed to the next step.
     - **NO**: Finish Step 2.

2. **PCM Failure (e.g., PM MIXER)**

3. **PCMTA HBR Circuit Failure**

4. **PCM Failure (e.g., High Pass Filter, Data Modulator Amplifier) or PCMTA Failure**

#### Remarks:
- Simultaneous ranging and PCM capability is lost. Crewman has option of retaining S-band PCM as configured, or he may reconfigure for ranging at expense of PCM as follows:
  - **COMM: S-BAND MODULATE sw - FM**
  - **COMM: S-BAND RANGE sw - RANGE**
- HBR PCM capability is lost.

#### Symptom: Light goes on if lock (received AGC signal) is lost.

1. **COMM: S-BAND MODULATE sw - FM**
   - MSFN reports PCM OK?
     - **YES**: Proceed to the next step.
     - **NO**: Finish Step 2.

2. **COMM: TLM PCM sw - LO**
   - MSFN reports PCM OK?
     - **YES**: Proceed to the next step.
     - **NO**: Finish Step 2.

3. **PCM Failure (e.g., PM MIXER)**

4. **PCM Failure (e.g., High Pass Filter, Data Modulator Amplifier) or PCMTA Failure**

#### Remarks:
- S-band telemetry capability is lost.

#### Symptom: If uplink lock is lost, noise will be heard in headset if COMM: UPLINK SQUELCH sw - OFF, COMM: SIGNAL STRENGTH ind. < 1.

1. **COMM: S-BAND RANGE sw - OFF/RESET, then TV/CMEA ENABLE**

2. **RF may be used for LM/MSFN link during earth-orbit missions, LM/COM link during lunar-orbital and lunar-layover periods.**

3. **Reacquisition requires up to 20 seconds.**

4. **All S-band functions are lost.**

---

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### Table 5-21. ECS Procedure Entry Sheet

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
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<tbody>
<tr>
<td>ECS caut lt</td>
<td>1</td>
<td>5.2-123</td>
</tr>
<tr>
<td>ECS caut lt &amp; SUIT FAN comp caut lt</td>
<td>2</td>
<td>5.2-123</td>
</tr>
<tr>
<td>ECS caut lt &amp; CO2 comp caut lt</td>
<td>3</td>
<td>5.2-124</td>
</tr>
<tr>
<td>ECS caut lt &amp; H2O SEP comp caut lt</td>
<td>4</td>
<td>5.2-124</td>
</tr>
<tr>
<td>GLYCOL comp caut lt</td>
<td>5</td>
<td>5.2-125</td>
</tr>
<tr>
<td>MASTER ALARM pb/lt, ECS caut lt, &amp; GLYCOL comp caut lt</td>
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<td>5.2-125</td>
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<td>GLYCOL caut lt</td>
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<td>5.2-126</td>
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<tr>
<td>CABIN warn lt</td>
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<td>5.2-127</td>
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<tr>
<td>WATER QTY caut lt</td>
<td>8</td>
<td>5.2-128</td>
</tr>
<tr>
<td>ECS: CABIN TEMP ind high</td>
<td>9</td>
<td>5.2-129</td>
</tr>
<tr>
<td>ECS: SUIT PRESS ind &gt;4.0 psia</td>
<td>10</td>
<td>5.2-129</td>
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**Symptom**

1. ECS

**PROCEDURE**

1. ECS comp caust it--on?
2. ECS comp caust it--on?
3. H2O SEP comp caust it--on?
4. GLYCOL comp caust it--on?

**Remarks**

1. ECS caution monitoring is degraded. MASTER ALARM ph/in & comp caust itts are only indication to crew of symptoms 2, 3, & 4.

---

**Symptom**

1. ECS

**PROCEDURE**

1. Flow in suit loop?
2. SUIT FAN sel-2
3. CB ECS: SUIT FAN 1--open?
4. SUIT NO. 3 FAILED
5. TEMPORARY OVERCURRENT TO SUIT FAN NO. 1
6. SHORT CIRCUIT OF SUIT FAN NO. 1
7. SUIT FAN NO. 3 OUTPUT DEGENERATED
8. CB ECS: SUIT FAN 1--open

**Remarks**

1. SUIT FAN NO. 1 was selected.
2. Suit loop flow is sensed by crew. H2O SEP comp caust it may go on as result of no flow from ARTS. This does not indicate second failure.
3. SUIT FAN warn It will go on mo- mentarily. This does not indicate second failure.
4. Crew may not have sensed reduction in suit flow.
5. Life support system is degraded; no backup suit fan.
6. Fan failure input to crew via CWEA is inoperative. H2O SEP comp caust it and sensing of suit flow are only indication to crew of failed suit flow.
## SYMPTOMS

**SYMPTOM**

1. ECS
   - **YELLOW**
   - Lights on if ECS PART PRESS CO₂ ind > 7.6 mm Hg

## PROCEDURE

1. ECS PART PRESS CO₂ ind 7.6 to 8.0 mm Hg?
   1. **YES**
      - ECS PART PRESS CO₂ ind - decreases & ECS caut it-off?
   2. **YES**
      - PRIMARY LION CARTRIDGE FAILED OR SATURATED.
   3. **NO**
      - ECS PART PRESS CO₂ Ind - decays & ECS caut it-off?
   4. **NO**
      - ECS caut it & CO₂ comp caut it go on at different ECS PART PRESS CO₂ ind readings, depending on operating pressure.

### REMARKS

- ECS caut it & CO₂ comp caut it go on at different ECS PART PRESS CO₂ ind readings, depending on operating pressure.

<table>
<thead>
<tr>
<th>PSIA</th>
<th>Actual CO₂ (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>5.35 to 8.25</td>
</tr>
<tr>
<td>7.6</td>
<td>8.45 to 10</td>
</tr>
</tbody>
</table>

## SYMPTOMS

2. CO₂ CANISTER sel svc - SEC
   - **YELLOW**
   - ECS caut it-off?

### PROCEDURE

1. CO₂ PARTIAL PRESSURE SENSOR FAILURE.
   1. **NO**
      - ECS caut it-off?
   2. **YES**
      - CO₂ CANISTER SEL svc - SEC

## SYMPTOMS

3. CO₂ PARTIAL PRESSURE SENSOR FAILURE.
   - **YELLOW**
   - ECS caut it-off?

## PROCEDURE

1. CO₂ PARTIAL PRESSURE SENSOR FAILURE.
   - **YES**
   - CO₂ CANISTER SEL svc - SEC

## SYMPTOMS

4. C/W CIRCUITRY FAILURE.
   - **YELLOW**
   - ECS caut it-off?

## PROCEDURE

1. ECS PART PRESS CO₂ IND FAILURE
   - **YES**
   - NO
   - CO₂ CANISTER SEL svc - SEC

## SYMPTOMS

5. ECS PART PRESS CO₂ IND FAILURE
   - **YELLOW**
   - ECS caut it-off?

## PROCEDURE

1. ECS PART PRESS CO₂ IND FAILURE
   - **YES**
   - ECS caut it-off?
   - CO₂ CANISTER SEL svc - SEC

## SYMPTOMS

6. H₂O SEPARATOR FAILED.
   - **YELLOW**
   - H₂O SEP comp caut it-off?

## PROCEDURE

1. H₂O SEPARATOR FAILED.
   - **YES**
   - NO
   - H₂O SEPARATOR INSTRUMENTATION FAILURE.

## SYMPTOMS

7. H₂O SEPARATOR INSTRUMENTATION FAILURE.
   - **YELLOW**
   - H₂O SEP comp caut it-off?

## PROCEDURE

1. H₂O SEPARATOR INSTRUMENTATION FAILURE.
   - **YES**
   - NO
   - H₂O SEP comp caut it-off?
   - WATER SEP SEL svc - PULL SEP 1 (PULL SEP 2)

## SYMPTOMS

8. WATER SEP SEL svc - PULL SEP 1 (PULL SEP 2)
   - **YELLOW**
   - H₂O SEP comp caut it-off?

## PROCEDURE

1. WATER SEP SEL svc - PULL SEP 1 (PULL SEP 2)
   - **YES**
   - NO
   - WATER SEP SEL svc - PULL SEP 1 (PULL SEP 2)

## SYMPTOMS

9. WATER SEP SEL svc - PULL SEP 1 (PULL SEP 2)
   - **YELLOW**

## PROCEDURE

1. WATER SEP SEL svc - PULL SEP 1 (PULL SEP 2)
   - **YES**
   - NO
   - WATER SEP SEL svc - PULL SEP 1 (PULL SEP 2)

## SYMPTOMS

10. WATER SEP SEL svc - PULL SEP 1 (PULL SEP 2)
    - **YELLOW**

## ENVIRONMENTAL CONTROL SUBSYSTEM

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SYMPTOM

1. ECS light on if pump < 3 psid
2. MASTER ALARM RED
3. ECS yellow (Momentary on)
4. GLYCOL yellow (Momentary on)
5. GLYCOL

PROCEDURE

1. ECS light on?
   - YES
     2. GLYCOL selected
       - YES
         3. CB ECS: GLYCOL PUMP AUTO TRNFR = open
         - YES
           4. GLYCOL PUMP NO. 2 FAILED
           - NO
             5. GLYCOL PUMP NO. 1 FAILED
     - NO
       6. GLYCOL PUMP NO. 1 FAILED

2. RELAY INRS FAILED CLOSED
   - YES
     7. GLYCOL set - PUMP 1

3. TEMPORARY CLOSURE OF PUMP A-P SWITCH
   - YES
     8. CB ECS: GLYCOL PUMP AUTO TRNFR - close
     - YES
       9. GLYCOL PUMP NO. 2 FAILED
       - NO
         10. GLYCOL PUMP NO. 2 FAILED

4. GLYCOL PUMP NO. 1 & AUTO TRANSFER FAILED
   - YES
     11. GLYCOL PUMP NO. 1 & AUTO TRANSFER FAILED

5. PRIMARY GLYCOL LOOP LEAK
   - YES

6. GLYCOL PUMP-A-P SWITCH FAILED CLOSED (MOM)
   - YES
     12. GLYCOL set - PUMP 2
     - NO
       13. GLYCOL PUMP-A-P SWITCH CAUSED AUTO TRANSFER

7. TEMPORARY CLOSURE OF PUMP A-P SWITCH CAUSED AUTO TRANSFER
   - YES
     14. CB ECS: GLYCOL PUMP AUTO TRNFR = open
     - YES
       15. GLYCOL PUMP NO. 2 FAILED
       - NO
         16. PRIMARY GLYCOL LOOP LEAK

8. GLYCOL PUMP-A-P SWITCH CAUGHT CLOSED (MOM)
   - YES

9. TEMPORARY OVERCURRENT
   - YES
     2. CB ECS: PUMP 1 - close
     - YES
       4. GLYCOL PUMP NO. 1 FAILED

10. GLYCOL PUMP NO. 1 FAILED
    - NO
      5. GLYCOL set - PUMP 2

11. GLYCOL PUMP-A-P SWITCH CAUGHT CLOSED (MOM)
    - YES

REMARKS

1. Auto-transfer monitoring capability is lost.
2. Primary loop redundancy is lost.
3. Primary loop flow must be started within 2 minutes to prevent freeze-up of primary sublimator.
4. Glucose monitoring capability is lost.
5. Primary loop flow must be started within 2 minutes to prevent freeze-up of primary sublimator.
6. Secondary loop redundancy is lost.
7. Component caution lights remain available for monitoring.
8. Primary loop flow must be started within 2 minutes to prevent freeze-up of primary sublimator.
9. Possible contamination of ascent H2O with glycol.
10. Assumption: PUMP 1 initially selected.
11. Primary loop redundancy is lost.
<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLYCOL</td>
<td>ECS GLYCOL temp ind &gt; 50°F</td>
<td>If CWEA or low level sensor failed, primary glycol loop monitoring capability is lost. GLYCOL cau1t will remain on.</td>
</tr>
<tr>
<td></td>
<td>GLYCOL TEMP ind increasing at high rate</td>
<td>ECS: GLYCOL press ind-monitor. If pressure decreases to &lt; 15 psia, slow leak confirmed. When GLYCOL comp cau1t goes on, proceed</td>
</tr>
<tr>
<td></td>
<td>PRIM EVAP FLOW No. 2 vtv-OPEN</td>
<td>PRIMARY PRESSURE REG FAILED CLOSED OR LINE BLOCKAGE</td>
</tr>
<tr>
<td></td>
<td>PRIM EVAP FLOW No. 2 vtv-CLOSE</td>
<td>PRIMARY SUBLIMATOR FAILURE</td>
</tr>
<tr>
<td></td>
<td>THERMAL OVERLOAD OR DEGRADED PERFORMANCE OF PRIMARY SUBLIMATOR</td>
<td>Primary sublimator dryout required before attempted restart per normal procedure.</td>
</tr>
</tbody>
</table>

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### APOLLO OPERATIONS HANDBOOK

#### ENVIRONMENTAL CONTROL SUBSYSTEM

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Both cabin fans on?</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td>EGS: GLYCOL temp ind. normal?</td>
<td>NO</td>
</tr>
<tr>
<td></td>
<td>EGS: CABIN TEMP ind. decreases?</td>
<td>NO</td>
</tr>
<tr>
<td></td>
<td>CABIN TEMP XDICER FAILED</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td>CABIN TEMP IND.</td>
<td>5. Only manual control of cabin temp is available.</td>
</tr>
</tbody>
</table>

#### PROCEDURE

1. **ECS: CABIN FAN 1 & 2 - close**
2. **CABIN TEMP XDICER FAILED**
3. **ECS: CABIN TEMP XDICER FAILED**
4. **CABIN TEMP XDICER FAILED**
5. **CABIN TEMP XDICER FAILED**

### SYMPTOM

<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>EGS: SUIT PRESS ind &gt;3.0 psia</td>
</tr>
<tr>
<td></td>
<td>PRESS REG A &amp; B vlv-XDICER (Normal suit pressure is 3.8 ± 0.2 psia)</td>
</tr>
<tr>
<td></td>
<td>EGS: SUIT PRESS ind - decreases?</td>
</tr>
<tr>
<td></td>
<td>PRESS REG A vlv - CLOSE</td>
</tr>
<tr>
<td></td>
<td>PRESS REG B vlv regulating high or failed open</td>
</tr>
<tr>
<td></td>
<td>PRESS REG B vlv regulating high or failed open</td>
</tr>
</tbody>
</table>

---

**Basic Date:** February 1969

**Change Date:** _______________
### Symptom: O₂ QTY

#### Procedure:

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vehicle staged?</td>
</tr>
<tr>
<td>2</td>
<td>Crew aware of abnormal use before O₂ QTY went - it-on?</td>
</tr>
<tr>
<td>3</td>
<td>ECS: O₂ QUANTITY ind - normal?</td>
</tr>
<tr>
<td>4</td>
<td>LEAK IN #1 ASC O₂ OUTSIDE CABIN</td>
</tr>
<tr>
<td>5</td>
<td>XDUCE FAILURE</td>
</tr>
<tr>
<td>6</td>
<td>ECS: O₂ QUANTITY ind - normal?</td>
</tr>
<tr>
<td>7</td>
<td>PRESS REG B vlv - DIRECT O₂ for min</td>
</tr>
<tr>
<td>8</td>
<td>LEAK IN #1 ASC O₂ LINE INSIDE CABIN</td>
</tr>
<tr>
<td>9</td>
<td>XDUCE FAILURE</td>
</tr>
<tr>
<td>10</td>
<td>DSCNT O₂ QUANTITY ind - decreases?</td>
</tr>
</tbody>
</table>

#### Remarks:

- **Assumption:** #1 ASC O₂ used initially.
- **Loss of CMGA requires observation of ECS O₂ QUANTITY ind for O₂ status.
- **MSFN monitors O₂ manifold pressure to verify loss of O₂.** DSS O₂ fill valve must be open & applicable tank selected for monitoring.
- **Onboard O₂ quantity monitoring capability is lost.**

---

### Symptom: O₂ QTY

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Vehicle staged?</td>
</tr>
<tr>
<td>12</td>
<td>Crew aware of abnormal use before O₂ QTY went - it-on?</td>
</tr>
<tr>
<td>13</td>
<td>ECS: O₂ QUANTITY ind - normal?</td>
</tr>
<tr>
<td>14</td>
<td>LEAK IN #1 ASC O₂ OUTSIDE CABIN</td>
</tr>
<tr>
<td>15</td>
<td>XDUCE FAILURE</td>
</tr>
<tr>
<td>16</td>
<td>ECS: O₂ QUANTITY ind - normal?</td>
</tr>
<tr>
<td>17</td>
<td>PRESS REG B vlv - DIRECT O₂ for min</td>
</tr>
<tr>
<td>18</td>
<td>LEAK IN #1 ASC O₂ LINE INSIDE CABIN</td>
</tr>
<tr>
<td>19</td>
<td>XDUCE FAILURE</td>
</tr>
<tr>
<td>20</td>
<td>DSCNT O₂ QUANTITY ind - decreases?</td>
</tr>
</tbody>
</table>

#### Remarks:

- **Assumption:** #1 ASC O₂ used initially.
- **Loss of CMGA requires observation of ECS O₂ QUANTITY ind for O₂ status.
- **MSFN monitors O₂ manifold pressure to verify loss of O₂.** DSS O₂ fill valve must be open & applicable tank selected for monitoring.
- **Onboard O₂ quantity monitoring capability is lost.**

---

### Symptom: O₂ QTY

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>DSCNT O₂ QUANTITY ind - decreases?</td>
</tr>
<tr>
<td>23</td>
<td>LEAK IN #2 ASC O₂ OUTSIDE CABIN</td>
</tr>
</tbody>
</table>

#### Remarks:

- **Assumption:** #1 ASC O₂ used initially.
- **Loss of CMGA requires observation of ECS O₂ QUANTITY ind for O₂ status.
- **MSFN monitors O₂ manifold pressure to verify loss of O₂.** DSS O₂ fill valve must be open & applicable tank selected for monitoring.
- **Onboard O₂ quantity monitoring capability is lost.**
### Apollo Operations Handbook

#### Environmental Control Subsystem

**Symptom:**
- Abnormal decrease in descent O₂ before CWS activation

**Procedure:**
1. **YES**
   - ECS CABIN PRESS ind > 5 psia?
     - DES O₂ PULL - CLOSE
     - CABIN REPRESS VLV - CLOSE
     - SUIT GAS DIVERTER VLV - FULL EGRESS
     - O₂-10% GYD MON set-DES
     - ECS O₂ QUANTITY ind - O₂ quantity decrease continues?

2. **YES**
   - DESCENT O₂ LEAK OUTSIDE CABIN

3. **NO**
   - Stable at >33% O₂ quantity?

4. **YES**
   - ECS CABIN PRESS ind - stable

5. **NO**
   - PRESS REG A VLV - CLOSE
   - DES O₂ VLV - OPEN

6. **YES**
   - ECS CABIN PRESS ind - 4.6 to 5.0 psia?

7. **NO**
   - PRESS REG B VLV FAILED OPEN

8. **YES**
   - ECS CABIN PRESS ind - 4.6 to 5.0 psia

9. **NO**
   - PRESS REG B VLV FAILED OPEN

10. **YES**
    - TEMPORARY UNSEATING OF CABIN REPRESS VLV OR TEMPORARILY FAILED - OPEN PRESSURE REG

11. **YES**
    - LEAK IN DESCENT O₂ SUPPLY BE YOND DES O₂ VLV & DESCENT O₂ SUPPLY LINE PENETRATION OF CABIN

12. **YES**
    - PRESS REG A VLV - CLOSE
    - PRESS REG B VLV - CLOSE
    - CABIN REPRESS VLV - AUTO
    - SUIT GAS DIVERTER VLV - PUSH CABIN

13. **YES**
    - AUTO position of CABIN REPRESS VLV is imperat.
SYMPTOM
RED
Light on if suit pressure <3.12 psia or suit fan No. 2 fails when selected.

PROcedure
1. Suit flow?
   YES: ΔP switch failure or CWEA failure
   NO: Press ind > 3.12
   YES: Suit fan ΔP switch failed
   NO: Suit fan No. 2 failed

SELECT SUIT FAN 1

REMARKS
Operating on suit fan No. 2 and suit fan No. 1 is still operable.
SUIT/FAN warning lit and SUIT FAN comp sel it off when ECS ECS:
SUIT FAN ΔP open. CWEA inputs of suit fan No. 1 or 2 are de-
activated. Crew must rely on sensing O2 flow.
SUIT/FAN warning is lost. If suit fan No. 2 fails, crew must rely on
sensing O2 flow.

H2O SEP comp caut it will go on
when H2O separator < 800 r.p.m.
Automatic form suit protection is
lost when ECS SUIT FLOW
CONT open.

ADDITIONAL SYMPTOMS

SYMPTOM
SUIT PRESSURE TRANSDUCER FAILURE

REMARKS
Change Date

ENVIROMENTAL CONTROL SUBSYSTEM

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### Symptom

- **Pressur 7 5 psia.**

### Procedure

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Procedure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ECS; SUIT &amp; CABIN PRESS ind- equal?</td>
<td>NO (SUIT PRESS = 4.6 TO 5.0 PSIA)</td>
<td>1. CABIN PRESSURE INDICATOR FAILED</td>
</tr>
<tr>
<td>3. ECS, SUIT PRESS ind. increases?</td>
<td>YES</td>
<td>3. Excess O2 into cabin was dumped overboard thru cabin pressure relief valves.</td>
</tr>
<tr>
<td>4. NO</td>
<td>3. To prevent overpressurization of cabin.</td>
<td></td>
</tr>
<tr>
<td>5. ECS, CABIN PRESS ind. increases?</td>
<td>YES</td>
<td>5. Rate of pressure increase is function of O2 leak rate into cabin.</td>
</tr>
<tr>
<td>6. PRESS REG B vlv- OPEN</td>
<td>YES</td>
<td>5. AUTO position of CABIN REPRESS vlv is lost.</td>
</tr>
<tr>
<td>7. PRESS REG A vlv- OPEN</td>
<td>YES</td>
<td>7. PRESS REG vlv redundancy is lost.</td>
</tr>
<tr>
<td>8. TEMPORARY LEAK INSIDE CABIN</td>
<td>YES</td>
<td>8. Excess O2 into cabin was dumped overboard thru cabin pressure relief valves.</td>
</tr>
<tr>
<td>9. OPEN #2 I# ASC O2 tank is depleted.</td>
<td>9. PRESS REG vlv can be set to CABIN mode in function of remaining O2 quantity. Real-time decrease.</td>
<td></td>
</tr>
<tr>
<td>10. CABIN REPRESS VLV LEAKS in AUTO POSITION</td>
<td>YES</td>
<td>9. Open #2 (or 1) ASC O2 tank when 1 (or 0) ASC O2 tank is depleted.</td>
</tr>
</tbody>
</table>

### Remarks

- (DECS, SUIT PRESS ind can be used to monitor cabin pressure in cabin mode.)
- (Assumption: #3 ASC O2 is used initially. If #2 ASC O2 is used initially, numbers in parentheses apply.)
### Symptom 15

**ECs Press: GLYCOL & quantity ind. fail; its on RED**

- **Procedure**
  1. CB ECS DISP - open? **YES**
  2. CB ECS DISP - remains closed? **NO**
  3. CB ECS DISP - OPEN INADVERTENTLY

**CAUTION**

- Following ECS indicators are inoperative:
  - Suit/Cabin Temp
  - Suit/Cabin press
  - Part press CO2
  - Glycol Temp/Press
  - O2/HeO2 Quantity

**Remarks**

1. Onboard capability for monitoring ECS parameters is lost.
2. MSFN can monitor ECS parameters while in LOS.

### Symptom 16

**ECS GLYCOL ind. fail: it on RED**

- **Procedure**
  1. To prevent freeze-up of HTS primary sublimator, this procedure must be accomplished within 1 minute.
  2. ECS GLYCOL press ind = 15 psia
  3. ECS PRESS IND/PWR FAIL LT FAIL: TRNFR - close

**CAUTION**

- Assumption: Pump No. 1, initially selected MASTER ALARM pbil. ECS and H & GLYCOL comp could go on.

**Remarks**

1. Onboard capability for monitoring glycol temperature pressure is lost.
2. MSFN still alerts crew to primary glycol-loop malfunction.
3. MSFN can monitor primary glycol-loop operation while in LOS.
### SYMPTOM 17

**ECS: PRESS ind per fail it on**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Action</th>
<th>NEXT Step</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cable pressurized?</td>
<td>YES</td>
<td>NEXT 2</td>
</tr>
<tr>
<td>2</td>
<td>- ECS: CABIN REPRESS - open</td>
<td>NO</td>
<td>NEXT 6</td>
</tr>
<tr>
<td>3</td>
<td>- ECS: ENGLISH - open</td>
<td>NO</td>
<td>NEXT 6</td>
</tr>
<tr>
<td>4</td>
<td>- ECS: QUANTITY ind per fail it on</td>
<td>RED</td>
<td>NEXT 8</td>
</tr>
<tr>
<td>5</td>
<td>ECS: QUANTITY ind per fail it on</td>
<td>YES</td>
<td>NEXT 10</td>
</tr>
<tr>
<td>6</td>
<td>ECS: QUANTITY ind per fail it on</td>
<td>NO</td>
<td>NEXT 11</td>
</tr>
</tbody>
</table>

### SYMPTOM 18

**ECS: QUANTITY ind per fail it on**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Action</th>
<th>NEXT Step</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vehicle staged?</td>
<td>YES</td>
<td>NEXT 2</td>
</tr>
<tr>
<td>2</td>
<td>- DES position of O\textsubscript{2}, H\textsubscript{2}O QTY MON set - DES</td>
<td>YES</td>
<td>NEXT 3</td>
</tr>
<tr>
<td>3</td>
<td>- O\textsubscript{2}, H\textsubscript{2}O QTY MON set - ASC 1</td>
<td>NO</td>
<td>NEXT 4</td>
</tr>
<tr>
<td>4</td>
<td>- O\textsubscript{2}, H\textsubscript{2}O QTY MON set - DES</td>
<td>NO</td>
<td>NEXT 5</td>
</tr>
</tbody>
</table>

### REMARKS

1. Assumption: Helmet & gloves are donned.
   - PGA pressure gage is not useful at this time because minimum reading is 2.3 psig.
2. Onboard capability for monitoring suit & cabin pressure is lost.
   - CMERA still alerts crew to low suit or cabin pressure.
   - MSFN can monitor suit & cabin pressure while in LOS.

3. DES position of O\textsubscript{2}, H\textsubscript{2}O QTY MON set is used to provide a different signal input to determine status of indicator. If indicator has failed, pointers will remain in position indicated when power is lost.
4. Onboard capability for monitoring O\textsubscript{2} and H\textsubscript{2}O quantity is lost.
5. Assumption: No. 1 ASC O\textsubscript{2} is being used, therefore, CMERA still alerts crew to low No. 1 ASC O\textsubscript{2} quantity.
6. Allows MSFN to monitor 1 ASC O\textsubscript{2} and H\textsubscript{2}O quantity when in LOS.
7. MSFN can monitor descent quantity when in LOS.
8. CMERA still alerts crew to low descent O\textsubscript{2} or H\textsubscript{2}O quantity or leak in ASC O\textsubscript{2} or H\textsubscript{2}O tanks.
5.2.12 EXPLOSIVE DEVICES

Table 5-23. ED Procedure Entry Sheet

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED RELAYS caut lt</td>
<td>1</td>
<td>5.2-139</td>
</tr>
<tr>
<td>Ascent fuel or oxid tank remains at blanket pressure after ascent</td>
<td>2</td>
<td>5.2-140</td>
</tr>
<tr>
<td>pressurization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED: STAGE SEQ RLY SYS A &amp; B comp caut lt not on when attempting to set</td>
<td>3</td>
<td>5.2-140</td>
</tr>
<tr>
<td>ED: MASTER ARM sw to ON</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5-24. ED Failure/Symptom Cross-Reference Index

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascent tank pressure indicator or circuitry failure</td>
<td>Ascent fuel or oxid tank remains at blanket pressure after ascent</td>
<td>2</td>
<td>5.2-140</td>
</tr>
<tr>
<td>pressurization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CWEA failure</td>
<td>ED RELAYS caut lt</td>
<td>1</td>
<td>5.2-139</td>
</tr>
<tr>
<td>Double failure of ED: ASC He PRESS sw</td>
<td>Ascent fuel or oxid tank remains at blanket pressure after ascent</td>
<td>2</td>
<td>5.2-140</td>
</tr>
<tr>
<td>explosive vlvs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double failure of ED: ASC He SEL sw or</td>
<td>Ascent fuel or oxid tank remains at blanket pressure after ascent</td>
<td>2</td>
<td>5.2-140</td>
</tr>
<tr>
<td>explosive vlvs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED: ASC He PRESS sw contacts did not make on first attempt</td>
<td>Ascent fuel or oxid tank remains at blanket pressure after ascent</td>
<td>2</td>
<td>5.2-140</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ed: MASTER ARM sw contacts did not make on first attempt</td>
<td>ED: STAGE SEQ RLY SYS A &amp; B comp caut lt not on when attempting to set</td>
<td>3</td>
<td>5.2-140</td>
</tr>
<tr>
<td></td>
<td>ED: MASTER ARM sw to ON</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED: MASTER ARM sw failed off (double failure)</td>
<td>ED: STAGE SEQ RLY SYS A &amp; B comp caut lt not on when attempting to set</td>
<td>3</td>
<td>5.2-140</td>
</tr>
<tr>
<td></td>
<td>ED: MASTER ARM sw to ON</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED: MASTER ARM sw jammed off</td>
<td>ED: STAGE SEQ RLY SYS A &amp; B comp caut lt not on when attempting to set</td>
<td>3</td>
<td>5.2-140</td>
</tr>
<tr>
<td></td>
<td>ED: MASTER ARM sw to ON</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED sys A relay K1, K3, K4, K5, or K6 failed closed</td>
<td>ED RELAYS caut lt</td>
<td>1</td>
<td>5.2-139</td>
</tr>
<tr>
<td>ED sys A stage command relay K2 temporarily failed closed</td>
<td>ED RELAYS caut lt</td>
<td>1</td>
<td>5.2-139</td>
</tr>
<tr>
<td>ED sys B relay K1, K3, K4, K5, or K6 failed closed</td>
<td>ED RELAYS caut lt</td>
<td>1</td>
<td>5.2-139</td>
</tr>
<tr>
<td>ED sys B stage command relay K2 temporarily failed closed</td>
<td>ED RELAYS caut lt</td>
<td>1</td>
<td>5.2-139</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ED RELAYS</td>
<td><strong>WARNING</strong> Do not set ED: MASTER ARM sw to ON; staging could occur.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>WARNING</strong> Light on if contacts of master arm relay K1 or relay K2 through KG in staging sequence (stage command, cable cutting, deadfacing, and separation of nuts &amp; bolts) fail closed.</td>
</tr>
<tr>
<td>2</td>
<td>ED: STAGE SEQ RLY SYS A comp caud R-off?</td>
<td>Reset relay <strong>ED: STAGE RELAY sw~RESET</strong> <strong>ED: STAGE SEQ RLY SYS A comp caud R-off?</strong></td>
</tr>
<tr>
<td>3</td>
<td>ED SYS A STAGE COMMAND RELAY K2 TEMPORARILY FAILED CLOSED</td>
<td>CB ED: LOGIC PWR A-open</td>
</tr>
<tr>
<td>4</td>
<td>ED SYS A RELAY K1, K3, K4, K5, OR KG FAILED CLOSED</td>
<td><strong>CAUTION</strong> When FITH is to be performed, redundancy of ED system must be regained. After ABORT STAGE push, CB ED: LOGIC PWR A close</td>
</tr>
<tr>
<td>5</td>
<td>ED STAGE SEQ RLY SYS B comp caud R-on?</td>
<td>Reset relay <strong>ED: STAGE RELAY sw~RESET</strong> <strong>ED: STAGE SEQ RLY SYS B comp caud R-on?</strong></td>
</tr>
<tr>
<td>6</td>
<td>ED SYS B STAGE COMMAND RELAY K2 TEMPORARILY FAILED CLOSED</td>
<td>CB ED: LOGIC PWR B-open</td>
</tr>
<tr>
<td>7</td>
<td>ED SYS B RELAY K1, K3, K4, K5, OR KG FAILED CLOSED</td>
<td><strong>CAUTION</strong> When FITH is to be performed, redundancy of ED system must be regained. After ABORT STAGE push, CB ED: LOGIC PWR A close</td>
</tr>
</tbody>
</table>

**REMARKS**

- DMSN can confirm failure via telemetry.
### SYMPTOM

2 AccesT fuel or oXid tank remains at blank pressure after ascent pressurization.

### PROCEDURE

1. MSFN: All ascent tanks pressurized? **YES**
   - **NO**

2. Attempt pressurization:
   - ED: ASC He SEL sw-uppressurized tank
   - ED: MASTER ARM sw-ON
   - ED: ASC He PRESS sw-FIRE
   - Tank pressurized? **YES**
     - **NO**

3. Attempt pressurization:
   - CB S/C: ABORT STAGE (2)-open
   - ABORT STAGE pb-push
   - ABORT STAGE pb-reset
   - CB S/C: ABORT STAGE (2)-close
   - Tank pressurized? **YES**
     - **NO**

4. Double failure of ED: ASC He SEL SW on EXPLOSIVE VLVS

5. ED: ASC He PRESS SW contacts did not make on first attempt

6. ED: MASTER ARM sw-OFF
   - MASTER ALARM sw-off
   - MASTER ALARM pb-reset
   - CB S/C: ABORT STAGE (2)-close
   - CB S/C: ABORT STAGE (2)-open
   - ED: RELAY caution-FIRE
   - MASTER ALARM pb-reset
   - MASTER ALARM sw-off
   - ABORT STAGE pb-push
   - ABORT STAGE pb-reset
   - CB S/C: ABORT STAGE (2)-open

### REMARKS

- Master alarm comes on when ED MASTER ARM sw set to OFF due to relay race removing OREA inhibit.

### SYMPTOM

3 EXPLOSIVE DEVICES

### PROCEDURE

1. ED: MASTER ARM sw-recycle

2. ED: MASTER ARM sw-ON

3. ED: STAGE SEQU L SY S A & B come on when attempting to set ED: MASTER ARM sw to ON

4. ED: STAGE SEQU L SY S A & B come on when attempting to set ED: MASTER ARM sw to OFF

5. ED: MASTER ARM SW FAILED OFF

6. ED: MASTER ARM SW contacts did not make on first attempt

### REMARKS

- ED caUt is -- on and MASTER ALARM -- on due to depressing ABORT STAGE pb while ABORT STAGE pb while ABORT STAGE pb are open.
- ED caUt is -- off when ABORT STAGE pb -- reset.

---

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**Page:** 5.2-140
<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
</table>
| 4       | EPS VOLTS ind.  
< 35 vdc open circuit | 1. Affected battery is considered lost, but will be used in conjunction with other ED system to perform ED functions.  
• CB ED LOGIC PWR A (B) - open | |
| 5       | MFN informs crew:  
closed failure in relay, (K1 thru K10) of sys A or B  
Disarm failed ED system. Do not arm system until cryogenic pressurization | 1. CB ED LOGIC PWR A (B) - open | |

**EXPLOSIVE DEVICES**

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5.2.13 LIGHTING

5.2.13.1 Assumptions

- Troubleshooting will be performed when mission phase and task loading permit. Accordingly, certain malfunction procedures will not be performed until a main engine burn or critical maneuver is completed.

- Malfunction procedures are entered from normal operational modes. Procedures for checkout modes are not included.

Table 5-25. LTG Procedure Entry Sheet

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead floodlights do not go on</td>
<td>1</td>
<td>5.2-147</td>
</tr>
<tr>
<td>Overhead floodlights remain on with LTG: FLOOD sw set to OFF &amp; overhead hatch closed</td>
<td>2</td>
<td>5.2-147</td>
</tr>
<tr>
<td>EL numerics failed on</td>
<td>3</td>
<td>5.2-147</td>
</tr>
<tr>
<td>EL numerics failed off</td>
<td>4</td>
<td>5.2-148</td>
</tr>
<tr>
<td>EL panel lights failed off</td>
<td>5</td>
<td>5.2-149</td>
</tr>
<tr>
<td>EL panel lights failed on</td>
<td>6</td>
<td>5.2-150</td>
</tr>
<tr>
<td>MASTER ALARM pb/lt and tone come on without C/W, or comp caut Its</td>
<td>7</td>
<td>5.2-150</td>
</tr>
<tr>
<td>Docking Its do not go on</td>
<td>8</td>
<td>5.2-150</td>
</tr>
<tr>
<td>Tracking lt does not go on</td>
<td>9</td>
<td>5.2-150</td>
</tr>
</tbody>
</table>

Table 5-26. LTG Failure/Symptom Cross-Reference Index

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-c dimmer failure</td>
<td>EL numerics failed off</td>
<td>4</td>
<td>5.2-148</td>
</tr>
<tr>
<td>Burned-out lamp or blown fuse in single output of lighting control assembly transformer</td>
<td>EL numerics failed off</td>
<td>4</td>
<td>5.2-148</td>
</tr>
<tr>
<td>CB failure or short in forward panels EL circuitry</td>
<td>EL panel lights failed off</td>
<td>5</td>
<td>5.2-149</td>
</tr>
<tr>
<td>CB left open</td>
<td>Docking Its do not go on</td>
<td>8</td>
<td>5.2-150</td>
</tr>
<tr>
<td>Circuitry failure in a-c dimmer high-power assembly</td>
<td>EL panel lights failed off</td>
<td>5</td>
<td>5.2-149</td>
</tr>
<tr>
<td>Docking hatch sw or LTG: FLOOD sw failed closed</td>
<td>Overhead floodlights remain on with LTG: FLOOD sw set to OFF &amp; overhead hatch closed</td>
<td>2</td>
<td>5.2-147</td>
</tr>
<tr>
<td>Docking lights circuit open</td>
<td>Docking Its do not go on</td>
<td>8</td>
<td>5.2-150</td>
</tr>
<tr>
<td>Failure in CWEA</td>
<td>MASTER ALARM pb/lt and tone come on without C/W, or comp caut Its</td>
<td>7</td>
<td>5.2-150</td>
</tr>
<tr>
<td>Failure in d-c circuit of lighting control assembly</td>
<td>MASTER ALARM pb/lt and tone come on without C/W, or comp caut Its</td>
<td>7</td>
<td>5.2-150</td>
</tr>
</tbody>
</table>
Table 5-26. LTG Failure/Symptom Cross-Reference Index (cont)

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure in dimmer circuitry</td>
<td>MASTER ALARM pb/lt and tone come on without C/W, or comp caut lts</td>
<td>7</td>
<td>5,2-150</td>
</tr>
<tr>
<td>Failure in EL dimming circuitry or control, or in LTG: OVERRIDE</td>
<td>EL panel lights failed on</td>
<td>6</td>
<td>5,2-150</td>
</tr>
<tr>
<td>INTEGRAL sw</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failure in LTG: FLOOD sw or floodlight circuitry</td>
<td>Overhead floodlights do not go on</td>
<td>1</td>
<td>5,2-147</td>
</tr>
<tr>
<td>Failure in numerics dimming circuit or control, or in LTG: OVERRIDE NUM sw</td>
<td>EL numerics failed on</td>
<td>3</td>
<td>5,2-147</td>
</tr>
<tr>
<td>Failure of lamps or exterior lighting control circuitry</td>
<td>Docking lts do not go on</td>
<td>8</td>
<td>5,2-150</td>
</tr>
<tr>
<td>Failure of SLA pressure sw on LM, Outrigger or associated circuitry, or failure of lamps or exterior lighting control circuitry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hatch pressure sw failed open</td>
<td>Overhead floodlights do not go on</td>
<td>1</td>
<td>5,2-147</td>
</tr>
<tr>
<td>Lamp failure in annuciator associated with malfunction</td>
<td>MASTER ALARM pb/lt and tone come on without C/W, or comp caut lts</td>
<td>7</td>
<td>5,2-150</td>
</tr>
<tr>
<td>LTG: ANUM/NUM cont open winding or bad wiper contact</td>
<td>EL numerics failed off</td>
<td>4</td>
<td>5,2-148</td>
</tr>
<tr>
<td>LTG: FLOOD cont winding open</td>
<td>Overhead floodlights do not go on</td>
<td>1</td>
<td>5,2-147</td>
</tr>
<tr>
<td>LTG: FLOOD sw OVHD/FWD position failed</td>
<td>Overhead floodlights do not go on</td>
<td>1</td>
<td>5,2-147</td>
</tr>
<tr>
<td>LTG: OVERRIDE INTEGRAL sw failed open in both positions</td>
<td>EL panel lights failed off</td>
<td>5</td>
<td>5,2-149</td>
</tr>
<tr>
<td>LTG: OVERRIDE NUM sw failed or numeric lighting circuitry open</td>
<td>EL numerics failed off</td>
<td>4</td>
<td>5,2-148</td>
</tr>
<tr>
<td>LTG: SIDE PANELS sw failed</td>
<td>EL panel lights failed off</td>
<td>5</td>
<td>5,2-149</td>
</tr>
<tr>
<td>One set of floodlights failed</td>
<td>EL panel lights failed on</td>
<td>6</td>
<td>5,2-150</td>
</tr>
<tr>
<td>Open circuit in EL lamp</td>
<td>Overhead floodlights do not go on</td>
<td>1</td>
<td>5,2-147</td>
</tr>
<tr>
<td>Open winding in dimmer control or bad wiper contact</td>
<td>EL panel lights failed off</td>
<td>5</td>
<td>5,2-149</td>
</tr>
<tr>
<td>Short in a-c dimmer low-power assembly or in LTG: ANUM/NUM cont</td>
<td>EL numerics failed off</td>
<td>4</td>
<td>5,2-148</td>
</tr>
<tr>
<td>Short in a-c dimming assembly</td>
<td>EL panel lights failed off</td>
<td>5</td>
<td>5,2-149</td>
</tr>
<tr>
<td>Short in both side panels EL circuitry</td>
<td>EL panel lights failed off</td>
<td>5</td>
<td>5,2-149</td>
</tr>
<tr>
<td>Short in CDR side panels EL circuitry</td>
<td>EL panel lights failed off</td>
<td>5</td>
<td>5,2-149</td>
</tr>
</tbody>
</table>

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Table 5-26. LTG Failure/Symptom Cross-Reference Index (cont)

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short in LMP side panels EL circuitry</td>
<td>EL panel lights failed off</td>
<td>5</td>
<td>5,2-149</td>
</tr>
<tr>
<td>Short in numeric lighting assembly or CB/AC BUS B: NUM LTG failure</td>
<td>EL numerics failed off</td>
<td>4</td>
<td>5,2-148</td>
</tr>
<tr>
<td>Tracking lit or circuitry failure</td>
<td>Tracking lit does not go on</td>
<td>9</td>
<td>5,2-150</td>
</tr>
</tbody>
</table>
SYMPTOM

1. Overhead floodlights do not go on
2. Overhead floodlights remain on with LTG FLOOD SW set to OFF & overhead hatch closed
3. EL numerics failed on

PROCEDURE

1. LTG FLOOD sw - ONHD/FWD
   - Overhead & forward floodlights - on
   - YES (NORMAL OPERATION)
   - HATCH PRESSURE SW FAILED OPEN
2. Only one pair (CR or LMP) of floodlights on
   - YES
   - LTG FLOOD SW FAILED CLOSED
   - FAILURE IN LTG FLOOD LIGHT CIRCUITRY
   - Use numerics only when required.
   - When numerics are not required:
     - LTG FLOOD sw - OFF
3. LTG FLOOD sw - ALL
   - Overhead, forward, & side panel floodlights - on
   - YES
   - LTG FLOOD SW ONHD/FWD POSITION FAILED

REMARKS

1. It is assumed that CR LTG FLOOD is closed.
2. This failure is detectable only when hatch is open.
3. If visual task permits, turn remaining set of floodlights on bright or use utility lights, penlights, or some combination of these lights.
4. Lower brightness range is used.

Supplementary Notes:
- If visual task permits, turn remaining set of floodlights on bright or use utility lights, penlights, or some combination of these lights.
- Lower brightness range is used.
SYMPTOM 5 EL panel lights failed off

PROCEDURE 1 How many EL lamps failed off?
- ALL
- ONE

2 LED SIDE PANELS sw FAILED
- LED SIDE PANELS sw (LMP or CDR)-off
- LED FLOOD sw ALL or OVHD/FWD

3 OPEN CIRCUIT IN EL LAMP

4 LED FLOOD sw ALL or OVHD/FWD (if needed)

5 Position of CB/AC BUS A: INTL LTG
- OPEN
- CLOSED

6 CB/AC BUS A: INTL LTG - remains closed?

7 SHORT IN A/C DIMMING ASSEMBLY

8 CB/AC BUS A: INTL LTG - remains closed?

9 SHORT IN LMP SIDE PANELS EL CIRCUITRY

10 SHORT IN CDR SIDE PANELS EL CIRCUITRY

11 CB FAILURE OR SHORT IN FORWARD PANELS EL CIRCUITRY
- LED FLOOD sw ALL or OVHD/FWD

12 CB FAILURE OR SHORT IN Forward PANELS EL CIRCUITRY
- LED FLOOD sw ALL or OVHD/FWD (as desired)

13 LED INTEGRAL cont - adjust over complete range

14 EL lights - on?

15 CIRCUIT FAILURE IN A/C DIMMER HIGH-POWER ASSEMBLY

REMARKS
- Floodlighting remains available.
- Dimming capability is lost.
- LED lamps on panels 12, 14, & 16, or 8 & 11.

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<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROCEDURE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>EL panel lights failed on</td>
<td><strong>1</strong> How many EL lamps failed on? <strong>2</strong> LTG SIDE PANELS SW FAILED ON <strong>3</strong> FAILURE IN EL DIMMING CIRCUITRY OR CONTROL OR IN LTG OVERRIDE INTEGRAL SW <strong>4</strong> CB/AC BUS A, INVOLVING LTG OPEN <strong>5</strong> LTG FLOOD SW ALL OR ONE/FWD</td>
</tr>
<tr>
<td>7</td>
<td>DIOEROR ALARM pb &amp;/and have come on w/ &amp; w/o C/W or comp card on</td>
<td><strong>1</strong> C/W PWR card it-on? <strong>2</strong> FAILURE IN CB/WR</td>
</tr>
<tr>
<td>8</td>
<td>Docking Its do not go on</td>
<td><strong>1</strong> Mission phase? <strong>2</strong> TRANSITION DOOKING</td>
</tr>
<tr>
<td>9</td>
<td>Tracking It does not go on</td>
<td><strong>1</strong> Tracking LT or CIRCUITRY FAILURE</td>
</tr>
</tbody>
</table>
5.2.12 HEATERS

5.2.12.1 Assumptions

- Assume no action will be taken during a critical mission phase.
- One heat system (4/QUAD) can maintain temperature above 119°F.

Table 5-23. HTR Procedure Entry Sheet

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sym No.</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEATER caut lt</td>
<td>1</td>
<td>5.2-153</td>
</tr>
<tr>
<td>RCS QUAD 1, 2, 3, or 4 temp &lt; 119°F or &gt; 190°F</td>
<td>2</td>
<td>5.2-153</td>
</tr>
<tr>
<td>S-band antenna temp &lt; -64°F or &gt; +153°F</td>
<td>3</td>
<td>5.2-154</td>
</tr>
<tr>
<td>RR temp &lt; -54°F or &gt; +148°F</td>
<td>4</td>
<td>5.2-155</td>
</tr>
<tr>
<td>LR temp &lt; -19°F or &gt; +148°F</td>
<td>5</td>
<td>5.2-155</td>
</tr>
</tbody>
</table>

Table 5-24. HTR Failure/Symptom Cross-Reference Index

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold soak or instrumentation failure</td>
<td>S-band antenna temp &lt; -64°F or &gt; +153°F</td>
<td>3</td>
<td>5.2-154</td>
</tr>
<tr>
<td></td>
<td>RR temp &lt; -54°F or &gt; +148°F</td>
<td>4</td>
<td>5.2-155</td>
</tr>
<tr>
<td>CWEA failure</td>
<td>HEATER caut lt</td>
<td>1</td>
<td>5.2-153</td>
</tr>
<tr>
<td>Heater circuitry failure or cold soak</td>
<td>LR temp &lt; -19°F or &gt; +148°F</td>
<td>5</td>
<td>5.2-155</td>
</tr>
<tr>
<td>Heat soak</td>
<td>S-band antenna temp &lt; -64°F or &gt; +153°F</td>
<td>3</td>
<td>5.2-154</td>
</tr>
<tr>
<td></td>
<td>RR temp &lt; -54°F or &gt; +148°F</td>
<td>4</td>
<td>5.2-155</td>
</tr>
<tr>
<td>Heat soak or instrumentation failure</td>
<td>S-band antenna temp &lt; -64°F or &gt; +153°F</td>
<td>3</td>
<td>5.2-154</td>
</tr>
<tr>
<td></td>
<td>RR temp &lt; -54°F or &gt; +148°F</td>
<td>4</td>
<td>5.2-155</td>
</tr>
<tr>
<td></td>
<td>LR temp &lt; -19°F or &gt; +148°F</td>
<td>5</td>
<td>5.2-155</td>
</tr>
<tr>
<td>Instrumentation failure</td>
<td>S-band antenna temp &lt; -64°F or &gt; +153°F</td>
<td>3</td>
<td>5.2-154</td>
</tr>
<tr>
<td></td>
<td>RR temp &lt; -54°F or &gt; +148°F</td>
<td>4</td>
<td>5.2-155</td>
</tr>
<tr>
<td></td>
<td>LR temp &lt; -19°F or &gt; +148°F</td>
<td>5</td>
<td>5.2-155</td>
</tr>
<tr>
<td>LR heater circuitry failure</td>
<td>LR temp &lt; -19°F or &gt; +148°F</td>
<td>5</td>
<td>5.2-155</td>
</tr>
</tbody>
</table>
# Table 5-24. HTR Failure/Symptom Cross-Reference Index (cont)

<table>
<thead>
<tr>
<th>Failure</th>
<th>Symptom</th>
<th>Sym No.</th>
<th>Page No.</th>
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</thead>
<tbody>
<tr>
<td>Probable instrumentation failure</td>
<td>S-band antenna temp $&lt; -64^\circ F$ or $&gt; +153^\circ F$</td>
<td>3</td>
<td>5.2-154</td>
</tr>
<tr>
<td></td>
<td>RR temp $&lt; -54^\circ F$ or $&gt; +148^\circ F$</td>
<td>4</td>
<td>5.2-155</td>
</tr>
<tr>
<td>Rndz rdr opr heater circuitry failure</td>
<td>RR temp $&lt; -54^\circ F$ or $&gt; +148^\circ F$</td>
<td>4</td>
<td>5.2-155</td>
</tr>
<tr>
<td>Rndz rdr stby heater circuitry failure</td>
<td>RR temp $&lt; -54^\circ F$ or $&gt; +148^\circ F$</td>
<td>4</td>
<td>5.2-155</td>
</tr>
<tr>
<td>S-band antenna heater circuitry failure</td>
<td>S-band antenna temp $&lt; -64^\circ F$ or $&gt; +153^\circ F$</td>
<td>3</td>
<td>5.2-154</td>
</tr>
<tr>
<td>Sys A/B-1 automatic heater sys failure or quad 1, 2, 3, or 4 temp $&lt; 119^\circ F$ or $&gt; 190^\circ F$</td>
<td>2</td>
<td>5.2-153</td>
<td></td>
</tr>
<tr>
<td>Sys A/B-2 automatic heater sys failure</td>
<td>RCS QUAD 1, 2, 3, or 4 temp $&lt; 119^\circ F$ or $&gt; 190^\circ F$</td>
<td>2</td>
<td>5.2-153</td>
</tr>
</tbody>
</table>
**Symptom**

- HEATER

**Procedure**

1. **SYMPTOM**
   - HEATER
     - LIGHT ON IF HEATER TEMP IS OUT OF TOLERANCE AS FOLLOWS:
     - RR < 54 ° or > 148 ° F
     - SB < 64 ° or > 153 ° F
     - RCS < 119 ° or > 190 ° F
     - LIGHT GOES OFF WHEN HEATER TEMPERATURE IS SET TO THE EFFECTED HEATER POSITION.

2. **SYMPTOM**
   - RCS QUAD 1, 2, 3, or 4 TEMP < 119 ° or > 190 ° F

**Remarks**

- After HEATER caust it goes off, temperature of affected heater must be monitored to determine that it comes back into limits. HEATER caust it will not go on again for that same failure or future fault of that heater until normal limits are established.
- Onboard monitoring capability is not yet fully coordinated with MFPN.

- Since 200 ° F is a user-limit when it pegs high, crew will have to close all RCS: SYS A & B QUAD 1, 2, 3 & 4 switches. TCA valve seat deformation can occur at high temperatures.

- MFPN monitor power consumption to determine heater performance.
SYMPTOM

S-band antenna temp

< -64°F or

> +153°F

Monitor S-band antenna temp.

PROCEDURE

1. Monitor S-band antenna temp.

2. Check heater circuitry.
   - CB HTR: S BD ANT - open
   - Temp decreases?

3. S-band antenna operating?

4. Leave CB HTR: S BD ANT open.
   - Temp remains same?

5. Check instrumentation.
   - Continue S-band antenna operation.

6. S-band antenna operating?

7. Heat soak

8. Probable instrumentation failure

9. Instrumentation failure

10. Leave CB HTR: S BD ANT open.

11. Attempt to increase temp.

12. Probable instrumentation failure

13. Cold soak

14. S-band antenna operating?

15. Consult MSFN.

16. Continuation of the procedure.

REMARKS

Heaters

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#### SYMPTOM

| RR temp <- 54°F or >= 148°F |

#### PROCEDURE

1. **Monitor RR temp.**
   - If HTR CONT. TEMP MON set, RNDZ RDR.
2. **HTR CONT. TEMP set?**
   - If <= 54°F, go to 3.
   - If >= 148°F, go to 4.
3. **Isolate heater circuitry failure.**
   - If CB HTR, RNDZ RDR closed and RNDZ RDR OPR open, go to 4.
4. **RNDZ RDR OPR HEATER CIRCUIT FAILURE**
   - Do not close CB HTR, RNDZ RDR.

#### REMARKS

- **SYMPTOM**

- **PROCEDURE**

- **REMARKS**