Rendezvous

STS-126

Mission Operations Directorate
Flight Design and Dynamics Division

Final
October 2, 2008

Verifying this is the correct version for the pending operation (training, simulation or flight). Electronic copies of FDF books are available. URL: http://mod.jsc.nasa.gov/do3/FDF/index.html
MISSION OPERATIONS DIRECTORATE

RENEZVOUS
STS-126

FINAL
October 2, 2008

PREPARED BY:

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Book Manager

APPROVED BY:

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Lead, Rendezvous Guidance and Procedure Group

ACCEPTED BY:

Scott Dunham
Chief, Orbit Dynamics Branch

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Incorporates the following:

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**AREAS OF TECHNICAL RESPONSIBILITY**

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NOTE
This checklist is the controlling crew document for the ISS-ULF2 rendezvous and separation. The Rendezvous Timeline begins at Ti -3:00 hr and continues through docking. This is a complete stand-alone document. The Separation Timeline begins 45 min prior to undock and continues through 1:15 after undock. The undock/separation profile assumes a subsequent ejectable deploy of the Pico Sat satellite.

Timeline pages assume an FD3 rendezvous and undocking on FD14. Lighting is based on planned rendezvous altitude of 205 nm. Targeting I-Loads are based on 210 nm.
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<td>RNDZ-17b/126/O/A</td>
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</tbody>
</table>

* – Omit from flight book
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**FLIGHT RULES SUMMARY**

**RNDZ/PROX OPS BREAKOUT PROCEDURES OVERVIEW**

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<tr>
<th>RANGE BREAKOUT REQD</th>
<th>BREAKOUT PROCEDURE AND SUMMARY</th>
</tr>
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<tr>
<td>Prior to Ti</td>
<td>Discontinue RNDZ burns; specific breakout only on MCC call</td>
</tr>
<tr>
<td>Ti - 5 Minutes</td>
<td>If GO for Ti not received, Perform Ti Delay Burn, 5-27</td>
</tr>
<tr>
<td>Between Ti and TORVA init (+X burns to start TORVA are complete)</td>
<td>RNDZ BREAKOUT (CONTINGENCY OPS), 5-18 3 fps retrograde</td>
</tr>
<tr>
<td>Between TORVA init (+X burns to start TORVA are complete) and Vbar arrival</td>
<td>SHUTTLE NOSE IN-PLANE BREAKOUT (CONTINGENCY OPS), 5-16 1.5 fps ±X burn, followed in 30 min by 4.3/3.6 fps retrograde/out-of-plane burn (posigrade if second approach is desired)</td>
</tr>
<tr>
<td>Between Vbar arrival and contact OR Between undock and flyaround start</td>
<td>VBAR BREAKOUT (CONTINGENCY OPS), 5-14 If RNG &lt; 150 ft, back out to 150 ft. When RNG &gt; 150 ft, perform 1.5 fps radial up burn in LO Z, followed in 28 min by 3.0 fps posigrade/retrograde burn</td>
</tr>
<tr>
<td>During flyaround</td>
<td>SHUTTLE NOSE IN-PLANE BREAKOUT (CONTINGENCY OPS), 5-16 1.5 fps ±X burn, followed in 30 min by 4.3/3.6 fps retrograde/out-of-plane burn (posigrade if second approach is desired)</td>
</tr>
<tr>
<td>Otherwise:</td>
<td>SEP MANEUVER (ORB OPS), Perform 1 fps away from target, followed in 2 min by 2 fps out of plane, followed in 15 min by 3 fps posigrade</td>
</tr>
</tbody>
</table>

**SHUTTLE BACKOUT**

| Prior to docking                                      | See VBAR CORRIDOR BACKOUT (CONTINGENCY OPS), 5-12                                             |
RNDZ BURN SOLUTION SELECTION GUIDELINES

<table>
<thead>
<tr>
<th>BURN</th>
<th>SOLUTION PRIORITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>All burns prior to, but not including, NCC</td>
<td>1) Ground solution</td>
</tr>
<tr>
<td>NCC &amp; Ti</td>
<td>1) Onboard FLTR solution if STRK or RR NAV converged* (for COAS, use step 2 below)</td>
</tr>
<tr>
<td></td>
<td>2) Onboard FLTR solution if it agrees with ground solution**</td>
</tr>
<tr>
<td></td>
<td>3) Onboard PROP solution if it agrees with ground solution</td>
</tr>
<tr>
<td></td>
<td>4) Ground solution</td>
</tr>
<tr>
<td>Post-Ti midcourse corrections</td>
<td>1) Onboard solution</td>
</tr>
</tbody>
</table>

*For the purpose of burn solution selection, NAV is converged if for the present sensor in acquisition (RR or STRK), at least 40 marks have been accepted with state vector position update of less than 0.5 Kft for at least the last 4 marks; or if state vector updates are small and stable. These criteria do not apply to COAS NAV

**Burn solutions are considered to be in agreement if delta Vs differ by no more than the ‘final-ground’ limits for each axis

RNDZ BURN ENGINE SELECTION GUIDELINES

<table>
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<tr>
<th>DELTA V</th>
<th>ENGINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4 fps</td>
<td>RCS – Primary technique is multi-axis</td>
</tr>
<tr>
<td>4 to 6 fps</td>
<td>RCS – Primary technique is +X</td>
</tr>
<tr>
<td>&gt; 6 fps</td>
<td>OMS – Single engine</td>
</tr>
<tr>
<td>FAILURE</td>
<td>RESPONSE</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>No sensor data (RR, STRK, or COAS) during RNDZ and no visual acquisition</td>
<td>Breakout Burn by MC2 + 20 min</td>
</tr>
<tr>
<td>Good sensor data (RR, STRK, or COAS) during RNDZ, but no visual or RR acquisition</td>
<td>Breakout Burn by MC2 + 24 min</td>
</tr>
<tr>
<td>Target &gt; 30 deg from COAS horizontal at start of radar fail correction</td>
<td>Breakout ASAP; use RNDZ BREAKOUT (CONTINGENCY OPS), 5-18, until RBAR arrival</td>
</tr>
<tr>
<td>Prop quantities violate bingo numbers on RNDZ PRPLT PAD (Cue Card) or Orbiter systems malfunctions require breakout</td>
<td>Breakout per overview on 1-2</td>
</tr>
<tr>
<td><strong>SYSTEMS:</strong></td>
<td></td>
</tr>
<tr>
<td>DPS: &lt; 2 GNC GPCs</td>
<td>2 GNC GPCs reqd for Ti and PROX OPS within 250 ft. Loss of GNC GPC redundancy inside 250 ft requires backout to 250 ft and stationkeep until reconfiguration to a 2 GNC redundant set is complete</td>
</tr>
<tr>
<td>GNC: Loss of redundant +Z Trans or PRCS TRANS, any axis ↓ or PRCS ROT, any axis ↓ or AFT THC (-Z sense), &gt; 1 TX contact ↓, all TY contacts ↓, all TZ contacts ↓ or AFT RHC, all channels, any axis ↓ or &lt; 2 IMUs</td>
<td>PROX OPS within 250 ft not permitted. For loss of 2 TX contacts in the “out” (-) direction, PROX OPS permitted if forward THC is available for braking redundancy and manned within 75 ft For loss of 2 TX contacts in the “in” (+) direction, PROX OPS permitted if DAP remains in Translation Pulse while aft Flight Control Power is ON</td>
</tr>
<tr>
<td>Both Left Aft firing jets ↓ or Both Right Aft firing jets ↓</td>
<td>Continue Approach, per DEGRADED +X TRANSLATION (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>Two Forward firing jets ↓</td>
<td>Continue Approach, per DEGRADED -X TRANSLATION (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>Both Forward Right firing jets ↓ or Both Forward Left firing jets ↓</td>
<td>PROX OPS within 250 ft not permitted. Approach or Backout to 250 ft per LOSS OF FORWARD SIDE FIRING JETS (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>One Forward Down firing jet ↓</td>
<td>Continue Approach per LOSS OF ONE FxD JET (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>Both Forward Down firing jets same side ↓</td>
<td>PROX OPS within 250 ft not permitted. Approach or Backout to 250 ft per LOSS OF BOTH FxD JETS (SAME SIDE) (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>Loss of VRCS</td>
<td>Use ALT in place of VERN during RNDZ, approach outside 2000 ft, and sep Use PRI in place of VERN during approach inside 2000 ft, and flyaround See LOSS OF VRCS (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>MECH: 1 KU ANTENNA STOW MOTOR ↓</td>
<td>Normal ops</td>
</tr>
</tbody>
</table>
ORB RENDEZVOUS PROFILE

PET EVENT
-3:00 START RNDZ T/L (not shown)
-2:22 NH BURN (not shown)
-1:32 NC BURN
-1:28 S TRK NAVIGATION
-0:58 NCC BURN
-0:44 RADAR NAVIGATION
-0:00 Ti BURN

ISS AT CENTER OF ROTATING LVLH REFERENCE FRAME
- S TRK NAVIGATION
- NIGHT

1-5

RNDZ/126/FIN
ORBIT POST Ti PROFILE

Vbar

-10 -20 -30 -40 -50 kft

MC4
SUNRISE
MC3

MC2
SUNSET

MC1

Ti
NOON

ISS AT CENTER OF
ROTATING LVLH
REFERENCE FRAME

PET EVENT
0:00 Ti BURN
0:05 RR NAV (OR S TRK NAV, IF REQD)
0:20 MC1 BURN
~0:31 OOP NULL BURN
0:36 SUNSET
~0:50 MC2 BURN
~1:07 MC3 BURN
~1:12 SUNRISE
~1:17 MC4 BURN, START MANUAL PHASE

S TRK
NIGHT

Rbar

kft

15
## TERMINAL PHASE, RPM, AND TORVA

<table>
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<th>MC2 ET (h:mm)</th>
<th>Range (ft) CG - CG</th>
<th>Rdot (fps)</th>
<th>EVENT</th>
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<tr>
<td>1</td>
<td>0:27 7000</td>
<td>-3.0</td>
<td>MANUALLY PHASE TAKEOVER (POST-MC4)</td>
</tr>
<tr>
<td></td>
<td>0:29 1700</td>
<td>-2.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0:31 1500</td>
<td>-2.1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0:36 1000</td>
<td>-1.3</td>
<td>TRANSITION TO LOWZ</td>
</tr>
<tr>
<td></td>
<td>0:37 900</td>
<td>-1.1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>800 -0.9</td>
<td></td>
<td>WHEN IN RBAR ATTITUDE LOAD DAP A9/B9 MOD DAP A PRI/VERN ROT RATE TO 0.75 DEG/SEC AND YAW JET OPTION TO BOTH NOSE &amp; TAIL (ALL) LOAD UNIV PTG P=145 DEG</td>
</tr>
<tr>
<td></td>
<td>700 -0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>650 -0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0:46 620</td>
<td>0.0</td>
<td>STATIONKEEP TO AVOID SHADOWING IF REQUIRED</td>
</tr>
<tr>
<td>6</td>
<td>1:00 OPTION 620</td>
<td>-0.35</td>
<td>INITIATE RPM: DAP A/PRI, ITEM 19 WHEN -Z ADI PITCH &gt; 100 DEG; DAP A/VERN WHEN -Z ADI PITCH &gt; 170 DEG; DAP FREE, RESET UNIV PTG P=270 DEG, ITEM 19, DAP PRI DIGITAL IMAGERY TAKEN FROM ISS SM WHEN -Z ADI PITCH &gt; 10 DEG; DAP AUTO WHEN RPM COMPLETE: DAP VERN</td>
</tr>
<tr>
<td></td>
<td>600 -0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>580 -0.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1:11 OPTION 600</td>
<td>-0.7</td>
<td>RELOAD DAP A9, LOAD UNIV PTG P=179 DEG, REESTABLISH RDOT PER TORVA ICs INITIATE TORVA: DAP A, ITEM 19 (+X PULSES AS REQ'D TO NULL TARGET MOTION IN CAMERA)</td>
</tr>
<tr>
<td></td>
<td>550 -0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>500 -0.4</td>
<td></td>
<td></td>
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</table>
VBAR APPROACH

<table>
<thead>
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<th>MC2 ET (h:mm)</th>
<th>Range (ft)</th>
<th>Rdot (fps)</th>
<th>EVENT</th>
</tr>
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<tbody>
<tr>
<td>8</td>
<td>1:25</td>
<td>320</td>
<td>-0.20</td>
</tr>
<tr>
<td></td>
<td>1:42</td>
<td>110</td>
<td>-0.15</td>
</tr>
<tr>
<td></td>
<td>1:46</td>
<td>75</td>
<td>-0.10</td>
</tr>
<tr>
<td>9</td>
<td>1:54</td>
<td>30</td>
<td>-0.07</td>
</tr>
<tr>
<td>10</td>
<td>2:05</td>
<td>0</td>
<td>-0.10</td>
</tr>
</tbody>
</table>
### UNDOCKING, TORS/TORF, AND FINAL SEPARATION

<table>
<thead>
<tr>
<th>UNDOCK ET (h:mm)</th>
<th>Range (ft)</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0:03</td>
<td>0</td>
<td>ORBITER AND ISS IN FREE DRIFT TO BEGIN UNHOOKING (ISS LVLH PYR 0, 0, 0, ATTITUDE)</td>
</tr>
<tr>
<td>1 0:00</td>
<td>0</td>
<td>UNDOCKING AT MIDNIGHT-2 MIN; DAP B/ALT MODE TO LVLH; MAINTAIN CORRIDOR</td>
</tr>
<tr>
<td>0:01</td>
<td>2</td>
<td>SELECT VERN; PERFORM DAP B +Z NORMZ BURNS AT 10 SEC INTERVALS TO BUILD OPENING RATE TO 0.15 FPS</td>
</tr>
<tr>
<td>&gt;0:03</td>
<td>&gt;30</td>
<td>DAP B +Z NORMZ BURNS AT 10 SEC INTERVALS TO BUILD OPENING RATE TO 0.20 FPS</td>
</tr>
<tr>
<td>2 0:07</td>
<td>75</td>
<td>TRANSITION TO LOWZ</td>
</tr>
<tr>
<td>3 0:29 [1:15]*</td>
<td>&gt;400 (CG-CG)</td>
<td>SEP1: 1.5 FPS +X RADIAL BURN [IF PROP AVAILABLE, PERFORM 1/4 LAP TORS BETWEEN 400 AND 600 FT (CG-CG); NULL OPENING RATE OUTSIDE 600 FT; PERFORM 3/4 LAP TORS BETWEEN 600 AND 700 FT; THEN PERFORM SEP 1]</td>
</tr>
<tr>
<td>4 0:57 [1:43]*</td>
<td>&gt;2000 (CG-CG)</td>
<td>SEP2: 5.0 FPS +X, NORMZ RETROGRADE BURN</td>
</tr>
<tr>
<td>1:43 [2:29]*</td>
<td></td>
<td>SEP3: 5.0 FPS +X NORMZ RETROGRADE BURN, APPROX. 1/2 REV AFTER SEP2</td>
</tr>
</tbody>
</table>

* Alternate Times are for Flyaround Case
UNDOCKING / SEPARATION TIMELINE

UNDOCKING/SEPARATION PAD (4A)

Nominal Undocking Time: __________:________:________
Orbiter Weight: __________

Flyaround Terminate Criteria Post-Undocking:
When FRCS QTY < ___ % or L or R RCS QTY < ___ %:

Go to SHUTTLE NOSE IN-PLANE BREAKOUT (CONTINGENCY OPS), 5-16 >>
UNDOCKING / SEPARATION TIMELINE

- **2-00:45:** DPS config for Undocking Ops - STRING 1233
- **2-00:40:** CONFIGURE FOR SEPARATION
- **2-00:35:** ENABLE RENDEZVOUS NAV
- **2-00:30:** ON RPOP PGSCs:
  - Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-15, then:
  - Perform RPOP OPS (RNDZ TOOLS), 7-16, then:
  - Perform TCS ACTIVATION, steps 1 thru 3 (RNDZ TOOLS), 7-18, then:
  - Perform TCS MANUAL ACQUISITION, step 1 (RNDZ TOOLS), 7-19
  
  (Set RANGE = 4 ft, AZIMUTH = 0, ELEVATION = 0)
  
  NOTE: TCS will not track until after undock
- **2-00:25:** Perform HHL CHECKOUT/OPS (RNDZ TOOLS), 7-14
- **2-00:20:** Perform DOCKING MECHANISM POWERUP (APDS), 8-5
  
  UNDOCKING PREP (APDS), 8-7
- **2-00:15:** Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZ TOOLS), 7-2
- **2-00:10:** MCC UPDATE
  
  ORB SV
  
  TGT SV
  
  Covar Matrix
- **2-00:05:** MCC UPDATE
  
  Undocking Time
- **2-00:00:** MCC FOR GO TO POWER UP Vern AND Pri DRIVERS (Pri in (6A)
  
  RJD MANF LS/FS/R5 DRIVER - ON
  
  Wait 5 sec.
  
  DAP: AUTO

**CONFIGURE FOR SEPARATION**

- **GNC 20 DAP CONFIG**
  
  CRT
  
  √DAP config: A12
  
  √DAP: LO Z
  
  √DAP: A/AUTO/VERN

- **A6U**
  
  ADI ATT - LVLH
  
  ERR - MED
  
  RATE - MED
  
  SENSE - Z
  
  √FLT CNTLR PWR - OFF

- **GNC 23 RCS**
  
  CRT
  
  RCS F – ITEM 1 EXEC (+)
  
  JET DES F1L – ITEM 9 EXEC (no *)
  
  F3L – ITEM 11 EXEC (no *)
  
  F2R – ITEM 13 EXEC (no *)
  
  F4R – ITEM 15 EXEC (no *)
  
  F1U – ITEM 17 EXEC (no *)
  
  F3U – ITEM 19 EXEC (no *)
  
  F2U – ITEM 21 EXEC (no *)

- **GNC UNIV PTG**
  
  TGT ID
  
  +2
  
  BODY VECT
  
  +5
  
  +180
  
  y
  
  +0
  
  OM
  
  +0
  
  √TRK - ITEM 19 EXEC (CUR - *)
  
  √ERR TOT - ITEM 23 EXEC (+)
  
  OPS 202 PRO

- **GNC ORBIT MNVR EXEC**
  
  Set TIG to Undocking Time and update Orbiter weight per (4A)
  
  Enter any non-zero ∆V
  
  LOAD – ITEM 22 EXEC
  
  TIMER – ITEM 23 EXEC
  
  OPS 201 PRO

  Install –Z COAS
  
  KU OPS Cue Card
  
  CORRIDOR Overlay
  
  RANGE RULER Overlay

**ENABLE RENDEZVOUS NAV**

- **GNC 35 REL NAV**
  
  CRT
  
  RNDZ NAV ENA - ITEM 1 EXEC (+)
  
  SV SEL, ITEM 4 - FLTR
**UNDOCKING OPERATIONS [6A]**

1. **PREP FOR UNDOCKING**
   - When MCC-H and ISS issue GO for Undocking:
     - CRT: ORB TO TGT - ITEM 10 EXEC
     - O14, O15, O16:E
     - A6U: FLT CNTLR PWR - ON

2. **RECONFIGURE DAP**
   - CRT: Config DAP A,B to A9,B9
     - X Jets ROT ENA – ITEM 7 EXEC (no *)
     - DAP: B/FREE/ALT
     - DAP TRANS: NO LO Z
     - DAP TRANS: PULSE/PULSE/PULSE
     - SENSE: –Z

3. **COMMAND UNDOCKING**
   - CRT: A7L  SM 167 DOCKING STATUS
     - A7L: If Hooks 1(2) fail to drive (HK1(2) DRV CMD - OFF): *
       - OPEN HOOKS pb - push
       - If Hooks 1(2) appear to stop before reaching end of travel *
       - [HK1(2) Pos > 4% + not decr]: *
       - Allow for single motor drive time (~4:40) before performing *
       - POWER OFF pb - push *
       - ON pb - push *

4. **POST UNDOCKING**
   - Inform MCC-H and ISS: “Physical Separation”
     - When petals clear:
       - DAP: B/LVLH/ALT
       - √DAP TRANS: PULSE/PULSE/PULSE, NO LO Z
         - THC: as reqd to maintain C/L target within 8 deg corridor on C/L camera
       - Note: DAP A allowed for ±X and –Z (in) THC

5. **POWER OFF**
   - CRT: A7L  POWER OFF pb - push
     - STATUS lt (eighteen) - lt off

**UNDOCKING / SEPARATION TIMELINE**

- **00:00**
  - √HOOKS 1, HOOKS 2 OPEN lt (two) - lt on [HK1,HK2 POS (two) = 4-5%]
  - UNDOCK COMPLETE lt - lt on
  - (confirmed by no physical separation):
    - Inform MCC: “Hooks failed to open”
    - POWER OFF pb - push
    - CLOSE HOOKS pb - push
    - HK1,HK2 POS (two) - incr
    - HOOKS 1, HOOKS 2 CLOSED lt (two) - lt on [HK1,HK2 POS=92-93%]
    - PERFORM DOCKING MECHANISM POWERDOWN (APDS), 8-6
    - MCC for IFM capability
    - Prepare for 96 BOLT EVA TIMELINE (EVA FS, ORB CONT EVA)
    - then,
    - Perform ODS HOOKS OPEN-CONTINGENCY (APDS), 8-27

- **00:00**
  - Inform MCC-H and ISS: “Physical Separation”

- **-02:20**
  - UNDOCKING pb - push
  - √HOOKS 1, HOOKS 2 CLOSED lt (two) - lt off [HK1,HK2 POS (two) < 92% + decr]

- **-00:30**
  - √INTERF SEALED lt - lt off
  - √READY TO HOOK lt - lt off [HK1,HK2 POS (two) approx 30%]

- **-03:00**

- **-02:20**
  - If Hooks 1(2) fail to drive (HK1(2) DRV CMD - OFF): *
  - OPEN HOOKS pb - push
  - If Hooks 1(2) appear to stop before reaching end of travel *
  - [HK1(2) Pos > 4% + not decr]: *
  - Allow for single motor drive time (~4:40) before performing *
  - POWER OFF pb - push *
  - ON pb - push *

- **-00:00**
  - √HOOKS 1, HOOKS 2 OPEN lt (two) - lt on [HK1,HK2 POS (two) = 4-5%]
  - UNDOCK COMPLETE lt - lt on
  - (confirmed by no physical separation):
    - Inform MCC: “Hooks failed to open”
    - POWER OFF pb - push
    - CLOSE HOOKS pb - push
    - HK1,HK2 POS (two) - incr
    - HOOKS 1, HOOKS 2 CLOSED lt (two) - lt on [HK1,HK2 POS=92-93%]
    - POWER OFF pb - push
    - PERFORM DOCKING MECHANISM POWERDOWN (APDS), 8-6
    - MCC for IFM capability
    - Prepare for 96 BOLT EVA TIMELINE (EVA FS, ORB CONT EVA)
    - then,
    - Perform ODS HOOKS OPEN-CONTINGENCY (APDS), 8-27

- **4. POST UNDOCKING**
  - Inform MCC-H and ISS: “Physical Separation”

- **5. POWER OFF**
  - POWER OFF pb - push
  - STATUS lt (eighteen) - lt off
  - GO TO SEP/FLYAROUND [6A]
MCC UPDATE
GO for Undocking

MCC: GO FOR UNDOCKING

UNDOCKING OPERATIONS [6A]

UNDOCK COMPLETE
## UNDOCKING / SEPARATION TimELINE

### SEP/FLYAROUND [BA]

1. **When RNG > 75 ft (DP-DP):**
   - **DAP:** LO Z
   - **THC:** (Maintain RDOT > 0.2 fps)
     - Maintain C/L tgt within 8 deg corridor on C/L camera
   - **NOTE:** DAP A allowed for ± X and ± Z THC

   - If TCS not tracking during corridor sep or flyaround, provide periodic HHL range updates to MCC

2. **When RNG > 150 ft (DP-DP):**
   - If radar desired, INIT RADAR ACQ [10A]
   - **NOTE:** DAP A allowed for all THC Inputs

3. **When RNG > 250 ft:**
   - Set RPOP POR: ORB CG - TGT CG
   - Set RPOP Overlay: Flyaround Zone [Shift][F7]
     - Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6

4. **When RNG = 450 ± 50 FT (CG-CG):**

   - **GNC UNIV PTG**
     - TGT ID: √ +2
     - BODY VECT: √ +5
     - P: √ +80
     - Y: √ +0
     - OM: √ +0
   - √ ERR TOT – ITEM 23 (+)
   - TRK – ITEM 19 EXEC (CUR - +)

   - If no flyaround, Go to SEP BURN [8B]

   - If flyaround, Go to FLYAROUND [9A]

### SEP BURNS [8B]

#### 1. RADIAL BURN

- **DAP TRANS:** NORM/PULSE/PULSE
- **THC:** +X (up) 6 sec (1.5 fps)
- **DAP:** A/AUTO/VERN(PRI)
- **DAP TRANS:** PULSE/PULSE/PULSE
- **FLT CNTRL PWR – OFF**

   - Inform MCC when SEP complete

   - **Record Radial Burn TIG _____/_____:______**

   - **[GNC_2 TIME]**
     - Set GNC TIMER counting to SEP-2 burn (Radial Burn TIG + 28 min)

#### 2. CONFIG FOR SEP-2 BURN

- At SEP-2 burn TIG – 1 minute:
  - **A6U** √ SENSE: –Z
  - **FLT CNTRL PWR – ON**
  - **DAP TRANS:** NORM/PULSE/PULSE
  - **DAP:** NO LO Z

#### 3. SEP-2 BURN

- At SEP-2 burn TIG:
  - Alt THC: +X (up) 24 sec (5.0 fps)
  - **DAP:** A/INRTL/VERN(PRI)
  - **DAP TRANS:** PULSE/PULSE/PULSE
  - **FLT CNTRL PWR – OFF**

   - Inform MCC when SEP complete

   - **[GNC_2 TIME]**
     - Set GNC TIMER counting to SEP-3 burn (Radial Burn TIG + 1hr 13min)

#### 4. CONFIG FOR SEP-3 BURN

- At SEP-3 burn TIG – 25 minutes:

   - **[GNC UNIV PTG]**
     - TGT ID: √ +2
     - BODY VECT: √ +5
     - P: √ +80
     - Y: √ +0
     - OM: √ +0
     - √ ERR TOT – ITEM 23 (+)
     - TRK – ITEM 19 EXEC (CUR - +)

   - At SEP-3 burn TIG – 1 minute:

   - **A6U** √ SENSE: –Z
   - **FLT CNTRL PWR – ON**
   - **DAP TRANS:** NORM/PULSE/PULSE

#### 5. SEP-3 BURN

- At SEP-3 burn TIG:
  - Alt THC: +X (up) 24 sec (5.0 fps)
  - **DAP TRANS:** PULSE/PULSE/PULSE
  - **FLT CNTRL PWR – OFF**

   - Inform MCC when SEP complete

   - Go to TERMINATE SEP OPS [8C]

## TERMINATE SEP OPS [8C]

- **GNC 33 REL NAV**
- **CRT**
  - RNDZ NAV ENA - ITEM 1 EXEC (no +)

- **A6L**
  - LIGHTS TRUSS FWD, AFT (two) - OFF
  - VESTIBULE PORT, STBD (two) - OFF

   - Exit RPOP - [Shift][F10]
   - Perform TCS DEACTIVATION (RNDZ TOOLS), 7-20
   - Perform HHL STOW (RNDZ TOOLS), 7-14

   - Go to FLIGHT PLAN
FLYAROUND

1. DAP: A/AUTO/VERN (PRI)
   THC: Maintain ISS CG inside ±15 degree vertical and ±20 degrees horizontal on C/L camera

2. Prior to –Rbar crossing (Aft ADI P = 270):
   GNC UNIV PTG
   P +0 (–VBAR)
   TRK - ITEM 19 EXEC (CUR - *)
   When RNG > 600 ft (CG-CG):
   THC: Maintain flyaround range of 650 ± 50 ft (CG-CG)

3. Prior to –Vbar crossing (Aft ADI P = 0):
   GNC UNIV PTG
   P +270 (+RBAR)
   TRK - ITEM 19 EXEC (CUR - *)

4. Prior to +Rbar crossing (Aft ADI P = 90):
   GNC UNIV PTG
   P +180 (+VBAR)
   TRK - ITEM 19 EXEC (CUR - *)

5. When Aft ADI P > 100 and prior to +Vbar crossing (Aft ADI P = 180):
   GNC UNIV PTG
   P +80
   TRK - ITEM 19 EXEC (CUR - *)

6. Repeat steps 2 thru 5 as reqd to continue flyaround

7. At flyaround completion – 10 minutes:
   If radar not tracking target:
   INITIAL RADAR ACQ (16A)

8. When flyaround complete (in +Vbar attitude),
   Go to SEP BURN (8B)

FLYAROUND RANGE REFERENCE

NOTE: Range conversion assumes ISS CG in center of centerline camera at a CG–CG range of 650 ft, with HHL aim point directly between HHL and ISS CG

<table>
<thead>
<tr>
<th>HHL Aim Point</th>
<th>Raw HHL Range (ft)</th>
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<tbody>
<tr>
<td>Node 2 - Fwd</td>
<td>579</td>
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<tr>
<td>Centerline Target</td>
<td>572</td>
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<tr>
<td>ISS Airlock</td>
<td>632</td>
</tr>
<tr>
<td>Progress - Aft</td>
<td>517</td>
</tr>
</tbody>
</table>

TCS Reflector Visibility During Flyaround

TCS/Reflector Visibility During Flyaround

for Flight ISS-ULF2 (STS-126)

Notes
1. Refl #3 becomes less visible as Orbiter Y_LVLH position becomes more positive (into the page)
2. Refl #5 may be acquired before Refl #2 (based on planar reflector performance flight history)
3. Flyaround range is 600 - 700 ft
4. Some arrays and radiator are not shown for clarity of the TCS reflector information
INITIAL RADAR ACQ [10A]

[GNC 33 REL NAV]
- CRT √ INH RNG, ITEM 18 - (*)
- √ RDOT, ITEM 21 - (*)
- √ Angles, ITEM 24 - (*)
- KU ANT ENA - ITEM 2 EXEC (*)
- GNC I/O RESET
- √ SV SEL, ITEM 4 - (FLTR)
- RADAR - ITEM 13 EXEC (*)

[SM ANTENNA]
- CRT RDR RNG MIN - ITEM 17 EXEC (*)
- A2 DIGI-DIS sel - R/RDOT
- A1U KU PWR - STBY
- MODE - RR PASSIVE
- RADAR OUTPUT - LO
- √ sel - GPC
- CNTL - PNL (wait 3 seconds)
- PWR - ON

IF NO RADAR LOCK-ON WITHIN 2 MIN
- KU sel - AUTO TRK
- SLEW EL,AZ to 0,0 deg
- KU SEARCH - SEARCH (tb – gray)

When lock on occurs:

[GNC 33 REL NAV]
- CRT AUT RNG - ITEM 17 EXEC (+)
- RDOT - ITEM 20 EXEC (+)
- Angles - ITEM 23 EXEC (+)
- If RATIO > 1.0,
  - Force aff mark until RATIO < 1.0

When RESIDs small and stable,

[SM ANTENNA]
- RDR RNG AUTO - ITEM 16 EXEC (+)
MANEUVER PADS
PRELIMINARY ORBIT MANEUVER PAD FOR NH

OMS BOTH 1
L 2
R 3
RCS SEL 4
TV ROLL 5
TRIM LOAD P 6
LY 7
RY 8
WT 9
TIG 10
TGT PEG 7
\( \Delta V_X \) 19
\( \Delta V_Y \) 20
\( \Delta V_Z \) 21

\( \Delta V_{TOT} \)
TGO

BURN ATT
R 24
P 25
Y 26

\( \Delta V_{GGO} \) X
\( \Delta V_{GGO} \) Y
\( \Delta V_{GGO} \) Z

PRE POST-BURN
RCS I'CNCT:
L PRI
L SEC
R PRI
R SEC
NONE

NONE

-\( X \) RCS BURNS:
BURN ATT
R
P
Y

ORBIT BURN MONITOR

NONE

CRIT BURN
NON-CRIT BURN

MAX TIG SLIP ___ MIN
DO NOT UPDATE TIG
UPDATE TIG AFTER ___ MIN

NOTES

MULTI-AXIS

L OMS → RCS
R OMS → RCS
NONE

NONE

2 OMS → 1 OMS
1 OMS → RCS
NONE

GPC FILL-INS ___ (___)

3-2  RNDZ/126/FIN
## Final Orbit Maneuver Pad for NH

### Burn Attitude

<table>
<thead>
<tr>
<th>Burn Attitude</th>
<th>R 24</th>
<th>VGO X ( )</th>
<th>VGO Y ( )</th>
<th>VGO Z ( )</th>
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### Trim Load

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<th>P 6</th>
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### TrIM Roll

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### RCS Selection

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### TV Roll

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### RCS INCT

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<th>R OMS → RCS</th>
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### Down Mode Options

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<th>2 OMS → 1 OMS</th>
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### RCS BURNS

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<th>P 15</th>
<th>Y 16</th>
<th>OM 17</th>
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<tr>
<td></td>
<td>R</td>
<td>P</td>
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### GPC Fill-Ins

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<td>NON-CRIT BURN</td>
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### Orbit Burn Monitor

<table>
<thead>
<tr>
<th>Orbit Burn Monitor</th>
<th>Max TIG Slip ___ Min</th>
<th>Do Not Update TIG</th>
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<tr>
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<td>Update TIG After ___ Min</td>
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### Notes

- None

### OMS GMBL CK

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<tr>
<th>OMS GMBL CK</th>
<th>PRE</th>
<th>POST-BURN</th>
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### RCS InCNCT

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### Notes

- None
PRELIMINARY ORBIT MANEUVER PAD FOR NC

OMS BOTH 1
L 2
R 3
RCS SEL 4
TV ROLL 5

TRIM LOAD P 6
LY 7
RY 8
WT 9
TIG 10

TGT PEG 7 ΔVX 19
ΔVY 20
ΔVZ 21

BURN ATT
R 24
P 25
Y 26

ΔVTOT
TGO

VGO X
VGO Y
VGO Z

HA
HP

OMS GMBL CK:
L PRI
L SEC
R PRI
R SEC
NONE

NOTES

ΔVTOT
TGO

RCS I’CNCT:
L OMS → RCS
R OMS → RCS
NONE

DOWN MODE OPTIONS:
2 OMS → 1 OMS
1 OMS → RCS
NONE

ORBIT BURN MONITOR

GPC FILL-INS

CRIT BURN
NON-CRIT BURN

MAX TIG SLIP

DO NOT UPDATE TIG
UPDATE TIG AFTER ___ MIN

OMS HE REG TEST:

A
B

GPC L OP CL

GPC R OP CL

A
B

-P 15
-Y 16
-OM 17

BURN ATT
R
P

LVLH ATT

NOTES

A
B

-PC FILL-INS

CRIT BURN
NON-CRIT BURN

DO NOT UPDATE TIG
UPDATE TIG AFTER ___ MIN

3-4
RNDZ/126/FIN
### Preliminary Orbit Maneuver Pad for Ti

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<thead>
<tr>
<th>OMS BOTH</th>
<th>L</th>
<th>R</th>
<th>RCS SEL</th>
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### Burn Attitude

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<td>R 24</td>
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### OMS GMBL CK

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<th>POST-BURN</th>
<th>RCS I’CNCT:</th>
<th>NOTES</th>
<th>DOWN MODE OPTIONS:</th>
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### OMS HE REG Test

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<th>-X RCS BURNS:</th>
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### TIDELAY

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### Ti Delay

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### Ti Delay

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<th>ΔVX</th>
<th>19</th>
<th>( )</th>
<th>( )</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>ΔVY</td>
<td>20</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td></td>
<td>ΔVZ</td>
<td>21</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
</tbody>
</table>

### Ti Slip

- If Ti not started by nominal TIG + ___ min, go to Ti DELAY, 5-27

Max Ti DELAY TIG slip ___ min

Do not update Ti

Update Ti after ___ min
### FINAL ORBIT MANEUVER PAD FOR Ti

<table>
<thead>
<tr>
<th>OMS BOTH 1</th>
<th>L 2</th>
<th>R 3</th>
<th>RCS SEL 4</th>
<th>TV ROLL 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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**TRIM LOAD**

<table>
<thead>
<tr>
<th>P 6</th>
<th>LY 7</th>
<th>RY 8</th>
<th>WT 9</th>
<th>TIG 10</th>
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</table>

**TGT PEG 7 ΔVX 19 ΔVY 20 ΔVZ 21**

<table>
<thead>
<tr>
<th>TGT PEG 7 ΔVX 19</th>
<th>ΔVY 20</th>
<th>ΔVZ 21</th>
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</thead>
<tbody>
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<td>( )</td>
<td>( )</td>
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**TIDELAY**

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<thead>
<tr>
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<th>ΔVY 20</th>
<th>ΔVZ 21</th>
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</thead>
<tbody>
<tr>
<td>( )</td>
<td>( )</td>
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**NEW Ti ( BASETIME )**

<table>
<thead>
<tr>
<th>NEW Ti ( BASETIME )</th>
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<tr>
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</table>

**BURN ATT**

<table>
<thead>
<tr>
<th>R 24</th>
<th>P 25</th>
<th>Y 26</th>
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**ΔVTOT TGO**

<table>
<thead>
<tr>
<th>VGO X ( )</th>
<th>VGO Y ( )</th>
<th>VGO Z ( )</th>
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<tr>
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**TGT**

<table>
<thead>
<tr>
<th>HA</th>
<th>HP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** NOTES**

- OMS GMBL CK:
  - PRE
  - POST-BURN
  - RCS I’CNCT:
    - L PRI
    - L SEC
    - R PRI
    - R SEC
    - NONE

- OMS HE REG TEST:
  - NONE

- ORBIT BURN MONITOR
  - GPC FILL-INS __ ( __ )
  - CRIT BURN
  - NON-CRIT BURN

- X RCS BURNS:
  - L OMS → RCS
  - R OMS → RCS
  - NONE

- ORD DOWN MODE OPTIONS:
  - 2 OMS → 1 OMS
  - 1 OMS → RCS
  - NONE

- TIG SLIP:
  - If Ti not started by nominal TIG + ___ min, go to Ti DELAY, 5-27
  - Max Ti DELAY TIG slip ___ min

- DO NOT UPDATE TIG
- UPDATE TIG AFTER ___ MIN
### ORBIT MANEUVER PAD FOR ___________

<table>
<thead>
<tr>
<th>Column</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OMS BOTH</td>
<td>1</td>
</tr>
<tr>
<td>L</td>
<td>2</td>
</tr>
<tr>
<td>R</td>
<td>3</td>
</tr>
<tr>
<td>RCS SEL</td>
<td>4</td>
</tr>
<tr>
<td>TV ROLL</td>
<td>5</td>
</tr>
<tr>
<td>TRIM LOAD</td>
<td>P 6</td>
</tr>
<tr>
<td></td>
<td>LY 7</td>
</tr>
<tr>
<td></td>
<td>RY 8</td>
</tr>
<tr>
<td>WT</td>
<td>9</td>
</tr>
<tr>
<td>TIG</td>
<td>10</td>
</tr>
<tr>
<td>TGT PEG 7</td>
<td>ΔVX 19</td>
</tr>
<tr>
<td></td>
<td>ΔVY 20</td>
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<tr>
<td></td>
<td>ΔVZ 21</td>
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### BURN ATT

<table>
<thead>
<tr>
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<th>Value</th>
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<tbody>
<tr>
<td>R</td>
<td>24</td>
</tr>
<tr>
<td>P</td>
<td>25</td>
</tr>
<tr>
<td>Y</td>
<td>26</td>
</tr>
</tbody>
</table>

### ΔVTOT

<table>
<thead>
<tr>
<th>Column</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TGO</td>
<td>:</td>
</tr>
</tbody>
</table>

### ORBIT BURN MONITOR

- **GPC FILL-INS**: ___ ( ___ )
- **CRIT BURN**: Non-CRIT BURN
- **NONE**: Non-CRIT BURN

### OMS HE REG TEST

- **NONE**: Non-CRIT BURN

### DOWN MODE OPTIONS

- **2 OMS → 1 OMS**: Non-CRIT BURN
- **1 OMS → RCS**: Non-CRIT BURN
- **NONE**: Non-CRIT BURN

### NOTES

- **DO NOT UPDATE TIG**: Non-CRIT BURN
- **UPDATE TIG AFTER ___ MIN**: Non-CRIT BURN

---

**3-8**

RNDZ/126/FIN
**ORBIT MANEUVER PAD FOR ___________**

<table>
<thead>
<tr>
<th>OMS BOTH</th>
<th>L</th>
<th>R</th>
<th>RCS SEL</th>
<th>TV ROLL</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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**TRIM LOAD**

<table>
<thead>
<tr>
<th>P</th>
<th>LY</th>
<th>RY</th>
<th>WT</th>
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</thead>
<tbody>
<tr>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
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</table>

**TV ROLL**

| 5 |

**TRIM LOAD**

<table>
<thead>
<tr>
<th>P</th>
<th>LY</th>
<th>RY</th>
<th>WT</th>
<th>TIG</th>
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<tbody>
<tr>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
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</table>

**RCS SEL**

| 4 |

**OMS BOTH 1**

<table>
<thead>
<tr>
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<tr>
<td>2</td>
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**MULTI-AXIS**

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**BURN ATT**

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<tbody>
<tr>
<td>24</td>
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**ΔVTOT**

<table>
<thead>
<tr>
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**TGT**

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<tr>
<th>HA</th>
<th>HP</th>
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**OMS GMBL CK:**

<table>
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<tr>
<th>PRE</th>
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<tr>
<td>L PRI</td>
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<tr>
<td>L SEC</td>
<td>R SEC</td>
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**RCS I’CNCT:**

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<tr>
<th>L OMS → RCS</th>
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**DOWN MODE OPTIONS:**

<table>
<thead>
<tr>
<th>2 OMS → 1 OMS</th>
<th>1 OMS → RCS</th>
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<table>
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<th>CRIT BURN</th>
<th>NON-CRIT BURN</th>
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**ORBIT BURN MONITOR**

<table>
<thead>
<tr>
<th>GPC FILL-INS</th>
<th>__ ( __ )</th>
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<table>
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<tr>
<th>CRIT BURN</th>
<th>NON-CRIT BURN</th>
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<table>
<thead>
<tr>
<th>MAX TIG SLIP</th>
<th>MIN</th>
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<table>
<thead>
<tr>
<th>DO NOT UPDATE TIG</th>
<th>UPDATE TIG AFTER __ MIN</th>
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**NOTES**

<table>
<thead>
<tr>
<th>GPC</th>
<th>L</th>
<th>OP</th>
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<th>NONE</th>
<th>NON-CRIT BURN</th>
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<tbody>
<tr>
<td>A</td>
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<td></td>
<td></td>
<td></td>
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<table>
<thead>
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<tbody>
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<table>
<thead>
<tr>
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<th>LVLH ATT</th>
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<tbody>
<tr>
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<th>-X RCS BURNS:</th>
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<th>OP</th>
<th>CL</th>
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<th>LVLH ATT</th>
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</tr>
</tbody>
</table>

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<th>GPC FILL-INS</th>
<th>__ ( __ )</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>CRIT BURN</th>
<th>NON-CRIT BURN</th>
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</thead>
</table>

<table>
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</table>

<table>
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<th>UPDATE TIG AFTER __ MIN</th>
</tr>
</thead>
</table>

3-9

RNDZ/126/FIN
AFT FLT STATION CONFIG FOR RNDZ [4A]

O14,16:E √cb MNA,C DDU AFT (two) - cl

A6U ADI ATT - LVLH
ERR - MED
RATE - MED
SENSE - minus Z

R13 √KU ANT - GND
A6U PWR - STBY
sel - MAN SLEW
MODE - RDR PASSIVE
RADAR OUTPUT - HI
CNTL - PNL (wait 3 seconds)
PWR - ON
SIG STRENGTH sel - KU
SLEW RATE - as reqd

A2 DIGI-DIS sel - R/RDOT
X-PNTR SCALE - X1

SM ANTENNA

CRT SELF TEST - ITEM 7 EXEC (∗)

NOTE
SELF TEST runs about 3 min

A1U √KU SCAN WARN tb - gray
√TRACK tb - gray
√SEARCH tb - gray

A2 √RANGE - 888.8
DIGI-DIS sel - EL/AZ

CRT SELF TEST - ITEM 7 EXEC (no ∗)

A1U KU MODE - COMM
sel - GPC
CNTL - CMD

Install:
-Z COAS
PCS BURN Cue Card
KU OPS Cue Card
APPROACH Cue Card
TARGET ALIGNMENT Cue Card
DOCKING SEQUENCE Cue Card
Velcro over Aft DAP PCT pbi (SPARE pbi)
RENDEZVOUS TIMELINE

PET

CDR AFT FLT STATION CONFIG FOR RNDZ  [4A]
PLT RNDZ OPS INITIALIZATION  [5A]

A7(B7)

-03:00

-02:55

-02:50

-02:45

-02:40

-02:35

-02:30

MCC UPDATE
Final NH Burn Pad, 3-5 (if reqd)

MCC UPLINK
ORB SV
TGT SV
Drag  K-factor

MS Perform 6.105 SSOR ACTIVATION, steps 1 and 2 (SODF: JOINT OPS, COMM/DATA)

If NH reqd:
CDR If OMS BURN, Perform RNDZ OMS BURN, steps 1-4  (CONTINGENCY OPS), 5-4
If +X RCS burn, Perform RCS BURN, steps 1-5 (Cue Card)
If -X RCS burn, Perform RENDEZVOUS -X RCS BURN (CONTINGENCY OPS), 5-32
Postburn DAP: A/LVLH/VERN(ALT)

RNDZ OPS INITIALIZATION  [5A]

√DPS Config for Rndz Ops - String 1233

[SM 2 TIME]
Set SM TIMER counting to Ti TIG per burn Pad, 3-6

Config DAP A,B to A7,B7

Record nominal TIGs in burn solution blocks per Execute Package:
NCC TIG pg 4-11
MC1 TIG pg 4-17
MC2 TIG pg 4-18

[GNC 55 GPS STATUS]
DES RCVR, ITEM 27 - (+)
√NH GPS to G&C, ITEM 33 - (+)
NAV, ITEM 36 - (+)
RENDEZVOUS TIMELINE

4-7

RENDEZVOUS TIMELINE

PET

-02:30
A7(B7)

-02:25
If reqd,
NH TIG
Postburn DAP: A/LVLH/VERN(ALT)

-02:20

-02:15
PLT
ENABLE RENDEZVOUS NAV [7A]

-02:10

-02:05

-02:00

MCC UPDATE
Final NC Burn Pad, 3-3

ENABLE RENDEZVOUS NAV [7A]

1. GNC 33 REL NAV
CRT RNDZ NAV ENA - ITEM 1 EXEC (*)
√ SV SEL, ITEM 4 - PROP
√ S TRK, ITEM 12 - (*)

2. GNC 34 ORBIT TGT
TGT NO - ITEM 1 + 1 EXEC
Set BASE TIME to Ti TIG, (Ti Burn Pad, 3-6)
LOAD - ITEM 26 EXEC

PLAN ORBIT CONFIGURATION (REF DATA FS, UTIL PWR)

PLT, On RPOP PGSCs:
MS Perform RPOP INITIALIZE (RNDZ TOOLS), 7-15, then
Perform RPOP OPS (RNDZ TOOLS), 7-16, then
Perform TCS ACTIVATION, step 1 (RNDZ TOOLS), 7-18

MS Perform HHL CHECKOUT/OPS (RNDZ TOOLS), 7-14

TIG – 5 min

MCC UPDATE
Final NC Burn Pad, 3-3
CDR If OMS BURN, Perform RNDZ OMS BURN, steps 1-4 (CONTINGENCY OPS), 5-4
If +X RCS burn, Perform RCS BURN, steps 1-5 (Cue Card)
If -X RCS burn, Perform RENDEZVOUS -X RCS BURN (CONTINGENCY OPS), 5-32

MCC UPDATE

LOAD TARGET TRACK [9A]

NOTE
If NH performed, delay mnvr to +X or OMS NC burn attitude until
NC TIG – 5 min to minimize attitude mnvr

CDR If OMS BURN, Perform RNDZ OMS BURN, steps 1-4 (CONTINGENCY OPS), 5-4
If +X RCS burn, Perform RCS BURN, steps 1-5 (Cue Card)
If -X RCS burn, Perform RENDEZVOUS -X RCS BURN (CONTINGENCY OPS), 5-32

LOAD TARGET TRACK [9A]

\[ \sqrt{\text{DAP: A/LVLH/VERN(ALT)}} \]

GNC UNIV PTG

CRT CNCL - ITEM 21 EXEC
TGT ID +1

\[ \text{BODY VECT} \begin{pmatrix} +3 \end{pmatrix} \begin{pmatrix} +4 \end{pmatrix} \]
\[ \text{P} \begin{pmatrix} +90 \end{pmatrix} \begin{pmatrix} +0 \end{pmatrix} \]
\[ \text{Y} \begin{pmatrix} +0 \end{pmatrix} \begin{pmatrix} +280.57 \end{pmatrix} \]
\[ \text{OM} \begin{pmatrix} +0 \end{pmatrix} \begin{pmatrix} +30 \end{pmatrix} \]

Do not INITIATE TARGET TRACK [9B] until post NC

PET

- 02:00
A7(B7)

- 01:55
- 01:50
- 01:45
- 01:40
- 01:35
- 01:30

\[ \text{TIG – 5 MIN} \]

\[ \text{NC TIG} \]

CDR INITIATE TARGET TRACK [9B]
PLT TARGET NCC BURN [11A] (Preliminary), 4-11

INITIATE TARGET TRACK [9B]

GNC UNIV PTG

TRK - ITEM 19 EXEC (CUR - *)
DAP: B/AUTO/ALT

When MNVR cmplt,
DAP: A/AUTO/VERN(ALT)
1. CONFIG FOR STRK NAV

- DAP: A/AUTO/VERN(ALT)
  - Turn down cabin lights to optimize target viewing through –Z COAS/overhead window

- IMU for Deselect _____ (If no comm, use IMU 1 for deselect)

2. INITIAL MEASUREMENT EVALUATION

- GNC 21 IMU ALIGN

- CRT IMU DES - ITEM 7(8,9) EXEC (+)

- MCC for NAV selected IMU _____

- GNC 33 REL NAV
  - If first NAV pass,
    - SV SEL, ITEM 4 - PROP
  - If previous NAV,
    - SV SEL, ITEM 4 - FLTR

- INH Angles, ITEM 24 - (+)

- S TRK, ITEM 12 - (+)

- GNC 22 S TRK/COAS_CNTL
  - –Y THOLD – ITEM 13 + 3 EXEC
  - –Z THOLD – ITEM 14 + 3 EXEC
  - –Z(–Y) TGT TRK - ITEM 6(5) EXEC (+)

- STATUS - blank

- SHUTTER - op

- GNC 22 S TRK/COAS_CNTL

- When S PRES - (+), continue

3. INCORPORATE DATA INTO NAV

- If SV SEL = PROP:
  - AUTO Angles - ITEM 23 EXEC (+)
  - Record 1st SV UPDATE POS =

- When SV UPDATE POS < 1.0 and Angle ACPT > 9:
  - SV SEL - ITEM 4 EXEC (FLTR) >>

- If SV = FLTR:
  - FLTR TO PROP - ITEM 8 EXEC

- AUTO Angles - ITEM 23 EXEC (+)

- Record 1st SV UPDATE POS =

- If FLTR MINUS PROP changes by more than 8 kft within a S TRK pass:*

- Perform S TRK NAV - HIGH FLTR MINUS PROP

- (CONTINGENCY OPS), 5-9

- END S TRK NAV 10B

- GNC 33 REL NAV

- CRT

- INH Angles - ITEM 24 EXEC (+)

- GNC 21 IMU ALIGN

- IMU DES - ITEM 7(8,9) EXEC (no +)
RENDZVOUS TIMELINE

4-11 RNDZ/126/FIN

TARGET NCC BURN [11A]

FINAL SOLUTION

OPS 202 PRO

GNC ORBIT MNVR EXEC

√Eng Sel CORRECT

MCC UPDATE

Nav Selected IMU

MCC UPDATE

Ground NCC Burn Solution

FINAL SOLUTION

If > 40 marks in current sensor pass and
SV UPDATE POS < 0.5 for the last 4 marks:

| Burn FLTR soln
| Burn FLTR soln
| Burn PROP soln
| Burn ground soln EXT ΔVs

PLT TARGET NCC BURN [11A] (Final)

If no comm and ΔVT > 6 fps:

| END S TRK NAV [10B]
| TARGET NCC BURN [11A] (Final)
| Perform RNDZ OMS BURN (CONTINGENCY OPS), 5-4

If ∆VT > 4 fps:

| END S TRK NAV [10B]
| TARGET NCC BURN [11A] (Final)
| Perform +X Burn, RCS BURN (Cue Card)

FINAL - GROUND LIMITS

(0.8)

(1.6)

(2.3)

PRELIMINARY

ΔVX

ΔVY

ΔVZ

ΔVT

INTERMEDIATE

ΔVX

ΔVY

ΔVZ

ΔVT

FINALEND S TRK NAV [10B]

- TIG – 10 min \textbackslash MCC for burn type
- TIG – 5 MIN

CDR Perform RCS BURN (Cue Card)
- Z AXIS TARGET TRACK

<table>
<thead>
<tr>
<th>CRT</th>
<th>GNC UNIV PTG</th>
</tr>
</thead>
<tbody>
<tr>
<td>TGT ID</td>
<td>+1</td>
</tr>
<tr>
<td>BODY VECT</td>
<td>+3 (–Z)</td>
</tr>
<tr>
<td>OM</td>
<td>+0</td>
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<tr>
<td>C3</td>
<td>DAP: B/AUTO/ALT</td>
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<tr>
<td>CRT</td>
<td>TRK - ITEM 19 EXEC (CUR - ∗)</td>
</tr>
</tbody>
</table>

When MNVR cmplt,
DAP: A/AUTO/VERN(ALT)
RENDEZVOUS TIMELINE

When NAV converged (SV UPDATES small and stable):

PLT  TARGET Ti BURN [13A] (Intermediate)

If no lock-on by 10 minutes after initial search:

MS  KU OPS, step 2 (Cue Card)

When RR RNG < 135 KFT:

PLT  Perform RR NAVIGATION [13B]

IF Y STRK TRACK

CDR  -2 AXIS TARGET TRACK [12A]

When:

GNC 33 REL NAV

NAV RNG < 150 KFT:

MS  KU OPS, step 1 (Cue Card)

TARGET Ti BURN [13A] (Preliminary)

RR NAVIGATION [13B]

CRT  RR - ITEM 13 EXEC (*)

√Elev, Az approx 0

Record Initial RESID RANGE = ______  RDOT = ______

IF RESID RANGE > 5.0 or RDOT > 3.0

SV SEL - ITEM 4 EXEC (PROP)

Proceed with taking data and contact MCC as soon as practical

FLTR TO PROP - ITEM 8 EXEC

AUTO RNG - ITEM 17 EXEC (*)

RDOT - ITEM 20 EXEC (*)

Angles - ITEM 23 EXEC (*)

Record 1st SV UPDATE POS = ______

IF SV SEL = PROP

When SV UPDATE POS < 0.3 and MARK ACPT > 9:

SV SEL - ITEM 4 EXEC (FLTR)
<table>
<thead>
<tr>
<th></th>
<th>PREL FLTR</th>
<th>INTER FLTR</th>
<th>FINAL FLTR</th>
<th>GND</th>
<th>PROP (If Req'd)</th>
<th>FINAL - GROUND LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>( )</td>
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<td>ΔVX (1.3)</td>
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<td>ΔVY (1.3)</td>
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<td>ΔVZ (1.1)</td>
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</tr>
</tbody>
</table>

**Rendezvous Timeline**

- **Final 3-7 Burn Pad Solution**
  - ΔVX: 1.3
  - ΔVY: 1.3
  - ΔVZ: 1.1

The table outlines various stages of the rendezvous process, with specific burn solutions and ground limits for ΔV (velocity change) components.
RENDZVOUS TIMELINE

PET

-00:30
A7(B7)

-00:25

-00:20

-00:15

-00:10

-00:05

00:00

TIG – 5 min
If Ti is multi-axis burn:
CDR
Perform RCS BURN (Cue Card)

TIG – 17 min
If Ti is multi-axis burn, delay final targeting until TIG-5
PLT
TARGET Ti BURN [15A] (Final)

TIG – 17 min
If Ti is -X RCS burn, Perform RENDEZVOUS -X RCS BURN (CONTINGENCY OPS), 5-32
CDR
Perform Ti DELAY BURN (CONTINGENCY OPS), 5-27

MCC UPDATE
GO for Ti

MCC UPDATE
Ti Final Ground Soln, Ti DELAY Soln, 3-7

√MCC for burn type. If no comm:
If ΔVT > 6, at TIG-17:
Perform RNDZ OMS BURN (CONTINGENCY OPERATIONS), 5-4
If 4 ≤ ΔVT ≤ 6, at TIG-17:
Perform +X RCS burn, RCS BURN (Cue Card)
If ΔVT< 4, at TIG-5:
Perform multi-axis RCS burn, RCS BURN (Cue Card)

If GO for Ti not received by TIG – 5 min or RNDZ DELAY called by MCC
CDR
Perform Ti DELAY BURN (CONTINGENCY OPS), 5-27

If Ti is +X RCS burn, Perform RENDEZVOUS +X RCS BURN (CONTINGENCY OPS), 5-32

TARGET Ti BURN [15A] (Final)

CRT
OPS 202 PRO

GNC ORBIT MNRV EXEC
Load Eng Sel, TVR, WT and Trims for Ti per Final Ti Burn Pad
LOAD - ITEM 22 EXEC

GNC 33 REL NAV
√SV SEL correct

GNC 34 ORBIT TGT
TGT NO - ITEM 1 -1 0 EXEC

√TGT Set data:
Ti TIG = BASE TIME
EL + 0
ΔT + 76.9
ΔX + 0
ΔY + 0
ΔZ + 1.8

COMPUTE Ti - ITEM 28 EXEC

Record solution in PAD

FINAL SOLUTION
If > 40 marks in current sensor pass and
SV UPDATE POS < 0.5 for the last 4 marks:
Burn FLTR soln
If FLTR within ground solution limits:
Burn FLTR soln
If PROP within ground solution limits:
Burn PROP soln
If none of the above:
Burn ground soln EXT ΔVs

PET -00:30
A7(B7)
POST Ti NAV \[16A\]

| A6U | √DAP: A/AUTO/VERN(ALT) |
| A1U | √KU sel - GPC |

\[GNC 33 REL NAV\]
IF SV SEL = FLTR:
- FLTR TO PROP - ITEM 8 EXEC (+)
IF RR Tracking TGT:
- √AUTO Angles - ITEM 23 EXEC (+)
IF RR NOT Tracking TGT:
- √Inhibit Data
  Perform KU OPS, steps 2 and 3 (Cue Card)
  If still no RR ACQ, assume RR Fail

\[GNC 22 S TRK/COAS_CNTL\]
CR T √ Z TGT TRK - ITEM 6 EXEC (+)

IF RR FAIL
- If –Z Star Tracker:
  √ –Z TGT TRK ATT, then:
  Perform STAR TRACKER NAV \[10A\]
- If COAS NAV:
  √ –Z TGT TRK ATT, then:
  Perform COAS NAVIGATION (CONTINGENCY OPS), 5-10
- If –Y Star Tracker:
  \[GNC UNIV_PTG\]
  TGT ID +1
  BODY VECT +4
  P √ +0
  Y √ +280.57
  OM +90
  DAP: B/AUTO/ALT
  TRK - ITEM 19 EXEC
  When MNVR comp:
  DAP: A/AUTO/VERN(ALT)
  Perform STAR TRACKER NAV \[10A\]
**TARGET MC 1 BURN**

Preliminary

When MNVR to att cmplt:

PLT TARGET MC 1 BURN (Preliminary)

CDR POST TI NAV

When NAV converged, (SV UPDATES small and stable):

PLT TARGET MC 1 BURN (Intermediate)

MS √Time of OOP null

When Y = 0:

PLT MANUAL OUT-OF-PLANE NULL (Final)

Perform RCS BURN ( Cue Card)

**TARGET MC 2**

Preliminary

When MNVR to att cmplt:

PLT TARGET MC 2 BURN (Preliminary)

**MC 1 BURN SOLUTION**

PRELIMINARY

<table>
<thead>
<tr>
<th>∆VX</th>
<th>∆VY</th>
<th>∆VZ</th>
<th>∆VT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</table>

INTERMEDIATE

<table>
<thead>
<tr>
<th>∆VX</th>
<th>∆VY</th>
<th>∆VZ</th>
<th>∆VT</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

FINAL

<table>
<thead>
<tr>
<th>∆VX</th>
<th>∆VY</th>
<th>∆VZ</th>
<th>∆VT</th>
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<tbody>
<tr>
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</table>

MEAN ± (3σ VARIATION)

<table>
<thead>
<tr>
<th>∆VX</th>
<th>∆VY</th>
<th>∆VZ</th>
<th>∆VT</th>
</tr>
</thead>
<tbody>
<tr>
<td>–0.1 ± (0.6)</td>
<td>–0.1 ± (0.7)</td>
<td>+0.5 ± (1.2)</td>
<td></td>
</tr>
</tbody>
</table>

**TARGET MC 2**

Preliminary

When MNVR to att cmplt:

PLT TARGET MC 2 BURN (Preliminary)

**MC 2 BURN SOLUTION**

PRELIMINARY

<table>
<thead>
<tr>
<th>∆VX</th>
<th>∆VY</th>
<th>∆VZ</th>
<th>∆VT</th>
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<tbody>
<tr>
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</table>

INTERMEDIATE

<table>
<thead>
<tr>
<th>∆VX</th>
<th>∆VY</th>
<th>∆VZ</th>
<th>∆VT</th>
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FINAL

<table>
<thead>
<tr>
<th>∆VX</th>
<th>∆VY</th>
<th>∆VZ</th>
<th>∆VT</th>
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</table>

MEAN ± (3σ VARIATION)

<table>
<thead>
<tr>
<th>∆VX</th>
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<th>∆VZ</th>
<th>∆VT</th>
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</table>

**TARGET MC 1 BURN**

Preliminary

When MNVR to att cmplt:

PLT TARGET MC 1 BURN (Preliminary)

CDR POST TI NAV

When NAV converged, (SV UPDATES small and stable):

PLT TARGET MC 1 BURN (Intermediate)

MS √Time of OOP null

When Y = 0:

PLT MANUAL OUT-OF-PLANE NULL (Final)

Perform RCS BURN ( Cue Card)

**TARGET MC 2**

Preliminary

When MNVR to att cmplt:
TARGET MC 2 BURN 18A (Intermediate)

CRT
SV SEL correct
GNC 34 ORBIT TGT
TGT NO - ITEM 1 + 12 EXEC
COMPUTE T1 - ITEM 28 EXEC
Record solution in PAD

TARGET MC 2 BURN 18B (Final)

CRT
SV SEL correct
GNC 34 ORBIT TGT
TGT NO - ITEM 1 + 12 EXEC
√ TIG change

IF TIG CHANGE < –3 OR > +7 MIN
Set BASE TIME to (Nominal MC 2 TIG –3 or +7 min as appropriate)
LOAD - ITEM 26 EXEC
TGT NO - ITEM 1 + 19 EXEC
√ TGT Set data:
T1 TIG = BASE TIME
EL + 0
Δ T + 27.0
Δ X + 0.9
Δ Y + 0
Δ Z + 1.8
COMPUTE T1 - ITEM 28 EXEC

Set EVENT TIMER counting to MC 2 TIG
Record solution in PAD
GNC 33 REL NAV
CRT
FLTR TO PROP - ITEM 8 EXEC

END S TRK NAV 18C

GNC 33 REL NAV
CRT
INH Angles - ITEM 24 EXEC (*)
GNC 21 IMU ALIGN
IMU DES - ITEM 7(8,9) EXEC (no *)

-Z AXIS TARGET TRACK 18D

GNC UNIV PTG
CRT
GNC 22 S TRK/COAS_CNTL
–Z(–Y) THOLD - ITEM 14(13) + 0 EXEC

When MNVR cmpl, DAP: B/AUTO/VERN(ALT)

NIGHTTIME STRK OPS 18E

1. GNC 33 REL NAV
INH Angles - ITEM 24 EXEC (*)
At sunset,
2. GNC 22 S TRK/COAS_CNTL
–Z(–Y) THOLD - ITEM 14(13) + 0 EXEC
3. Perform STAR TRACKER NAV 10A, steps 2 and 3

PRELIMINARY
Δ VX ( ) *
Δ VY ( ) *
Δ VZ ( ) *
Δ VT *

INTERMEDIATE
Δ VX ( ) *
Δ VY ( ) *
Δ VZ ( ) *
Δ VT *

FINAL
Δ VX ( ) *
Δ VY ( ) *
Δ VZ ( ) *
Δ VT *

MEAN ± (3σ VARIATION)
+0.0 ± (0.4)
+0.0 ± (0.2)
+0.9 ± (2.5)

TIG
TIG SLIP (COMPUTED-NOM)

PREL / : : : __ : __
INTER / : : : : : __
NOMINAL / : : : : __
**RENDEZVOUS TIMELINE**

**PET**

- **00:30**
  - MS Perform 6.105 SSOR ACTIVATION, step 3 (SODF: JOINT OPS, COMM/DATA)

- **00:35**
  - **IF S TRK NAV**
  - At sunset – 2 minutes:
  - PLT TARGET MC 2 BURN (Intermediate)

- **00:40**
  - **MC2 ET**
  - **00:10**
    - On RPOP PGSC:
      - MS Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZ TOOLS), 7-2
      - MS When RNG < 30,000 ft:
        - SSOR comm check with ISS

- **00:45**
  - **00:05**
    - **TIG – 5 min**
    - PLT TARGET MC 2 BURN (Final)
    - Perform RCS BURN (Cue Card)

- **00:50**
  - **00:00**
    - **MC2 TIG**
    - PLT TARGET MC 3 BURN (Preliminary)
    - **IF INITIAL RR ACQ POST-MC2**
    - CDR Perform LATE RR NAV (20E)

- **00:55**
  - **00:05**
    - **IF –Y S TRK TRACK**
    - END STAR TRACKER NAV (18C)
    - **–Z AXIS TARGET TRACK (18D)**

- **01:00**
  - **00:10**
    - **IF S TRK NAV,**
    - PLT END STAR TRACKER NAV (18C)

**MANUAL OUT-OF-PLANE NULL (19A)**

- **CRT**
  - When Y = 0:
  - F7 FLT CTLLR PWR - ON
    - DAP: A/AUTO/PRI
    - THC: Null YDOT
  - If –Z AXIS TRACK,
    - +YDOT = FWD THC left
    - AFT THC right
  - If –Y S TRK TRACK,
    - +YDOT = FWD THC down
    - AFT THC out

- **F7**
  - FLT CTLLR PWR - OFF
  - DAP: A/AUTO/ALT
  - When rates nulled:
  - DAP: VERN(ALT)

**TARGET MC 3 (19B)**

- **CRT**
  - SV SEL correct
    - GNC 34 ORBIT TGT
  - TGT NO - ITEM 1 + 1 3 EXEC
  - √TGT Set data:
    - T1 TIG = BASE TIME + 0/00:17:00
    - EL + 0
    - ΔT + 10.0
    - ΔX – 0.9
    - ΔY + 0
    - ΔZ + 1.8
  - COMPUTE T1 - ITEM 28 EXEC
  - Record solution in PAD

**MC 3 BURN SOLUTION**

- TIG
  - PRELIMINARY
    - ΔX
    - ΔY
    - ΔZ
  - FINAL
    - ΔX
    - ΔY
    - ΔZ
- MEAN ±
  - (3σ VARIATION)
    - ΔX (+0.9 ± 1.3)
    - ΔY (+0.0 ± 0.5)
    - ΔZ (+1.1 ± 2.6)
### RENDEZVOUS TIMELINE

#### 4-20 RNDZ/126/FIN

**MC 4 BURN SOLUTION**

<table>
<thead>
<tr>
<th>TIG</th>
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<tbody>
<tr>
<td>PRELIMINARY</td>
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<tr>
<td>∆VX</td>
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<td>∆VY</td>
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<tr>
<td>∆VT</td>
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<tr>
<td>FINAL</td>
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</tr>
<tr>
<td>MEAN ±</td>
<td>3σ VARIATION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+1.3 ± (1.3)</td>
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</tr>
<tr>
<td>-0.1 ± (0.6)</td>
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<tr>
<td>+0.9 ± (2.2)</td>
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</table>

**TARGET MC 4 BURN**

- **CRT**: √ SV SEL correct
- **GNC 34 ORBIT TGT**: TGT NO - ITEM 1 : 1 EXEC
  - √ TGT Set data:
    - T1 TIG = BASE TIME + 0:00:27:00
    - EL + 0
    - ∆X + 13.0
    - ∆Y + 0
    - ∆Z + 0.6
- **COMPUTE T1**: ITEM 28 EXEC
  - Record solution in PAD

**ESTABLISH RBAR**

- **A6U**: FLT CNTLR PWR - ON
  - √ SENSE - Z
  - √ DAP: A/LVLH/PRI
  - THO: as reqd to control TGT motion in COAS

**CONFIG FOR RBAR**

- **GNC UNIV PTG**: ERR TOT - ITEM 23 EXEC (+)
  - When ERR <2 deg each axis
  - **GNC 20 DAP CONFIG**: Config DAP A,B to A8,B8

**LATE RADAR NAV**

- **GNC 33 REL NAV**: CRT
  - FLTR TO PROP - ITEM 8 EXEC
  - SV SEL, ITEM 4 - PROP
  - √ RR - ITEM 13 EXEC (+)
  - AUTO RING - ITEM 17 EXEC (+)
  - RDOT - ITEM 20 EXEC (+)
  - Angles - ITEM 23 EXEC (+)
  - Go to RADAR FAIL PROCEDURE

**RADAR FAIL PROCEDURE**

- Note: When TGT visible, report TGT Tally-Ho to MCC
- **MS**: If TGT outside COAS reticle, config CCTV as reqd to measure vertical position

1. **At MC2 TIG+14:00 (MC3 TIG–3:00):**
   - **PLT**: TARGET MC3 [19B] (final)
   - **CDR**: Perform RCS BURN ( Cue Card )

**AT MC2+18 IF NO VISUAL ACQUISITION OR TARGET > 30 DEG FROM COAS HORIZONTAL**

- **CDR**: Go to RNDZ BREAKOUT (CONTINGENCY OPS), 5-18 >>

2. **At MC2 TIG + 19:00:**
   - **A6U**: FLT CNTLR PWR - ON
     - √ SENSE - Z
     - DAP: A/LVLH/PRI
     - COAS for TGT vertical position
     - THO: +X (or –X) per COAS LOGIC:
       - If TGT = N deg high in COAS, perform 2N +X (up) pulses
       - If TGT = N deg low in COAS, perform 1N –X (down) pulses
     - DAP: A/LVLH/PRI
     - Inform MCC of TGT vertical position in COAS and number of pulses performed
     - Following radar fail X correction,
       - THO: As reqd to control out of plane motion and manage RDOT
     - Perform CONFIG FOR RBAR [20B]

3. **At MC2 TIG + 24:00 or 2000 ft, whichever comes first:**
   - **GNC UNIV PTG**: CRT
     - TRK - ITEM 19 EXEC (CUR - *)
   - **A6U**: DAP: A/AUTO/VERN (PRI)
     - THO: as reqd to stabilize and maintain TGT docking port between 0 and 10 deg high in COAS
     - At 2000 ft:
       - Perform APPROACH (Cue Card)
RENDEZVOUS TIMELINE

01:00

A7(B7)

PET

01:10

If no RR into NAV
CDR: Go to RADAR FAIL PROCEDURES [20D]

01:05

MC2 ET

01:15

TIG – 3 min
PLT: TARGET MC3 BURN [19B] (Final)
Perform RCS BURN (Cue Card)

MC 3 TIG

01:20

TIG – 3 min
PLT: TARGET MC 4 [20A] (Final)
Perform RCS BURN (Cue Card)

MC 4 TIG

01:25

CDR: CONFIG FOR RBAR [20B]

01:30

IF NO RR INTO NAV
CDR: Go to RADAR FAIL PROCEDURES [20D]

01:35

A8(B8)

01:40

01:00

MS:

Begin HHL Operations

01:05

HHL REPORT

R and Rdot

01:10

CREW REPORT

ISS tally-ho

01:15

IF NO RR INTO NAV
CDR: Go to RADAR FAIL PROCEDURES [20D]

01:20

01:25

01:30

01:35

Manual Trajectory Control
TERMINATE RNDZ OPS [22A]

1. ORBITER CONFIG FOR MATED ATTITUDE CONTROL

   IF VERNs available:
   O14:F, Pri RJD LOGIC, DRIVER (sixteen) – OFF
   O15:F, RJDA 1A L2/R2 MANF DRIVER – ON
   O16:F
   O14:E, All DDU cbs (six) – op
   O15:E, O16:E

   CDR
   A6U  √ FLT CNTLR PWR  - OFF
   GNC 23 RCS
   CRT
   RCS F – ITEM 1 EXEC (+)
   JET DES F1L – ITEM 9 EXEC (+)
   F3L – ITEM 11 EXEC (+)
   F2R – ITEM 13 EXEC (+)
   F4R – ITEM 15 EXEC (+)
   F1U – ITEM 17 EXEC (+)
   F3U – ITEM 19 EXEC (+)
   F2U – ITEM 21 EXEC (+)

   GNC 20 DAP CONFIG
   Config DAP A,B to A12,B12
   X JET ROT ENA - ITEM 7 EXEC (+)
   EDIT A9 - ITEM 3 + 9 EXEC
   PRI RATE DB - ITEM 52 + 0.2 EXEC
   LOAD - ITEM 5 EXEC
   EDIT B9 - ITEM 4 + 9 EXEC
   PRI RATE DB - ITEM 52 + 0.2 EXEC
   LOAD - ITEM 5 EXEC

   SM 167 DOCKING STATUS
   √ 12 hooks closed

   DAP: LO Z
   If Loss of Verns:
   √ DAP: FREE
   √ MCC for attitude control
   If VERN:
   DAP: LVLH
   * If ISS attitude control required,
   * Perform 3.111 HANDOVER ATTITUDE CONTROL ORBITER TO
   * CMG TA, (SODF: JOINT OPS, MATED OPERATIONS)

2. ORBITER CONFIG FOR MATED OPS

   MS
   Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6
   A6L
   LTS TRUSS FWD, AFT (two) - OFF
   VEST PORT, STBD (two) - OFF
   Exit RPOP - [Shift][F10]
   Perform HHL STOW (RNDZ TOOLS), 7-14
   √ Z COAS - OFF

RETURN TO FLIGHT PLAN

...
CONTINGENCY OPS

RNDZ OMS BURN................................................................. 5-3
SENSOR FAIL ........................................................................ 5-7
  S TRK NAV – HIGH INITIAL RESID .................................... 5-8
  FLTR MINUS PROP....................................................... 5-9
COAS NAVIGATION ............................................................ 5-10
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RNDZ NAV RECOVERY ..................................................... 5-29
TGT ITER ........................................................................... 5-30
LOSS OF COMM .............................................................. 5-31
RENDZVOUS -X RCS BURN ............................................... 5-32
DEGRADED CONTROL ....................................................... 5-33
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  ONE FxD JET ............................................................ 5-38
  BOTH FxD JETS (SAME SIDE) .................................. 5-39
VRCS .............................................................................. 5-41
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RNDZ OMS BURN
RNDZ OMS BURN

1. **OMS BURN PREP**
   
   **C2** Install OMS2/ORBIT OMS BURNS (Cue Cards) (two) and
   
   **Wedge** ORBIT BURN MONITOR (Cue Cards) (two) (F6,F8)
   
   **CRT1** GNC 20 DAP CONFIG
   
   **1: GNC ORBIT MNVR EXEC**
   
   **2: GNC SYS SUMM 2**

2. **LOAD TGT DATA**
   
   **If onboard-computed burn:**
   
   √ Eng sel, TV ROLL, TRIM LOAD, and WT per Burn Pad
   
   √ TIG and TGT PEG 7 ΔVs per Final ORBIT TGT solution
   
   √ Guidance option is LAMBERT
   
   **If ground-computed burn:**
   
   √ TGT data per Burn Pad (reload WT as reqd)
   
   LOAD – ITEM 22 EXEC
   
   TIMER – ITEM 23 EXEC
   
   √ Burn data

   **C3** DAP: A/AUTO/ALT(B/ALT as reqd)

   **CRT1** MNVR – ITEM 27 EXEC (*)

   **If RR ops:**

   **A1U** KU sel – AUTO TRK
   
   **1: GNC 33 REL NAV**

   **CRT1** INH Angles – ITEM 24 EXEC (*)
   
   **1: GNC ORBIT MNVR EXEC**

   **When mnvr to att complete:**

   √ DAP: A/AUTO/ALT

3. **PERFORM RNDZ OMS BURN**

   **TIG-3 F6,F8** ADI RATE (two) – MED (1 deg/sec)

   **FLT CNTLR PWR** (two) – ON

   Perform **OMS2/ORBIT OMS BURNS** (Cue Card)

4. **OMS POST BURN RECONFIGURATION**

   **F6,F8** FLT CNTLR PWR (two) – OFF

   **O8** L,R OMS He PRESS/VAP ISOL (four) – CL

   **C3** DAP: B/INRTL/ALT

   **DAP TRANS:** PULSE/PULSE/PULSE

   **CRT1** RCS SEL – ITEM 4 EXEC (*)

   Perform OMS TVC GMBL CK per Burn Pad

   * If down arrow(s) or M(s), *
   
   * select good GMBL *

   **GNC, OPS 201 PRO**

   Cont next page
5. **MNVR TO POST BURN ATTITUDE**

<table>
<thead>
<tr>
<th>1: <strong>GNC UNIV PTG</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired UNIV PTG load active</td>
</tr>
</tbody>
</table>

C3 DAP: B/AUTO/ALT

If RR ops, when ATT ERR < 30 deg:

A1U

<table>
<thead>
<tr>
<th>KU sel – GPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>KU TRACK tb – gray</td>
</tr>
</tbody>
</table>

   | 1: **GNC 33 REL NAV** |

CRT1

   | AUTO Angles – ITEM 23 EXEC (*) |

   | 1: **GNC UNIV PTG** |

When in attitude and rates nulled:

C3 DAP: A/AUTO/VERN(ALT)
SENSOR FAIL
S TRK NAV – HIGH INITIAL RESID

1. NAV SAFING
   1: GNC 33 REL NAV
   CRT1 √INH Angles – ITEM 24 EXEC (*)

On MCC GO (if no comm, continue):
2. CHECK FOR S TRK FALSE LOCK
   2: GNC 22 S TRK/COAS CNTL
   If -Z S TRK, perform COAS visual check:

   NOTE
   GNC 33 REL NAV: COAS X (+up) and COAS Y (+left)
   provide approx TGT position in COAS based on -Z
   S TRK measurement

   √For debris near TGT position
   If no debris near TGT position or TGT not visible:
   Go to step 3
   If debris near TGT position:
   CRT2 -Z BREAK TRK – ITEM 8 EXEC
   When S PRES – (*):
   CRT1 Monitor RESID V and H. Repeat BREAK TRK as reqd until
   stable lock-on
   Go to STAR TRACKER NAV, step 2 10A
   If -Y S TRK, perform visual check through W1:
   √For debris near TGT line-of-sight
   If no debris near TGT line-of-sight or TGT not visible:
   Go to step 3
   If debris near TGT line-of-sight:
   CRT2 -Y BREAK TRK – ITEM 7 EXEC
   When S PRES – (*):
   CRT1 Monitor RESID V and H. Repeat BREAK TRK as reqd until
   stable lock-on
   Go to STAR TRACKER NAV, step 2 10A

3. CHECK IMU MISALIGNMENT
   2: GNC 21 IMU ALIGN
   CRT2 Nav sel IMU – des,sel (If Nav sel IMU unknown, pick one of two remaining IMUs)
   CRT1 Record RESID V ______ and H ______
   If RESID V and H < 0.6:
   Go to STAR TRACKER NAV, step 3 10A
   CRT2 Other IMU – des,sel
   CRT1 Record RESID V ______ and H ______

4. RESUME PASS
   Continue with pass per STAR TRACKER NAV, step 3 10A, then:
   After S TRK pass, on MCC GO:

   NOTE
   SELF-TEST may false fail. √MCC for S TRK status

   2: GNC 22 S TRK/COAS CNTL
   CRT2 -Z(-Y) SELF-TEST – ITEM 2(1) EXEC (*)
S TRK NAV – HIGH FLTR MINUS PROP

1. NAV SAFING
   1: GNC 33 REL NAV
   CRT1 INH Angles – ITEM 24 EXEC (*)

   On MCC GO (continue if no comm):
   2. CHECK FOR S TRK FALSE LOCK
      2: GNC 22 S TRK/COAS CNTL
      If -Z S TRK, perform COAS visual check:

      NOTE
      GNC 33 REL NAV: COAS X (+up) and COAS Y (+left)
      provide approx TGT position in COAS based on -Z
      S TRK measurement

      √For debris near TGT position
      If no debris near TGT position or TGT not visible:
      Go to step 3
      If debris near TGT position:
      SV SEL – ITEM 4 EXEC (PROP)
      PROP TO FLTR – ITEM 9 EXEC
      CRT2 -Z BREAK TRK – ITEM 8 EXEC
      When S PRES – (*):
      CRT1 Monitor RESID V and H. Repeat BREAK TRK as reqd until stable
      lock-on
      Go to STAR TRACKER NAV, step 2 10A
      If -Y S TRK, perform visual check through W1:
      √For debris near TGT line-of-sight
      If no debris near TGT line-of-sight or TGT not visible:
      Go to step 3
      If debris near TGT line-of-sight:
      SV SEL – ITEM 4 EXEC (PROP)
      PROP TO FLTR – ITEM 9 EXEC
      CRT2 -Y BREAK TRK – ITEM 7 EXEC
      When S PRES – (*):
      CRT1 Monitor RESID V and H. Repeat BREAK TRK as reqd until stable
      lock-on
      Perform STAR TRACKER NAV, step 2 10A

3. RESUME PASS
   AUTO Angles – ITEM 23 EXEC (*)
   Continue -Z S TRK pass
   After S TRK pass, on MCC GO:

   NOTE
   SELF-TEST may false fail. √MCC for S TRK status

   2: GNC 22 S TRK/COAS CNTL
   CRT2 -Z(-Y) SELF-TEST – ITEM 2(1) EXEC (*)
COAS NAVIGATION

NOTE
Do not execute MC1 or Out-Of-Plane null.
Prior COAS cal reqd to perform COAS NAV.
VERN reqd to perform COAS NAV.
COAS Nav must be started within ~10 min of Ti to guarantee
adequate geometry for nav convergence.
Breakout – If tgt not visible at MC2+18, refer to 1-4 for
breakout criteria

1. COAS NAV CONFIG
   A6U
   √ SENSE: -Z
   √ DAP: B7/AUTO/VERN(ALT)
   CRT
   GNC 22 STRK/COAS CNTRL
   COAS: SIGHT MODE – ITEM 22 EXEC (*)
   REQD ID – ITEM 21 +1 EXEC
   √ POS -Z: ITEM 27 (*)
   GNC 33 REL NAV
   INH Angles – ITEM 24 EXEC (*)
   √ SV SEL, ITEM 4 – FLTR
   If TGT NOT in COAS FOV:
   | √ MCC
   If TGT in COAS FOV:
   FLTR TO PROP – ITEM 8 EXEC
   COAS – ITEM 14 EXEC (*)
   Upon MCC uplink of COVARIANCE MATRIX,
   COVAR REINIT – ITEM 16 EXEC

2. COAS MARKS
   A6U
   FLT CNTLR PWR – ON
   DAP: B/FREE/PRI
   RHC: As reqd to move TGT near COAS center and maintain BODY YAW
   ERR < 10 deg
   DAP: B/FREE/VERN
   RHC: As reqd to maintain TGT at COAS center and maintain BODY YAW
   ERR < 10 deg
   When TGT centered in COAS, ATT REF pb – push
   CRT
   GNC 33 REL NAV
   If X and Y RESID magnitudes ≥ 1.0:
   | √ MCC
   If X and Y RESID magnitudes < 1.0:
   FOR – ITEM 25 EXEC
   √ SV UPDATE – non-zero (within 8 sec), then
   – 0.0 (after 8 sec more)
   Repeat step 2 per schedule:
   One mark every 10 to 20 sec until sunset Post-Ti
   At sunset,
3. END COAS NAV
   A6U
   DAP: A7/AUTO/VERN(ALT)
   FLT CNTLR PWR – OFF
   CRT
   GNC 22 STRK/COAS CNTRL
   COAS: DES – ITEM 25 EXEC (*)
   Resume rendezvous timeline
BACKOUT/BREAKOUTS
VAH CORRIDOR BACKOUT

CAUTION
Constraints for use:
Orbiter on + Vbar in approach corridor

If RNG < 75 ft:
1. INITIATE CORRIDOR BACKOUT
   DAP: B/LVLH/VERN(PRI), no LO Z

   NOTE: DAP A allowed for ±X and -Z (in) THC

   THC: +Z (out) to establish a +0.1 ft/sec opening rate
       Maintain 8 deg corridor

   If PCT ARMED:
   F4
   DISARM PCT: SPDBRK/THROT pb – AUTO
   √lt – OFF

   If 30 ft STATIONKEEPING desired:
       Maintain tgt in 5 deg corridor
       When RNG = 30 ft:
       THC: -Z (in) as reqd establish 30 ± 5 ft stationkeeping >>

   When RNG > 50 ft:
   DAP config: A9/B9
   [GNC 23 RCS]
   RCS F – ITEM 1 EXEC (*)
   JET DES F2F – ITEM 35 EXEC (no *)
   F3F – ITEM 33 EXEC (no *)

   If(When) RNG > 75 ft:
   2. INITIATE(CONTINUE) CORRIDOR BACKOUT
      DAP: A(B)/LVLH/VERN(PRI), LO Z

      NOTE: DAP A allowed for ±X and ±Z THC

      THC: +Z (out) to establish a +0.1 ft/sec opening rate
          Maintain 8 deg corridor

      DAP: B(A)

   When opening rate established and RNG > 150:
   3. PERFORM CORRIDOR BACKOUT OR BREAKOUT
      If BREAKOUT desired:
          Go To VBAR BREAKOUT, 5-14 >>
      Else:
          Maintain 8 deg corridor

      When desired stationkeeping range reached:
          THC: -Z (in) as reqd to establish stationkeeping range

Cont next page
4. **REAPPROACH**  
   **DAP: AUTO**  
   
   Go to **VBAR APPROACH** (Cue Card) from current stationkeeping range
VBAR BREAKOUT

| CAUTION |
| Constraints for use: |
| Orbiter on \( \pm \) Vbar in approach attitude |
| Range < 1000 ft cg to cg |
| Tgt stable on orbiter -Z axis |
| Orbiter X and Z axes are in-plane |

If RNG < 75 ft:
1. **INITIATE CORRIDOR BACKOUT**
   DAP: B/LVLH/VERN(PRI), no LO Z

   **NOTE**: DAP A allowed for \( \pm \)X and -Z (in) THC

   THC: +Z (out) to establish a +0.1 ft/sec opening rate
   Maintain 8 deg corridor

When RNG > 50 ft:
   DAP config: A9/B9
   [GNC 23 RCS]
   RCS F – ITEM 1 EXEC (*)
   JET DES F2F – ITEM 35 EXEC (no *)
   F3F – ITEM 33 EXEC (no *)

If(When) 75 < RNG < 150 ft:
2. **INITIATE(CONTINUE) CORRIDOR BACKOUT**
   DAP: A(B)/LVLH/VERN(PRI), LO Z

   **NOTE**: DAP A allowed for \( \pm \)X and \( \pm \)Z THC

   THC: +Z (out) to establish a +0.1 ft/sec opening rate
   Maintain 8 deg corridor

   DAP: B(A)

If(When) RNG > 150 ft:
3. **PERFORM RADIAL BURN ON \( \pm \) VBAR**
   If Rdot negative (closing on the target):
   THC: +Z (out) to null closing rate (Rdot \( \geq \) 0 fps)
   Config DAP A,B to A7,B7
   DAP: A/LVLH/VERN(PRI), LO Z

   DAP TRANS: NORM/PULSE/PULSE

   THC: +X (up) for 6 sec (1.5 fps)

   DAP TRANS: PULSE/PULSE/PULSE
   FLT CNTLR PWR – OFF
   DAP: A/INRTL/VERN(ALT)

   Record Radial Burn TIG ___/___:___:

   Inform MCC when SEP complete

Cont next page
4. PERFORM POSIGRADE/RETROGRADE BURN
   √MCC for breakout direction

   **NOTE**
   Posigrade burn performed if second docking attempt desired

   GNC, OPS 202 PRO
   [GNC ORBIT MNVR EXEC]
   √RCS SEL – ITEM 4 EXEC (*)

   If radial burn from +Vbar:
   TV ROLL – ITEM 5 +1 8 0 EXEC
   If radial burn from -Vbar:
   TV ROLL – ITEM 5 +0 EXEC

   Set TIG to Radial Burn +28 min:
   If Posigrade Sep:
   TGT PEG 7 ΔVX – ITEM 19 +3 EXEC
   ΔVY – ITEM 20 +0 EXEC
   ΔVZ – ITEM 21 +0 EXEC
   If Retrograde Sep:
   TGT PEG 7 ΔVX – ITEM 19 –3 EXEC
   ΔVY – ITEM 20 +0 EXEC
   ΔVZ – ITEM 21 +0 EXEC

   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC

   When RNG > 1000 ft:
   DAP: NO LO Z

   At TIG -8:00:
   DAP: B/AUTO/ALT
   MNVR – ITEM 27 EXEC

   At TIG -0:30:
   DAP: A/INRTL/PRI
   FLT CNTLR PWR – ON

   At TIG, THC: Trim VGOs ≤ 0.2 fps

   FLT CNTLR PWR – OFF
   DAP: A/INRTL/VERN(ALT)

   Inform MCC when SEP complete

   GNC, OPS 201 PRO
SHUTTLE NOSE IN-PLANE BREAKOUT (R < 700 ft)

CAUTION
Constraints for use:
Orbiter X and Z axes in-plane
Range \(\leq 700 \text{ ft cg to cg}\*
Tgt stable on orbiter -Z axis

*On approach use RNDZ Breakout until TORVA init
(+X burns to start TORVA are complete)

If RNG < 75 ft:
1. INITIATE CORRIDOR BACKOUT
   DAP: B/LVLH/VERN(PRI), no LO Z

   NOTE
   DAP A allowed for \(\pm X\) and \(-Z\) (in) THC

   THC: +Z (out) to establish a +0.1 ft/sec opening rate
   Maintain 8 deg corridor

When RNG > 50 ft:
   DAP: config: A9/B9
   \[\begin{array}{c}
   \text{GNC 23 RCS} \\
   \text{RCS F – ITEM 1 EXEC (*)} \\
   \text{JET DES F2F – ITEM 35 EXEC (no *)} \\
   \text{F3F – ITEM 33 EXEC (no *)}
   \end{array}\]

If(When) 75 < RNG < 150 ft:
2. INITIATE(CONTINUE) CORRIDOR BACKOUT
   DAP: A(B)/LVLH/VERN(PRI), LO Z

   NOTE
   DAP A allowed for \(\pm X\) and \(\pm Z\) THC

   THC: +Z (out) to establish a +0.1 ft/sec opening rate
   Maintain 8 deg corridor

   DAP: B(A)

If(When) RNG > 150 ft:
3. PERFORM +X OR -X BURN
   DAP TRANS: NORM/PULSE/PULSE

   If Nose-Forward (TGT ID = 2 and OM = 0):
   THC: +X (up) for 6 sec (1.5 fps)
   If Tail-Forward (TGT ID = 2 and OM = 180):
   THC: -X (down) for 6 sec (1.5 fps)

   DAP TRANS: PULSE/PULSE/PULSE

   DAP: A/INRTL/VERN(ALT)

   Record (\(\pm X\)) Burn TIG ___/___:___:___
   Report Tig to MCC

   A6U  FLT CNTLR PWR – OFF

Cont next page
4. **PERFORM FINAL BURN** (+X Burn, Posigrade/Retrograde and Out-of-Plane)

   GNC, OPS 202 PRO
   [GNC ORBIT MNVR EXEC]

   √RCS SEL – ITEM 4 EXEC (*)
   √MCC for breakout direction and TV ROLL

   **NOTE**
   Posigrade burn will be performed if second docking attempt desired

   Set TIG to (±X) burn + 30 min
   If Posigrade Sep:
   - TGT PEG 7 ΔVX – ITEM 19 +4.3 EXEC
   - ΔVY – ITEM 20 +3.6 EXEC
   - ΔVZ – ITEM 21 +0 EXEC
   If Retrograde Sep:
   - TGT PEG 7 ΔVX – ITEM 19 -4.3 EXEC
   - ΔVY – ITEM 20 +3.6 EXEC
   - ΔVZ – ITEM 21 +0 EXEC

   TV ROLL – ITEM 5 + _ _ _ EXEC
   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC
   Config DAP A,B to A7,B7

   At TIG -8 min:
   - DAP: B/ALT, NO LO Z
   - MNVR – ITEM 27 EXEC (*)
   - DAP: AUTO

   At TIG -0:30:
   - DAP TRANS: as reqd
   - DAP: A/INRTL/PRI
   - F7 FLT CNTLR PWR – ON

   At TIG, THC: Trim VGOs ≤ 0.2 fps
   - F7 FLT CNTLR PWR – OFF

   DAP TRANS: PULSE/PULSE/PULSE
   DAP: A/INRTL/VERN(ALT)

   GNC, OPS 201 PRO

   On MCC call:
   Go to **TERMINATE SEP OPS [8C], 2-8**
RNDZ BREAKOUT

NOTE
This procedure may be performed anytime between Ti and TORVA init (+X burns to start TORVA are complete)

1. BREAKOUT BURN PREP
   DAP: A/AUTO/PRI
   FLT CNTLR PWR – ON

2. 3 FPS RETROGRADE
   CRT
   OPS 202 PRO
   [GNC ORBIT MNVR EXEC]

√RCS SEL – ITEM 4 (*)
Set TIG to current time
TGT PEG 7 ΔVX – ITEM 19 -3 EXEC
   ΔVY – ITEM 20 +0 EXEC
   ΔVZ – ITEM 21 +0 EXEC
LOAD – ITEM 22 EXEC
TIMER – ITEM 23 EXEC
Do not maneuver to burn attitude
DAP TRANS: as reqd
Deflect THC to null VGOs
FLT CNTLR PWR – OFF

CRT
OPS 201 PRO
DAP: A/AUTO/VERN(ALT)
EXPEDITED SEPS
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SHUTTLE EMERGENCY SEPARATION

NOTE
9.101 JOINT EMERGENCY UNDOCK AND SEPARATION (SODF: JOINT OPS, EMERGENCY RESPONSE) meets all constraints for use.

Constraints for use:
Maneuver mated stack to the ±Vbar attitude
Attitude rates ≤0.12 deg/axis
Initial separation includes APDS spring pushoff
Nominal Undock Orbiter DAP and RCS config

1. INITIAL SEPARATION SEQUENCE

When petals clear:
DAP: B9/LVLH/ALT
\(\sqrt{\text{DAP TRANS: PULSE/PULSE/PULSE, no LO Z}}\)
THC: as reqd to maintain target within 8 degree corridor on C/L camera or COAS

NOTE: DAP A allowed for ±X and -Z (in) THC

At physical sep + 1:00:
DAP: VERN(ALT)
THC: +Z (out) pulses at 10 sec intervals to establish RDOT > 0.1 fps

At physical sep + 3:00 and when RNG > 30 ft (DP-DP):
THC: +Z (out) as reqd at 10 sec intervals to establish and maintain RDOT > 0.2 fps

When RNG > 50 ft (DP-DP):

GNC 23 RCS
\(\sqrt{\text{RCS FWD – ITEM 1 EXEC (*)}}\)
JET DES F2F – ITEM 35 EXEC (no *)
F3F – ITEM 33 EXEC (no *)

When RNG > 75 ft (DP–DP):
DAP: LO Z

NOTE: DAP A allowed for ±X and ±Z THC

When RNG > 100 ft (DP–DP):
If radar desired, perform INIT RADAR ACQ [10A], 2-10
Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6

2. PERFORM RADIAL BURN ON ±VBAR

When RNG > 150 ft (DP–DP):
DAP: A/LVLH/VERN(PRI), LO Z
DAP TRANS: NORM/PULSE/PULSE
THC: +X (up) for 12 sec (3.0 fps)
DAP TRANS: PULSE/PULSE/PULSE

FLT CNTLR PWR – OFF
DAP: A/INRTL/VERN(ALT)
Record Radial Burn TIG ___ / ___ : ___
Inform MCC when burn complete

At radial burn TIG + 6 min or when RNG > 1000 ft confirmed:

GNC 20 DAP CONFIG
Config DAP A,B to A7,B7
DAP: no LO Z

Cont next page
3. PERFORM FINAL BURN

**NOTE:** OMS burns:
- If initial sep from +Vbar attitude, Final burn TIG should be NET Radial Burn TIG + 13 min and NLT Radial Burn TIG + 60 min
- If initial sep from -Vbar attitude, Final burn TIG should be NET Radial Burn TIG + 13 min and NLT Radial Burn TIG + 40 min

+ X burns:
  - Final Burn TIG is Radial Burn TIG + 13 min

If performing emergency deorbit:
  - √MCC/PGSC for deorbit burn TIG/PAD
  - TV ROLL – ITEM 5 +1 8 0 EXEC
  - Go to EMERGENCY DEORBIT PREP/ENTRY (CONT DEORBIT, EMERGENCY)
  - Use single OMS burn procedures >>

If prop leak:
  - Go to LEAKING OMS PRPLT/He BURN (ORB PKT, OMS) >>

If other OMS burn:
  - Go to RNDZ OMS BURN, 5-4, use single OMS burn procedures >>

If +X burn:
  - √MCC for +X burn TIG and direction
  - **NOTE:** Posigrade burn should be performed if second docking attempt desired or if deorbit same day

**GNC, OPS 202 PRO**

- **GNC ORBIT MNVR EXEC**
- **RCS SEL – ITEM 4 EXEC (**)**

If posigrade sep desired:
  - TGT PEG 7 ΔVX – ITEM 19 +3 EXEC
  - ΔVY – ITEM 20 +0 EXEC
  - ΔVZ – ITEM 21 +0 EXEC

If retrograde sep desired:
  - TGT PEG 7 ΔVX – ITEM 19 –3 EXEC
  - ΔVY – ITEM 20 +0 EXEC
  - ΔVZ – ITEM 21 +0 EXEC

**LOAD – ITEM 22 EXEC**
**TIMER – ITEM 23 EXEC**
**MNVR – ITEM 27 EXEC (**)**

**DAP:** B/AUTO/PRI

At TIG -0:30:
- FLT CNTLR PWR – ON
- DAP: A/INRTL/PRI

At TIG:
- THC: Trim VGOs ≤ 0.2 fps
- FLT CNTLR PWR – OFF
- DAP: A/INRTL/VERN(ALT)

**GNC, OPS 201 PRO**

Go to TERMINATE SEP OPS [8C], 2-8
ANY ATTITUDE SEPARATION

CAUTION
For time-critical undocking procedures, go to 9.101 JOINT EXPEDITED UNDOCKING AND SEPARATION (SODF: JOINT OPS, EMERGENCY RESPONSE)
If not hard-mated, start in step 3
Constraints for use:
Stack angular rates ≤ 0.12 deg/sec per axis
APDS ring relative misalignment < 5º per axis (as read in C/L camr)

1. INSTALL RNDZ TOOLS
If rendezvous tools already installed, go to step 2
Perform C/L CAM INSTALL (PHOTO/TV, CENTERLINE (C/L) CAMR)
Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZ TOOLS), 7-2
If reqd, install -Z COAS
If RPOP setup reqd:
  [GNC 33 REL NAV]
  ORB TO TGT – ITEM 10 EXEC
  RNDZ NAV ENA – ITEM 1 EXEC (*)

  Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-15, then:
  Perform RPOP OPS (RNDZ TOOLS), 7-16, then:
  Perform TCS ACTIVATION (RNDZ TOOLS), 7-18, steps 1 to 3, then:
  Perform TCS MANUAL ACQUISITION (RNDZ TOOLS), 7-19, step 1
  (Set RANGE = 4 ft, AZIMUTH = 0, ELEVATION = 0)
  Note: TCS will not track until after undock
Perform HAND-HELD LIDAR CHECKOUT/OPS (RNDZ TOOLS), 7-14

2. CONFIGURE FOR UNDOCKING
√ISS: FREE
√DAP: FREE
√SENSE: -Z
AFT ADI ATT – LVLH
   ERR – MED
   RT – MED

  [GNC 20 DAP CONFIG]
Config DAP A,B to A9/B9
X Jets ROT ENA – ITEM 7 EXEC (no *)

DAP: B/FREE/ALT, no LO Z
√DAP TRANS: PULSE/PULSE/PULSE

  [GNC 23 RCS]
Reselect manually deselected primary jets (no *) except F2F and F3F

O14:E, All DDU cbs (six) – cl
O15:E,
O16:E
O14:F, Pri RJD LOGIC, DRIVER (sixteen) – ON
O15:F,
O16:F

Perform DOCKING MECHANISM POWERUP (APDS), 8-5

Cont next page
3. **COMMAND SEPARATION**
   Perform UNDOCKING PREP (APDS), 8-7

   If APDS spring-assisted separation not expected (not hard-mated):
   
   On MCC GO, and when $-0.12 \leq \text{ROLL, PITCH, YAW RATE} \leq 0.12$
   
   - A7L APDS CIRC PROT OFF pb – push
   - \( \sqrt{\text{CIRCUIT PROTECT OFF}} \) lt – lt on
   - OPEN LATCHES pb – push
   - \( \sqrt{\text{LATCHES CLOSED}} \) lt – lt off
   - \( \sqrt{\text{OPEN}} \) lt – lt on

   If APDS spring-assist expected (hard-mated):
   
   On MCC Go, and when $-0.12 \leq \text{ROLL, PITCH, YAW RATE} \leq 0.12$
   
   Perform UNDOCKING OPERATIONS \[6A\], 2-6, step 3

4. **INITIAL SEPARATION SEQUENCE**

   A6U FLT CNTLR PWR – ON

   When capture latches/hooks open:

   - If no spring-assisted separation:
     
     - DAP: B/FREE/ALT, no LO Z
     - THC: +Z (out) 4 pulses at 10 sec intervals
     - Do not attempt to maintain 8 degree corridor
   
   - If spring-assisted separation:
     
     - When petals clear:
       
       - DAP: B/LVLH/ALT, no LO Z
       - THC: as reqd to maintain target within 8 deg corridor on C/L camera

   At physical sep +1:00:
   
   - DAP: LVLH/VERN(PRI)
   - THC: as reqd to maintain target within 8 degree corridor on C/L camera
   
   - THC: +Z (out) pulses at 10 sec intervals to establish RDOT $> 0.1$ fps, then
     
     - no +Z (out) pulses until 30 ft step
   
   - Note: DAP A allowed for ±X and -Z (in) THC

   If Rdot falls below 0.02 fps, establish opening rate $\leq 0.05$ fps using +Z (out) pulses at 10 second intervals, then wait $> 2$ min to perform 30 ft step

   If reqd, perform TCS MANUAL ACQUISITION (RNDZ TOOLS), 7-19, step 2

   At physical sep +3:00 and when RNG > 30 ft (DP to DP):
   
   - THC: +Z (out) as reqd at 10 sec intervals to establish and maintain
     
     - RDOT $> 0.2$ fps

   When RNG > 50 ft (DP to DP):
   
   - \[ \text{GNC 23 RCS} \]
   - \( \sqrt{\text{RCS FWD}} \) – ITEM 1 EXEC (*)
   - JET DES F2F – ITEM 35 EXEC (no *)
   - F3F – ITEM 33 EXEC (no *)

   When RNG > 75 ft (DP to DP):
   
   - DAP: LO Z
   
   - Note: DAP A allowed for ±X and ±Z THC

   When RNG > 100 ft (DP to DP):
   
   - If radar desired, perform INIT RADAR ACQ \[10A\], 2-10
   
   - A7L POWER OFF pb – push
   
   - If reqd, perform DOCKING RING RETRACTION (NOT MATED) (APDS), 8-9
   
   - Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6

Cont next page
5. **PERFORM +X BURN AT RNG > 150 FT**

When RNG > 150 ft (DP-DP):
- **DAP:** A/LVLH/VERN(PRI), LO Z
- **DAP TRANS:** NORM/PULSE/PULSE
- **THC:** +X (up) for 8 sec (2.0 fps)
- **DAP TRANS:** PULSE/PULSE/PULSE

Record +X Burn TIG ___ / ___ : ___ : ___
Stop maintaining 8 deg corridor
Inform MCC when burn complete

6. **ROTATE TO PLACE AND MAINTAIN ISS IN OVHD WINDOW**

**DAP:** A/INRTL/PRI
Perform manual pitch rotation as reqd:
- **DAP ROT:** DISC/PULSE/DISC
- **RHC:** ± PITCH as reqd to place and maintain ISS in OVHD Window

When RNG > 1000 ft (CG–CG):
- **DAP:** no LO Z

7. **PERFORM OUT-OF-PLANE BURN**

**[GNC 20 DAP CONFIG]**
Config DAP A,B to A7/B7
- **GNC, OPS 202 PRO**
- **[GNC ORBIT MNVR EXEC]**
- √**RCS SEL – ITEM 4 EXEC (*)**

Set TIG to +X Burn TIG + 22 min
- **TGT PEG 7 ΔVX** – **ITEM 19 +0 EXEC**
  - ΔVY – **ITEM 20 +2.5 EXEC**
  - ΔVZ – **ITEM 21 +0 EXEC**

**LOAD** – **ITEM 22 EXEC**
**TIMER** – **ITEM 23 EXEC**

If VGO Z is negative:
- **TGT PEG 7 ΔVY** – **ITEM 20 -2.5 EXEC**
- **LOAD** – **ITEM 22 EXEC**
- **TIMER** – **ITEM 23 EXEC**
- √**VGO Z ≥ 0**

Do not maneuver to burn attitude

At TIG:
- √**RNG > 1500 ft (CG–CG)**
- **A6U**
  - FLT CNTLR PWR – OFF
  - **DAP ROT:** DISC/DISC/DISC
- **F6**
  - FLT CNTLR PWR – ON
  - **THC:** trim VGOs ≤ 0.2 fps
  - FLT CNTLR PWR – OFF

Record Out-of-Plane Burn TIG ___ / ___ : ___ : ___
8. **PERFORM FINAL BURN**

- MCC for final burn engine selection and breakout direction

**NOTE:** Posigrade burn should be performed if second docking attempt desired or if deorbit same day

If single OMS burn:
- MCC for burn TIG
  - Perform RNDZ OMS BURN, 5-4

If + X burn:
- If posigrade sep desired:
  - If $\Delta V_Y$ from Out-of-Plane burn (step 4) was positive:
    - TV ROLL – ITEM 5 +2 7 0 EXEC
  - If $\Delta V_Y$ from Out-of-Plane burn (step 4) was negative:
    - TV ROLL – ITEM 5 +9 0 EXEC
  - TGT PEG 7 $\Delta V_X$ – ITEM 19 +7.0 EXEC
  - $\Delta V_Y$ – ITEM 20 +0 EXEC
  - $\Delta V_Z$ – ITEM 21 +0 EXEC

- If retrograde sep desired:
  - If $\Delta V_Y$ from Out-of-Plane burn (step 4) was positive:
    - TV ROLL – ITEM 5 +9 0 EXEC
  - If $\Delta V_Y$ from Out-of-Plane burn (step 4) was negative:
    - TV ROLL – ITEM 5 +2 7 0 EXEC
  - TGT PEG 7 $\Delta V_X$ – ITEM 19 -7.0 EXEC
  - $\Delta V_Y$ – ITEM 20 +0 EXEC
  - $\Delta V_Z$ – ITEM 21 +0 EXEC

Set TIG to Out-of-Plane Burn TIG + 22 min

- LOAD – ITEM 22 EXEC
- TIMER – ITEM 23 EXEC
- MNVR – ITEM 27 EXEC (*)
- DAP: B/AUTO/PRI

At TIG -0:30:
- F6 FLT CNTLR PWR – ON
- DAP: A/INRTL/PRI

At TIG:
- THC: trim VGOs $\leq$ 0.2 fps
- F6 FLT CNTLR PWR – OFF
- DAP: A/INRTL/VERN(ALT)
- GNC, OPS 201 PRO

Go to TERMINATE SEP OPS 8C, 2-8
Ti DELAY BURN

1. **OPS 202 PRO**

   [GNC ORBIT MNVR EXEC]

   Load Ti Delay Pad, 3-7

   If no Ti Delay targets available:
   - Add 3.0 fps to $\Delta V_x$ of last Ti burn solution
   - Burn $\Delta V_y$ and $\Delta V_z$ as computed in last Ti burn solution
   - Max TIG Slip is 4 minutes

   **NOTE**
   Guidance will downmode to EXT $\Delta V$

   If RCS:
   - Perform RCS BURN (Cue Card)

   If OMS:
   - Perform RNDZ OMS BURN (CONTINGENCY OPS), 5-4

2. **Reload new BASETIME per final Ti PAD, 3-7**

   [GNC 34 ORBIT TGT]

   TGT NO – ITEM 1 +1 EXEC
   Set BASETIME to new Ti TIG ___/___:___:___
   Load – ITEM 26 EXEC
   Reset ET, SM timers to new Ti TIG

   **NOTE**
   If Ti Delay executed because no comm:
   - Add 0/01:32:00 to BASE TIME for subsequent delay rev
   - See LOSS OF COMM (CONTINGENCY OPS), 5-31

   **If no comm for 2 delay revs:**
   - Ti Delay breakout is a 1.5 fps posigrade burn at the next Ti point

   Perform RNDZ BREAKOUT (CONTINGENCY OPS), 5-18, with the following deltas:
   - Set TIG to BASE TIME
   - TGT PEG 7 $\Delta V_X$ – ITEM 19 +1.5 EXEC
   - $\Delta V_Y$ – ITEM 20 +0 EXEC
   - $\Delta V_Z$ – ITEM 21 +0 EXEC
   - Perform TERMINATE SEP OPS [8C], 2-8

3. **Perform Post Ti Nav [16A], 4-16, then**

   Return to RENDEZVOUS TIMELINE at PET: -01:25, 4-11

   **NOTE**
   Extra NCC Burn and Ti Onboard Solution pads, 5-28
### NCC Burn Solution

#### Preliminary

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### Ti Onboard Solutions

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#### Final-Ground Limits

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### Final Ti Pad (MNVR Pads)
RNDZ NAV RECOVERY

1. If Recovery from OPS MODE RECALL:
   (add/delete GPC to/from redundant set)
   
   GNC 33 REL NAV

   RNDZ NAV ENA – ITEM 1 EXEC (*)

   GNC UNIV PTG

   TRK – ITEM 19 (CUR-*)

   Go to step 3

2. If Recovery from OPS TRANSITION (G8/G3 to G2):

   GNC 34 ORBIT TGT

   TGT NO – ITEM 1 +1 EXEC

   Set BASE TIME to Ti TIG (Ti Burn Pad, 3-6)

   LOAD – ITEM 26 EXEC

   GNC 33 REL NAV

   Upon MCC uplink of TGT SV,
   RNDZ NAV ENA – ITEM 1 EXEC (*)

   NOTE

   If RNDZ NAV not enabled (no *),
   DO NOT PROCEED. √MCC

   Select appropriate target track attitude

   GNC UNIV PTG

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   TRK – ITEM 19 (CUR-*)

3. DAP: ALT

   DAP: A/AUTO

   DAP ROT: DISC/DISC/DISC

   When in attitude, DAP: VERN

   If NAV sensor data available:

   If STRK NAV:
   Go to STAR TRACKER NAV 10A, 4-10 >>

   If RR NAV:

   GNC 33 REL NAV

   CRT

   KU ANT ENA – ITEM 2 (*)

   GNC I/O RESET

   Go to RR NAVIGATION 13B, 4-13
TGT ITER

When in Lambert Targeting and TGT ITER occurs:

If PRED MATCH other than 999999 (all 9s):

√MCC and read down PRED MATCH from SPEC 34 (MCC has delta Vs)
On MCC GO or if no comm:
   Recall TGT set and recompute
If TGT ITER recurs and PRED MATCH less than 400:
   Contact MCC and read down PRED MATCH from SPEC 34
   On MCC GO or if no comm:
      Load current delta Vs and execute as Lambert burn >>
If TGT ITER recurs and PRED MATCH greater than 400:
   Contact MCC and read down PRED MATCH from SPEC 34
   On MCC GO or if no comm:
      Load ground solution and execute as EXT DV burn
      (If MC burn, uplink of ground solution reqd) >>
      If ground solution not available: No burn >>

If PRED MATCH 999999 (all 9s):
On MCC GO or if no comm:
   Load ground solution and execute as EXT DV burn
   (If MC burn, uplink of ground solution reqd) >>
   If ground solution not available: No burn >>
LOSS OF COMM

If comm with MCC is lost during rendezvous ops, attempt to establish comm by performing 6.105 SSOR ACTIVATION (SODF: JOINT OPS, COMM/DATA), and COMM LOST (ORB PKT, COMM). Do not maneuver out of target track attitude unless all other means of acquiring comm are expended

Ground-Targeted Burns

1. If NH or NC PADs not available, do not perform burn

2. If a day of rendezvous NC or NH maneuver was not performed nominally, then discontinue rendezvous operations

3. If the day of rendezvous NC maneuver is performed using preliminary pads, a large NCC burn can be expected

Lambert-Targeted Burns

1. If “GO for Ti” not received from MCC by Ti TIG - 5 min, perform Ti DELAY BURN (CONTINGENCY OPS), 5-27. If comm is not recovered after two delay revs, perform modified RNDZ BREAKOUT per Ti DELAY BURN (CONTINGENCY OPS), 5-27

2. If radar nav was stopped in an attempt to get Ku comm during the delay, do not perform second or third NCC burn unless radar nav is re-enabled and sufficient radar marks are taken to provide a converged solution

3. If no comm for any midcourse correction (MC) burn, perform burn and continue to prox ops

Prox Ops

1. If “GO for RPM” not received from MCC, do not perform Rbar Pitch Maneuver. Proceed directly to the TORVA and continue to the Vbar. On the Vbar, stationkeep for a maximum of 1 rev and attempt to re-establish comm. If no comm after 1 rev of stationkeeping, perform VBAR BREAKOUT (CONTINGENCY OPS), 5-14

2. If “GO to proceed inside 600 ft” not received from MCC, do not approach inside 600 ft (CG-CG). Stationkeep on the Vbar outside of 600 ft for a maximum of 1 rev and attempt to re-establish comm. If no comm after 1 rev of stationkeeping, perform VBAR BREAKOUT (CONTINGENCY OPS), 5-14

3. If “GO for docking” not received from MCC do not attempt docking. Back out (if required) and stationkeep outside of 250 ft for a maximum of 1 rev and attempt to re-establish comm. If no comm after 1 rev of stationkeeping, go to VBAR BREAKOUT (CONTINGENCY OPS), 5-14
RENDZVOUS -X RCS BURN

If -X NH Burn: (perform these steps instead of the timeline callouts thru TIG)
1. At TIG -18 min perform MNVR TO -X BURN ATTITUDE [A].
   Note: If burn specific Univ Ptg inputs have not been received from the MCC, perform
   the maneuver using the reference inputs in the block. If burn specific inputs are
   received from MCC prior to TIG -5 min, repeat MNVR TO -X BURN ATTITUDE [A].
2. At TIG -5 minutes, perform -X RCS BURN (Cue Card)
3. Return to nominal timeline at PET = -2:15 ENABLE RENDEZVOUS NAV [7A]

If -X NC Burn: (perform these steps instead of the timeline callouts thru TIG)
1. At TIG -18 min perform MNVR TO -X BURN ATTITUDE [A].
   Note: If burn specific Univ Ptg inputs have not been received from the MCC, perform
   the maneuver using the reference inputs in the block. If burn specific inputs are
   received from MCC prior to TIG -5 min, repeat MNVR TO -X BURN ATTITUDE [A].
2. At TIG -5 minutes, perform -X RCS BURN (Cue Card), steps 1 – 5
3. After burn perform MNVR TO TGT TRACK ATTITUDE [B]
4. Return to nominal timeline at PET = -1:30 TARGET NCC BURN [11A], 4-11

If -X Ti Burn: (perform these steps instead of the timeline callouts thru TIG)
1. At TIG -18 min perform intermediate TARGET Ti BURN [13A], 4-13
2. At TIG -15 min perform MNVR TO -X BURN ATTITUDE [A]
   Note: If burn specific Univ Ptg inputs have not been received from the MCC, perform
   the maneuver using the reference inputs in the block. If burn specific inputs are
   received from MCC prior to TIG -5 min, repeat MNVR TO -X BURN ATTITUDE [A].
3. At TIG -10 min perform TARGET Ti BURN [15A] (Final), 4-15
4. At TIG -5 minutes, perform -X RCS BURN (Cue Card), steps 1- 5
5. After burn perform MNVR TO TGT TRACK ATTITUDE [B]
6. Return to nominal timeline at PET = +0:01 TARGET MC1 BURN [17A] (Preliminary), 4-17

MNVR TO -X BURN ATTITUDE [A]

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TRK – ITEM 19 EXEC (CUR*)
DAP: A/AUTO/ALT (B/ALT as reqd)
If RR Ops:
A6U KU SEL – AUTO TRK
   GNC 33 REL NAV
CRT INH Angles – ITEM – 24 EXEC (*)

MNVR TO TGT TRACK ATTITUDE [B]

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TRK – ITEM 19 EXEC (CUR – *)
DAP: B/AUTO/ALT
If RR Ops, when ATT ERR < 30 deg:
A6U KU SEL – GPC
   √KU TRACK tb – gray
   GNC 33 REL NAV
CRT AUTO Angles – ITEM – 23 EXEC (*)
When MNVR cmplt, DAP: A/AUTO/VERN(ALT)
DEGRADED CONTROL
DEGRADED +X TRANSLATION

NOTE 1
Degraded +X occurs with loss of L1A and L3A or R1A and R3A. Perform these procedures in addition to nominal approach or separation procedures.
√MCC for additional procedure updates

NOTE 2
NO-GO for RPM.
LO Z +Z translation is not effective, do not perform LO Z +Z translation (braking).
+X translation pulses must be doubled to attain desired $\Delta V$.
+X translation couples into Y translation toward the failed jets (selection of DAP P,Y – ALL minimizes coupling)

1. Between Ti and TORVA initiation, continue to Rbar and initiate TORVA:
   Perform APPROACH (Cue Card), with the following deltas:
   Bias Rdot 0.1 fps slower than Cue Card
   Do not perform LO Z +Z translation (braking)
   Perform DAPS A9, B9 PITCH AND YAW TO ALL A
   Do not perform RPM
   Initiate TORVA with approx 0.1 fps slower Rdot
   Double +X pulses to initiate TORVA
   Null Ydot (approx 0.1 fps) immediately after TORVA initiation

2. Between TORVA initiation and RNG = 250, continue to Vbar:
   Perform APPROACH (Cue Card) with the following deltas:
   Do not perform LO Z +Z translation (braking)
   Perform DAPS A9, B9 PITCH AND YAW TO ALL A
   When ready to ESTABLISH VBAR
   DAP: No LO Z, stay No LO Z thru dock
   If Rdot exceeds cue card limit:
      DAP: B
      THC: Brake to cue card limit using 10 sec pulse spacing

3. Inside RNG = 250, continue approach to docking
   Perform VBAR APPROACH (Cue Card) with the following deltas:
   If RNG > 75 ft:
      DAP: No LO Z, stay No LO Z thru dock
      Perform DAPS A9, B9 PITCH AND YAW TO ALL A
      If Rdot exceeds cue card limit:
         DAP: B
         THC: Brake to cue card limit using 10 sec pulse spacing
   If RNG < 75 ft, No changes to approach procedures

4. During docked operations, or undocking and separation:
   √MCC for updates to UNDOCKING/SEP TIMELINE

DAPS A9, B9 PITCH AND YAW TO ALL A

GNC 20 DAP CONFIG
DAP EDIT – ITEM 3 +9 EXEC
PRI P OPTION – ITEM 55 EXEC – (ALL)
PRI Y OPTION – ITEM 56 EXEC – (ALL)
LOAD – ITEM 5 EXEC
DAP EDIT – ITEM 4 +9 EXEC
PRI P OPTION – ITEM 55 EXEC – (ALL)
PRI Y OPTION – ITEM 56 EXEC – (ALL)
LOAD – ITEM 5 EXEC

EXEC

PRI P OPTION – ITEM 55 EXEC – (ALL)
PRI Y OPTION – ITEM 56 EXEC – (ALL)
LOAD – ITEM 5 EXEC
DEGRADED -X TRANSLATION

NOTE 1
Degraded -X occurs with loss of any two forward-firing jets (F1F, F2F, F3F). Perform these procedures in addition to nominal approach or separation procedures.
MCC for additional procedure updates

NOTE 2
LO Z +Z translation (braking) couples strongly into +X translation. Forward-firing jet deselect/reselect at 75 ft not required

During approach, backout, breakout, or separation:
If LO Z +Z translation (braking) is required, perform 4-6 -X pulses for every 1 LO Z +Z pulse
Double the number of degraded -X pulses to achieve desired -X translation
LOSS OF FORWARD SIDE-FIRING JETS

NOTE 1
This failure occurs with the loss of F1L and F3L or F2R and F4R. Perform these procedures in addition to the nominal approach, or separation procedures. \(\sqrt{\text{MCC}}\) for additional procedure updates

NOTE 2
DAP disables \(\pm Y\) translation.
NO-GO for RPM, approach within 250 ft, or docking

During approach:
If failure occurs post-Ti:
   Do not trim VGO \(Y\) on MC1-4
   If in -Z TGT TRK, do not perform MANUAL OUT-OF-PLANE NULL [19A], 4-19

Do not approach inside 250 ft (interface to interface)

If inside 250 ft, perform VBAR CORRIDOR BACKOUT (CONTINGENCY OPS), 5-12 to RNG > 250 ft, with the following deltas:
   Maintain 8 deg corridor in X-axis direction
If 8 deg corridor is violated in X or Y direction and 250 ft > RNG > 150 ft, go to VBAR BREAKOUT (CONTINGENCY OPS), 5-14
When RNG = 250 ft, \(\sqrt{\text{MCC}}\) for further actions
LOSS OF ONE FxD JET

NOTE
Failure occurs with the loss of any one of the following jets: F1D, F2D, F3D, or F4D. Perform these procedures in addition to nominal approach or separation procedures.
NO-GO for RPM

If VERNS failed, perform APPROACH and VBAR APPROACH Cue Cards with following deltas:
   Do not perform braking (LO Z or NORM Z) between 600 ft and the Vbar (PITCH ERR < 2 deg)
   When in Vbar attitude (PITCH ERR < 2 deg):
      DAP: NO LO Z, maintain NORM Z until docking
      For braking, use DAP B +Z (out) pulses at 10-sec intervals

   When RNG = 75 ft:
      10-sec intervals for +Z (out) pulses no longer required

When RNG = 30 ft:
   Stationkeep:
      THC: +Z (out) as reqd to null Rdot
   When ready to initiate final approach:
      THC: -Z (in) as reqd to establish Rdot = -0.07 fps
      Note: This verifies the health of the remaining FxD jet
LOSS OF BOTH FxD JETS (SAME SIDE)

**IMMEDIATE ACTIONS**
* Perform the IMMEDIATE ACTIONS for the 2FxD CASE on the RCS
* FAILURE DURING PROX OPS Cue Card

**NOTE 1**
Failure occurs with loss of F1D and F3D, or F2D and F4D.
Perform these procedures in addition to nominal approach or separation procedures.
\/~MCC for additional procedure updates

**NOTE 2**
NO-GO for RPM, approach within 250 ft, or docking.
DAP disables ±Y translation.
Reselecting failed forward down-firing jet overrides DAP lockout of ±Y translation.
Do not perform LO Z +Z translation(braking) or PCT.
LO Z +Z translation(braking) will couple into -Z translation(closing) and Y translation toward failed jets.
Norm Z DAP B braking on Vbar (when RNG > 75 ft) is to be performed at 10-sec intervals (pulses at 10 sec intervals minimizes structural resonance).
-Z translation couples into Y translation toward failed jets.
-X translation couples into -Z translation (closing) in LO Z PRI control.
DAP PRI P OPTION – TAIL, Y OPTION – ALL minimizes Y translation effects resulting from attitude control firings

1. If failure occurs prior to Ti, delay RNDZ until failed jet(s) recovered:
   Perform CONFIG PITCH OPTION TO TAIL A
   If failed jet(s) not recovered, \/~MCC for breakout procedure >>

2. If failure occurs between Ti and TORVA initiation, continue to Rbar:
   Perform CONFIG PITCH OPTION TO TAIL A
   Do not trim VGO Y on MC1-4
   If in -Z TGT TRK, do not perform MANUAL OUT-OF-PLANE NULL 19A 4-19
   After CONFIG FOR RBAR 20B 4-20 perform CONFIG PITCH OPTION TO TAIL A
   Perform APPROACH (cue card) with following deltas:
   Bias Rdot 0.1 ft/s slower than cue card
   Do not perform LO Z +Z(braking) translation
   Perform CONFIG YAW OPTION TO ALL B
   Do not perform RPM
   Do not initiate TORVA
   If failed jet(s) not recovered by RNG = 500 ft,
   Go to RNDZ BREAKOUT (CONTINGENCY OPS), 5-18 with following deltas:
   Do not trim VGO Y >>

Cont next page
3. If failure occurs between TORVA initiation and Vbar arrival, continue approach:
   Perform CONFIG YAW OPTION TO ALL  B
   Do not perform LO Z +Z (braking) translations
   If RNG < 345 cg-cg (280 dp-dp) prior to Vbar arrival, or if 8 deg corridor violated in
   Y-axis direction:
   Go to SHUTTLE NOSE IN-PLANE BREAKOUT (R < 700 ft), 5-16 >>
   When ready to ESTABLISH VBAR (PITCH ERR ≤ 2 deg):
   DAP: No LO Z
   Use DAP B +Z (out) pulses at 10 second intervals to maintain Interface
   RNG > 250 ft
   Perform REGAIN Y CONTROL  C
   Establish and maintain 8 deg corridor
   If failed jet(s) not recovered, go to step 6

4. If failure occurs after Vbar arrival, backout to RNG > 250 ft:
   Perform VBAR CORRIDOR BACKOUT (CONTINGENCY OPS), 5-12 with following
deltas:
   After establishing opening rate:
   Config DAP to A9, B9
   Perform REGAIN Y CONTROL  C
   Perform CONFIG DAP YAW OPTION TO ALL  B
   When RNG > 75 ft,
   √DAP: No LO Z
   Use DAP B +Z (out) pulses at 10-second intervals to maintain opening RDOT
   If 8 deg corridor violated and 250 ft > RNG > 150 ft, go to step 6
   When RNG > 250 ft, do not perform -Z translation (maintain opening RDOT)
   If failed jet(s) not recovered, go to step 6

5. If failure occurs while docked, or during undocking/separation:
   √MCC for updates to UNDOCKING/SEP TIMELINE  >>

6. Perform VBAR BREAKOUT (CONTINGENCY OPS), 5-14 with following deltas:
   √DAP: No LO Z
   In steps 2 and 3, do not select DAP LO Z
   After step 3:
   Perform DESELECT FAILED FORWARD DOWN-FIRING JET  D
   DAP: LO Z
   In step 4, do not trim VGO Y

   CONFIG PITCH OPTION TO TAIL  A
   GNC 20 DAP CONFIG
   A PRI P OPTION – ITEM 15 EXEC (twice)(TAIL)
   B PRI P OPTION – ITEM 35 EXEC (twice)(TAIL)

   CONFIG YAW OPTION TO ALL  B
   GNC 20 DAP CONFIG
   A PRI Y OPTION – ITEM 16 EXEC (ALL)
   B PRI Y OPTION – ITEM 36 EXEC (ALL)

   REGAIN Y CONTROL  C
   √MCC for which jet to reselect
   GNC 23 RCS
   RCS FWD – ITEM 1 EXEC (*)
   JET DES FxD – ITEM XX EXEC (no *)
   NOTE: Do not perform any THC: -Z (in) commands

   DESELECT FAILED FORWARD DOWN-FIRING JET  D
   Deselect manually reselected jet
   GNC 23 RCS
   RCS FWD – ITEM 1 EXEC (*)
   JET DES FxD – ITEM XX EXEC (*)
LOSS OF VRCS

NOTE
This procedure overrides LOSS OF VERNIERS (ORB OPS, RCS) during rendezvous ops

1. Utilize VERN fail downmodes (PRI/ALT) specified in parentheses and follow VERN fail starred blocks per timeline. If VERN fail downmode not specified, use PRI Nose and Tail control

2. COAS NAV should not be performed if VERN fail

3. Additional braking pulses (+Z) may be reqd due to LO Z PRI attitude control cross coupling

4. PCT modes to FREE/VERN. In the event of failed capture, mode DAP to PRI per FAILED CAPTURE block, step 2

5. Twelve hooks reqd for mated attitude control in ALT
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<tr>
<td>POST-CONTACT THRUST (PCT) REFERENCE DATA</td>
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- 19  39
- 20  40
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- 22  42
- 23  43
- 24  44
- 25  45
- 26  46
- 27  47
- 28  48
POST-CONTACT THRUST (PCT) REFERENCE DATA

PBI FUNCTION WHENEVER IN OPS 2:

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¹ The following actions occur when PCT terminated by either automatic timeout or manual abort via above PBIs:
- PCT firing sequence terminated
- DAP moded to A/VERN
- DAP A,B configured to A9,B9 (Prox Ops DAP)

² Once PBI is depressed, PCT sequence will be initiated within maximum of 0.28 sec. The PCT sequence for ISS docking missions consists of 0.56 sec jet firing sequence, followed by 0.96 delay, completed with 0.88 sec jet firing sequence, giving total PCT sequence duration of 2.4 sec. Two nose jets and two tail jets fire during sequence

- PCT firing sequence can also be aborted by taking RHC/THC out of detent
## TARGETING DATA

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TCS REFLECTOR VISIBILITY DURING APPROACH

Refl #3 becomes less visible as Orbiter Y-LVLH position becomes more positive (into the page)

Expected TCS/Refl Acquisition Range
Refl #2 at TCS max range limit of 5000-6000 ft
NOTE: Refl #5 has been acquired before Refl #2 (based on planar reflector performance flight history)

Arrays, radiators, and manipulators are not shown for clarity of the TCS reflector information
NOTE: Array & Radiator Feathering Not Shown
Roll indicators are to be used with the vertical and horizontal lines on the CTVC monitor overlays. All six sets of roll indicators are sized to give roll misalignments in increments of 2 degrees. At least two sets of roll indicators on opposite sides of the target backplate are required during roll misalignment determination (see roll misalignment example). The outer roll indicators (extra set on horizontal axis) may not be used with the inner roll indicator.

Pitch and yaw indicators are to be used with the pointers on the stand-off cross (see pitch misalignment example). Both sets of pitch indicator and yaw indicators are sized to give misalignments in increments of 2, 3, 4, 5, and 6 degrees.
ISS ATTITUDE CONTROL SYSTEM MODING INDICATORS

- INDICATOR LIGHTS STEADY __ ISS ACS ACTIVE
- INDICATOR LIGHTS FLASHING __ ISS IN FREE DRIFT
- INDICATOR LIGHTS OFF __ LIGHTS FAILED OR SOFTWARE OFF

### Unit/LEDs

| Starboard LEDs 1 & 2 | LA-1 DIO Card Slot 4 Channel 13 |
| Starboard LEDs 3 & 4 | LA-1 DIO Card Slot 4 Channel 14 |

### Location wrt Orbiter Structure:

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* Full Truss from S5 to P6
**Half Truss is the Port side of ISS from P6 to center of ISS
RENNDEVOUS TOOLS

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CCTV CONFIG FOR DOCKING/UNDOCKING

1. ACTIVATION
   Perform ACTIVATION (Cue Card, TV)
   √ Monitors set to USCAN – ON
   √ MCC: VSU Sync/Async configuration

Pwr up Cameras for Docking/Undocking:
   CENTERLINE
   Camrs A,C,D
   Camr B
   Install Monitor Sunshades

2. SET CCTV CAMERA FUNCTIONS
   2.1 For Centerline Camera:
      ALC pb – press
      AVG pb – press
      √ GAM BLK STR – ON
      √ COLOR BAL – SUN
   2.2 For Cameras A,C,D:
      ALC pb – press
      AVG pb – press
      GAM BLK STR – ON
      √ COLOR BAL – SUN
      SHUTTER – ON pb press as reqd
   2.3 For Camera B:
      ALC pb – press
      AVG pb – press
      LT LEVEL pb – press
      NIGHT pb – press
      GAM BLK STR – ON

3. SET CAMERA ZOOM SETTINGS
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4. MONITOR SETUP
   MON 1,2 L-DATA – on
   C-DATA – grn
   XHAIR – grn

5. CAMERA SETUP – CAMERA A,D
   MON 2 – Camr A (Range Ruler), D (Backup Range Ruler)
   Zoom = 74.4° FOV (full unzoom), Focus = 12 ft
   Pan: as reqd to center ODS in monitor (see figure next page)
   Tilt: as reqd until bottom of ODS Interface Ring touches bottom of screen (see figure next page)

6. FINAL CONFIG FOR APPROACH AND UNDOCKING/SEPARATION
   MON 1 – CENTERLINE
   MON 2 – RANGE RULER

   Install CORRIDOR overlay:
   Use green XHair to center overlay

   Install RANGE RULER overlay:
   Place contact ring tangent line on top of ODS Contact Ring (see Figure 7-1)
Figure 7-1.— Camr A,D Range Ruler View Approach Config.
RNDZ TOOLS CHECKOUT

1. √MCC uplink to TGT SV
   [GNC 33 REL NAV]
   RNDZ NAV ENA – ITEM 1 EXEC (*)

2. √RNDZ TOOLS connected per PGSC Usage Chart (if available) or UTILITY OUTLET PLUG-IN PLAN ORBIT CONFIGURATION (REF DATA FS, UTIL PWR)

3. Perform WINDECOM OPS – ACT (ORB OPS, PGSC)
   If WinDecom data is static:
     Perform WINDECOM OPS – TROUBLESHOOTING (ORB OPS, PGSC)
     Steps C-1 through C-5 as required to receive data
     Report status to MCC

4. Perform RPOP INITIALIZATION, 7-15
   Verify good WinDecom data to RPOP
   If “RPOP is not receiving PCMMU Data” is displayed:
     Perform RPOP not receiving PCMMU Data, 7-7
     Report status to MCC

   On MCC GO:
   5. Perform TCS ACTIVATION, steps 1 and 2, 7-18

   On MCC GO:
   6. Perform HAND-HELD LIDAR CHECKOUT/OPS, 7-14

   On MCC GO:
   7. When checkout complete, perform TCS DEACTIVATION, 7-20, then:
     Exit RPOP – [SHIFT]/[F10], then:
     HHL PWR SW – OFF, then:
     Temp stow Rndz Tools as reqd

   8. [GNC 33 REL NAV]
      RNDZ NAV ENA – ITEM 1 EXEC (no *)
RNDZ TOOLS TROUBLESHOOTING

Notify MCC of problem, verify the configuration, then perform each step from the appropriate procedure, one at a time, until functionality restored. Inform MCC of the status after each step.

The objective of these actions is to quickly return functionality to a minimum TRAD system (one RPOP with PCMMU data via serial RS422 data) and minimize time spent trying to recover the Network/Telemetry Server or determine the root cause of the problem.

Troubleshooting steps assume RPOP is configured to receive PCMMU data via the network with Telemetry Server, but the RS-422 data cables are connected as a backup.

INITIAL CONFIGURATION

Verify the current configuration before contacting MCC (and inform MCC of the status).

**COMM Port Config:**

On RPOP: Config [CNTL][F10] > Comm Ports

<table>
<thead>
<tr>
<th>Config</th>
<th>Com1</th>
<th>Com2</th>
<th>Com3</th>
<th>Com4</th>
<th>DLL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tlm Server</td>
<td>HHL</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>PCMMU TCS</td>
</tr>
<tr>
<td>Serial</td>
<td>HHL</td>
<td>None</td>
<td>None</td>
<td>PCMMU</td>
<td>TCS</td>
</tr>
</tbody>
</table>

On TCS CADS: Config > Comm Port > COM2 (√)

**WinDecom**

<table>
<thead>
<tr>
<th>TFL Correct per (ORB OPS FS, COMM/INST)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telemetry Monitor</td>
</tr>
<tr>
<td>Status and Packet data not backlit yellow or red</td>
</tr>
<tr>
<td>Telemetry Tab &gt; Stream &gt; “STSXXX-rt gnc”</td>
</tr>
<tr>
<td>Status = OK</td>
</tr>
<tr>
<td>Packet 40 Present (may need to scroll down)</td>
</tr>
</tbody>
</table>

**Telemetry Server (status icon in Windows system tray)**

Verify green (GO) indicator displayed

Cont next page
TROUBLESHOOTING
Each step below is an independent troubleshooting attempt. Inform MCC the status after each step. These may repeat some of the steps from the INITIAL CONFIGURATION section

A. TCS CADS not receiving TCS data
NOTE: Assumes TCS ACTIVATION has been completed successfully
NOTE: If problem on Backup RPOP PGSC, continue use of Prime RPOP PGSC (do not alter config of Prime RPOP PGSC or TCS unit)

A1. If TCS MODE = Acq and reflector out of field-of-view >>

A2. √TX/RX end of TCS cable securely connected to Prime RPOP PGSC MCIU card COM2 (A)
√RX end of TCS cable securely connected to Backup RPOP PGSC MCIU card COM2 (A)
√PDIP PORT end of TCS cable connected to PDIP J101 port
If serial extension cables in use, verify all connections are secure

A3. If TCS CAD “Error Reading from Device” message (MCIU card problem)
If on Prime RPOP PGSC:
   TCS PWR – OFF (tb-bp)
   Perform RPOP PGSC Reboot, 7-9
   Perform TCS ACTIVATION, 7-18 steps 1–3 (expect “Auto Seed” message)
If on B/U RPOP PGSC:
   If time permits, check connections (MCIU card and serial cable)
   If serial cable unplugged – reconnect cable
   If MCIU card unseated: Perform RPOP PGSC Reboot, 7-9
   Perform TCS ACTIVATION 7-18, step 1 and 3
   (expect “Auto Seed message”)

If TCS status information restored:
   If reqd, perform RPOP INITIALIZATION, 7-15
   perform RPOP OPS, 7-16
   If Prime RPOP PGSC, perform TCS ACTIVATION, 7-18, step 4 >>
If TCS data not restored, inform MCC

A4. Perform TCS CADS software restart (per the following sequence):
   If problem on Prime RPOP PGSC, TCS PWR – OFF (tb-bp)
   TCS CADS: File > Exit TCS CAD
   Perform TCS ACTIVATION, 7-18 (if backup RPOP, step 1 and 3 only)

A5. Remove and replace TCS cable (including serial extension cables, if applicable) and MCIU card (per the following sequence):
   If problem on Prime RPOP PGSC, TCS PWR – OFF (tb-bp)
   Shut down suspect PGSC
   Install backup TCS cable and MCIU card
   Disconnect PCMMU data cables
   Verify TX/RX end of TCS cable connected to MCIU card COM2
   Perform RPOP PGSC Reboot, 7-9
   Perform RPOP INITIALIZATION, 7-15
   Perform RPOP OPS, 7-16
   Perform TCS ACTIVATION, 7-18 (if backup RPOP, step 1 and 3 only)
   If TCS data not restored, inform MCC

A6. √MCC for steps in RNDZ TOOLS CONFIGURATION STATUS, 7-10

Cont next page
B. RPOP not receiving PCMMU data
If either RPOP PGSC is receiving good PCMMU data, the WinDecom PGSC is NOT the source of the problem. Start on step B2

B1. On WinDecom PGSC, verify WinDecom receiving dynamic data
If WinDecom data is static, √PCMMU cable connection to Panel O5 (port as reqd) and WinDecom PGSC
If WinDecom data active and RPOP not receiving PCMMU Data:
Reboot WinDecom PGSC and restart WinDecom – Prime

NOTE
Perform steps B2 thru B5 for both Prime and/or Backup RPOP PGSC

B2. Verify Telemetry Server status indicator in the Windows system tray
If red (STOP) indicator:
Double left click the red (STOP) indicator to open [Telemetry Server] window
If “Not Connected to WinDecom” displayed:
Check wireless card or network cable and reconnect if required
> File > Reset Server
Wait 30 seconds, then reassess PCMMU data to RPOP
If yellow (TFL) indicator: Contact MCC >>
If green (GO) indicator:
Shut down any other programs running on that PGSC (except TSC CADS), then
Double left click the green (GO) indicator to open [Telemetry Server] window
> View > Applications Using The Server
Verify RPOP is the only application listed

B3. On [RPOP], verify configuration for PCMMU data
Config [CNTL]/[F10] > [Comm Ports…]
Under DLL, verify that PCMMU is selected
Verify “PCM” mode selected – status displayed above F6 in Function Key Menu
If “No PCM” displayed,
Select PCM mode with [CNTL]/[F6]
TCS Data [CNTL] / [F3] > Select “NAV (filtered)”

B4. Verify correct end of RS-422 Y-cable connections to MCIU card COM4 (B) lead
Prime RPOP PGSC: TX/RX
B/U RPOP PGSC: RX
WinDecom PGSC: SRC
If serial extension cables in use, verify all connections

B5. Configure [RPOP] ports for serial data:
Config [CNTL]/[F10] > [Comm Ports…]
Under COM4, select PCMMU, then “OK” both RPOP Config windows
If “Access is denied” error message received, repeat step B5.
If no joy, repeat step B5 one more time

NOTE
This terminates the Telemetry Server, so expect the status indicator in the Windows system tray to disappear

Cont next page
B6. Verify MCIU card securely seated in the RPOP PGSC
   If connection not secure or card temporarily disconnected:
      Perform RPOP PGSC Reboot, 7-9
      Perform RPOP INITIALIZATION, 7-15
      Perform step B5 to configure RPOP for serial port
   If PCMMU data recovered:
      Perform RPOP OPS, 7-16
      If Prime RPOP: Perform TCS ACTIVATION, 7-18 (all steps) >>
      If B/U RPOP: Perform TCS ACTIVATION, 7-18, step 1 and 3 only >>

B7. Remove and replace RS-422 PCMMU serial cable (including serial extension cables, if applicable) and MCIU card (per the following sequence):
   If Prime RPOP PGSC:
      Perform RPOP PGSC Reboot, 7-9 (install new card/cable at step E2)
      Perform RPOP INITIALIZATION, 7-15
      Perform step B5 to configure RPOP for serial port
      Perform RPOP OPS, 7-16
      Perform TCS ACTIVATION, 7-18
   If B/U RPOP PGSC: inform MCC >>
      (Do not alter config of Prime RPOP PGSC if it is working)

B8. √MCC for steps in RNDZ TOOLS CONFIGURATION STATUS, 7-10

C. RPOP not receiving HHL data
C1. Verify good raw HHL data displayed on HHL unit
C2. √HHL cable securely connected to HHL unit and COM1
C3. √RPOP port config for HHL
   Config [CNTL]/[F10] > [Comm Ports…]
   Under COM1, verify that HHL is selected
C4. Connect HHL cable to other RPOP PGSC (COM1 port) and check data flow
C5. As reqd, swap to backup HHL data cable or backup HHL unit
C6. √MCC for steps in RNDZ TOOLS CONFIGURATION STATUS, 7-10
D. RPOP not receiving TCS data (TCS CADS is receiving data on the same PGSC)
D1. √ RPOP configured to receive TCS data via DLL
   Config [CNTL]/[F10] > [Comm Ports…]
   Under DLL, verify that TCS is selected

D2. On [RPOP], verify that RPOP is receiving PCMMU data
   If RPOP not receiving PCMMU data, perform RPOP is not receiving PCMMU data, 7-7

D3: On [RPOP], reset DLL function by cycling TCS config
   Config [CNTL]/[F10] > [Comm Ports…]
   Under DLL, deselect TCS, then “OK” both RPOP Config windows
   Config [CNTL]/[F10] > [Comm Ports…]
   Under DLL, reselect TCS, then “OK” both RPOP Config windows
   Wait 30 seconds, then reassess TCS data to RPOP

D4. Quit and restart RPOP:
   Exit RPOP – [SHIFT]/[F10], (Expect TCS CADS “Auto seed message”) then:
   Perform RPOP INITIALIZATION, 7-15
   Perform RPOP OPS, 7-16

D5. Reboot RPOP PGSC and restart RPOP (per the following sequence):
   Perform RPOP PGSC Reboot, 7-9 (step E2 not reqd)
   Perform RPOP INITIALIZATION, 7-15
   Perform RPOP OPS, 7-16
   Perform TCS ACTIVATION, 7-18

D6. √MCC for steps in RNDZ TOOLS CONFIGURATION STATUS, 7-10

E. RPOP PGSC Reboot
E1. Shut down/power off PGSC
E2. Eject and reseat MCIU card
E3. Disconnect serial data cables from MCIU card
E4. Reboot PGSC

When “Time-Vector Server” finished (in Windows task bar)
E5. Reconnect serial data cables
### RNDZ TOOLS CONFIGURATION STATUS

On MCC request, provide the answers to the following questions:

#### RPOP (answer for all suspect RPOP PGSCs)

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Which PGSC is being used?</td>
<td>1.</td>
</tr>
<tr>
<td>2</td>
<td>Which version of RPOP (per RPOP title bar)?</td>
<td>2.</td>
</tr>
<tr>
<td>3</td>
<td>COM1 port (on PGSC aft)</td>
<td>3a.</td>
</tr>
<tr>
<td></td>
<td>a. Report associated cable label</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Cable securely connected?</td>
<td>3b.</td>
</tr>
<tr>
<td>4</td>
<td>COM4 port (on MCIU card, B leg)</td>
<td>4a.</td>
</tr>
<tr>
<td></td>
<td>a. Report associated cable label</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Cable securely connected?</td>
<td>4b.</td>
</tr>
<tr>
<td></td>
<td>c. Grey box installed in proper orientation?</td>
<td>4c.</td>
</tr>
<tr>
<td></td>
<td>d. If serial cable extension in use, verify 4a and 4b at extension cable interface</td>
<td>4d.</td>
</tr>
<tr>
<td>5</td>
<td>Network</td>
<td>5a.</td>
</tr>
<tr>
<td></td>
<td>a. Network card securely installed in PGSC?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Cable securely connected?</td>
<td>5b.</td>
</tr>
<tr>
<td></td>
<td>c. Verify secure network cable connections between WinDecom and RPOP PGSCs (and/or wireless router)</td>
<td>5c.</td>
</tr>
<tr>
<td></td>
<td>d. If wireless network, report wireless router status.</td>
<td>5d.</td>
</tr>
<tr>
<td>6</td>
<td>Check MCIU card status</td>
<td>6a.</td>
</tr>
<tr>
<td></td>
<td>a. Start &gt; Settings &gt; Control Panel &gt; Administrative Tools &gt; Computer Management &gt; Device Manager &gt; Ports &gt; MCIU PCMCIA Serial Ports (COM2 and/or COM4)</td>
<td>6b.</td>
</tr>
<tr>
<td></td>
<td>b. MCIU card securely installed in PGSC?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Verify correct orientation of card(s), i.e., right side up</td>
<td>6c.</td>
</tr>
<tr>
<td>7</td>
<td>RPOP &gt; Config (CNTL/F10) &gt; Comm Ports: report config</td>
<td>7a.</td>
</tr>
<tr>
<td></td>
<td>a. COM1, COM2, COM3, COM4</td>
<td>7b.</td>
</tr>
<tr>
<td>8</td>
<td>PCMMU data to RPOP</td>
<td>8a.</td>
</tr>
<tr>
<td></td>
<td>a. Red error message “RPOP not receiving PCMMU data” displayed?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Is there active data on SV (F1) or Radar (F2)? (check for “Prop Age” updates in upper-left corner of display)</td>
<td>8b.</td>
</tr>
<tr>
<td></td>
<td>c. What is displayed above F6 in the Function Key Menu? (“PCM” or “No PCM”)</td>
<td>8c.</td>
</tr>
<tr>
<td>9</td>
<td>TCS data to RPOP (if applicable)</td>
<td>9a.</td>
</tr>
<tr>
<td></td>
<td>a. Red error message “RPOP not receiving TCS data” displayed?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Is there active data on TCS (F3)? (check for “Prop Age” updates in upper-left corner of TCS(F3) display)</td>
<td>9b.</td>
</tr>
<tr>
<td></td>
<td>c. What is displayed above F3 in the Function Key Menu? (TCS NAV, TCS AUTO, TCS MAN, NONE)</td>
<td>9c.</td>
</tr>
<tr>
<td>10</td>
<td>HHL data to RPOP (if applicable)</td>
<td>10a.</td>
</tr>
<tr>
<td></td>
<td>a. When taking an HHL marks, does “Prop Age” update? (RPOP &gt; HHL(F4), upper-left corner of display)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. When taking an HHL marks, does HHL data “Age” update? (RPOP &gt; Rdot window (F5))</td>
<td>10b.</td>
</tr>
<tr>
<td></td>
<td>c. Does RPOP request orbiter attitude with each mark? (If not, is attitude override box checked on SHIFT/F5?)</td>
<td>10c.</td>
</tr>
<tr>
<td>11</td>
<td>Any unusual messages (popup windows, state vector messages, etc)?</td>
<td>11.</td>
</tr>
<tr>
<td>12</td>
<td>Reserved</td>
<td></td>
</tr>
</tbody>
</table>

Cont next page
## TCS (answer for all suspect RPOP PGSCs)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Which PGSC is being used?</td>
<td>21.</td>
</tr>
<tr>
<td>22</td>
<td>Which version of TCS CADS (per Help &gt; About TCS CAD…)? (On request, report the exact location of the CADS icon)</td>
<td>22.</td>
</tr>
</tbody>
</table>
| 23 | COM2 port  
   a. Report associated cable label  
   b. Cable securely connected?  
23b.  
23c. |
| 24 | PDIP panel  
   a. Report associated cable label  
   b. Report associated PDIP port  
   c. Cable securely connected? | 24a.  
24b.  
24c. |
| 25 | Check MCIU card status  
   a. Start > Settings > Control Panel > Administrative Tools >  
      Computer Management > Device Manager > Ports > MCIU PCMCIA Serial Ports (COM2 and/or COM4)  
   b. MCIU card securely installed in PGSC?  
   c. Verify correct orientation of card(s), i.e. right side up | 25a.  
25b.  
25c. |
| 26 | TCS OPS window  
   a. Report Mode status (Acq, Stby, blank)  
   b. Report Data status (Good or Bad)  
   c. Report hardware status  
   d. Report messages in message box  
   e. If self-test failed, click "Self-Test" button and report status (Shutter, Z-Latch, CW laser, Pulse laser)  
   f. If TCS CADS processing TCS data (active Range, Rdot, etc.), does the data appear stable and reasonable?  
   g. If TCS CADS processing TCS data (active Range, Rdot, etc.), is the data being received by RPOP? | 26a.  
26b.  
26c. Shutter ______  
Z-Latch ______  
CW ______  
CW Pwr ______  
Pulse ______  
Seed Rng ______  
Temp ______  
Cal ______  
Volts ______  
Self Tst ______  
26d.  
26e.  
26f.  
26g. |
| 27 | TCS C&DI (menus)  
   a. Macros > report macros available (not greyed out)  
   b. Commands > report cmds available (not greyed out)  
   c. Override > report any selected items  
   d. Config > Com Port > report current config | 27a.  
27b.  
27c.  
27d. |
| 28 | Was TCS CADS started before TCS was powered on? | 28. |
| 29-40 | Reserved | 29-40 |

---

Cont next page
### HHL (answer for all suspect RPOP PGSCs)

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
</tr>
</thead>
</table>
| **41** HHL unit unresponsive? | a. Report power status -- switch ON, battery connected?  
   If no power, have you tried alternate batteries?  
   b. Did you adjust the display brightness? |
| **42** HHL marks unsuccessful | a. Did you try “test” mode? If so, what were the results?  
   b. Have you tried taking test marks on alternate targets? |
| **43** HHL marks successful, but no transfer to PGSC | a. Which PGSC is being used?  
   b. Verify cable securely connected on HHL unit  
   c. Check COM port config -- refer to question 7 |

### WinDecom

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>61</strong> Which PGSC is being used?</td>
<td></td>
</tr>
<tr>
<td><strong>62</strong> Which version of WinDecom was launched? (WinDecom-Prime, WinDecom-RMS, or WinDecom-FCMS)?</td>
<td></td>
</tr>
</tbody>
</table>
| **63** COM4 port | a. Report associated cable label  
   b. Cable securely connected?  
   c. Grey box installed in proper orientation? |
| **64** Network | a. Network card securely installed in PGSC?  
   b. Cable securely connected?  
   c. Verify secure network cable connections between WinDecom and RPOP PGSCs (and/or wireless router)  
   d. If wireless network, report wireless router status. |
| **65** Check MCIU card status | a. Start > Settings > Control Panel > Administrative Tools > Computer Management > Device Manager > Ports > MCIU PCMCIA Serial Ports (COM2 and/or COM4)  
   b. Verify correct orientation of card(s), i.e. right side up |
| **66** Is WinDecom processing data | a. Report GNC packet status (any yellow or red backlight?)  
   b. Verify packet (PKT) 40 data is processing |

### Reserved

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>67-80</strong> Reserved</td>
<td></td>
</tr>
</tbody>
</table>

Cont next page
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>81 Which PGSC is being used?</td>
<td></td>
</tr>
<tr>
<td>82 What indicator is shown in the system tray?</td>
<td></td>
</tr>
<tr>
<td>(red “stop” sign, green “go” light, etc)</td>
<td></td>
</tr>
<tr>
<td>** Double left click this icon to open Telemetry Server window</td>
<td></td>
</tr>
<tr>
<td>83 Which version of Telemetry Server (window title bar)</td>
<td></td>
</tr>
<tr>
<td>84 What message is being displayed? (e.g., green highlight</td>
<td></td>
</tr>
<tr>
<td>“Receiving serial data from…”</td>
<td></td>
</tr>
<tr>
<td>85 Report packets being processed (main TlmSrvr window)</td>
<td></td>
</tr>
<tr>
<td>86 View &gt; Applications Using the Server -- report results</td>
<td></td>
</tr>
<tr>
<td>87 Source &gt; report current config</td>
<td></td>
</tr>
<tr>
<td>(Serial Windecom; Networked Windecom; Networked ISP)</td>
<td></td>
</tr>
<tr>
<td>88 If Serial Windecom:</td>
<td></td>
</tr>
<tr>
<td>a. Port -- report current config (COM1 thru COM7)</td>
<td></td>
</tr>
<tr>
<td>b. Baud -- report current config (9600, 19200, 38400)</td>
<td></td>
</tr>
<tr>
<td>89 Report any other messages</td>
<td></td>
</tr>
<tr>
<td>90 Did you attempt a “File &gt; Reset Server” ?</td>
<td></td>
</tr>
</tbody>
</table>
HAND-HELD LIDAR CHECKOUT/OPS

1. Unstow HHL, Battery Pack(s), and RS-232 cable

   Connect RS-232 cable from HHL to PGSC
   Plug Battery Pack into HHL
   Display Intensity knob – Adjust intensity to minimum acceptable level

   Verify RPOP program enabled per RPOP INITIALIZATION, 7-15

2. Power sw – ON

   **NOTE**
   If msg ‘LoB’ or flashing [8888] on display or irregular tone emitted, replace battery

3. Take multiple (~10) Range and Velocity measurements using top center of aft PLB bulkhead or S0 Truss Segment as TGT
   Select Range or Velocity decimal place by toggling RANGE/VELOCITY buttons
   - Range pb – 1 ft or 0.1 ft
   - Velocity pb – 0.1 fps or 0.01 fps

   √HHL data received by RPOP (HHL trajectory source must be selected)

   Range check:
   - √Range from aft port window to bulkhead = 60 ft
   - or
   - √Range from overhead window to S0 Truss Segment = ~44 ft

   Velocity check:
   - Depress trigger for 5 sec
   - √Velocity = 0.0 fps

   Report range and velocity discrepancies to MCC

   Self-Test: Press and hold Test Mode button, √8.8.8.8. Select range

HAND-HELD LIDAR STOW

Power sw – OFF

Remove RS-232 cable
Unplug Battery Pack

Stow HHL, Battery Pack(s), and RS-232 cable
RPOP INITIALIZATION

1. Power on RPOP/TCS PGSCs
   √ Data, power cables installed per PGSC Usage Chart (if available) or UTILITY OUTLET PLUG-IN PLAN, ON-ORBIT CONFIG (REF DATA FS; UTIL PWR)

2. Select Shuttle Apps Icon
   Select RPOP folder
   Select appropriate RPOP icon
   RPOP logo display
   Initialization

3. Enter current MET:
   Days>____/Hrs>___:Min>___;Sec>___
   Click [OK] to continue

   NOTE
   Time synchronized on [OK]

4. √ RPOP window title bar – verify mission-specific scenario
   √ MET correct (upper right corner of trajectory display)

5. √ PCM selected – status displayed above F6 in Function Key Menu
   If “No PCM” displayed, select PCM mode with [CNTL][F6]
   √ RPOP is receiving PCMMU data
   If RPOP not receiving PCMMU data,
   “RPOP is not receiving PCMMU data” message on display
   Inform MCC and refer to RNDZ TOOLS TROUBLESHOOTING, 7-5

   NOTE
   If no target state vector on board, expect error message
   If RNDZ NAV not enabled, expect bad relative state
RPOP OPS

1. Select desired trajectory/sensor data as needed (F1 thru F4 keys)
   Reference TRAD FAIL RANGE AND RANGE RATE DETERMINATION, 7-21, for
   recommended RPOP and TRAD configuration

2. Configure HHL settings
   - [CNTL]/[F4]  [HHL]
   - √ Appropriate aimpoint configuration per table

<table>
<thead>
<tr>
<th>HHL Aim Point</th>
<th>Angle Source</th>
<th>Angle Aim Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual phase</td>
<td>Tgt CG</td>
<td>Dock Cam</td>
</tr>
<tr>
<td>+Vbar</td>
<td>Node2-Fwd/Top</td>
<td>Dock Cam</td>
</tr>
<tr>
<td>Flyaround</td>
<td></td>
<td>C/L Target</td>
</tr>
<tr>
<td></td>
<td></td>
<td>As appropriate</td>
</tr>
</tbody>
</table>

   Configure Vert(deg) and Horiz(deg) angles to 0 deg
   Lock Vert(deg) and Horiz(deg) angles (click box below input field)
   NOTE: User may unlock angles and input angle data if desired
   Click [Update Settings] button to close [HHL] window

3. Use [F5] to display/hide [Rdot] window
   Click [sources] button to select/deselect additional data sources
   NOTE: Nominal configuration is to display “HHL/dt” and “HHLRaw”

4. Adjust configuration as required
   - Use [SHIFT]/[F1] thru [SHIFT]/[F4] to show/hide trajectory plots
   - NOTE: Cannot hide currently selected trajectory/sensor
   - Use [CNTL]/[F8] to cycle through Points of Reference (POR)
   - Use [F11] to cycle thru declutter levels
   - Use [F12] to snap a range ruler mark; [SHIFT]/[F12] to delete it
   - Use [SPACEBAR] to toggle on-screen Function Key Menu ON/OFF
   - Move axes or zoom in/out per RPOP KEYSSTROKE SUMMARY, 7-25
   - For other options, reference RPOP FUNCTION KEY SUMMARY, 7-22

   NOTE
   Display of some data input windows (such as [CNTL]/[F4] [HHL]) prevents background sensor processing (e.g., TCS NAV). Minimize the time that these data input windows are displayed as much as practical.

   Sensor processing is NOT affected by display of the [Rdot] or [THC-to-Go] windows or associated sub-windows

5. To exit RPOP program – [SHIFT]/[F10]
* **Configure TCS reflectors**
  * [CNTL][F10] [RPOP Configuration]
  * Select [TCS/Reflector...] button [Select TCS/Reflector Set]
  * Select appropriate Reflector No.
  * **NOTE:** for a single TCS unit, TCS No. selection is irrelevant

* **Configure RPOP Guidance, if desired for approach**
  * [CNTL][F5] [Select Guidance Type]
  * Select desired flight phase to start prox ops guidance sequence
  * If +Rbar Acquisition,
  * If no RPM, uncheck “with RPM” option
  * If RPM stationkeeping (SK) required,
    * Select “with SK until MET”
  * Enter RPM start window open time (per APPROACH cue card)

* **Update target attitude**
  * √ MCC for target attitude data
  * [SHIFT][F6] [Enter Target Vehicle Attitude Info]
  * Input appropriate reference frame and attitude (PYR Seq)
    * Pitch>____  Yaw>_____  Roll>_____
  * Input appropriate attitude rate mode and rates
  * **NOTE:** nominal dock and undock settings are “LVLH to Tgt Body”,
    * 0 / 0 / 0 deg attitude, and “LVLH Hold” rate

* **Input subtended angle data**
  * [F5] [Rdot]
  * Click [sources] button, then select “SubAng” option
  * Click [SubAng] button or [F6] to open data input window
  * **NOTE:** timetag is recorded when [SubAng] or [F6] button is clicked
  * Input appropriate structural element and angle (measured via COAS or CCTV with SUB ANG RULER overlay)
  * Click [OK] to incorporate mark, or [Back 1] to delete previous mark

* **Configure comm ports**
  * [CNTL][F10] [RPOP Configuration]
  * Select [Comm Ports...] button [RPOP Communications Setup]
  * Configure com ports and DLL
    * **NOTE:** TCS source must be set to DLL
    * HHL source must be set to COM1
    * PCMMU source if TLMServer (network or serial) is DLL
    * PCMMU source if no TLMServer (serial) is COM4

* For assistance with other options, √ MCC, [F10] [Help], or RPOP FUNCTION*
* KEY SUMMARY, 7-22
TCS ACTIVATION

1. CADS BOOTUP
   - √ RPOP/TCS PGSC powered ON
   - PGSC: √ Data cables installed per PGSC Usage Chart (if available) or UTILITY OUTLET PLUG-IN PLAN ORBIT CONFIGURATION (REF DATA FS, UTIL PWR)

   **SHUTTLE APPS**
   > RPOP > TCS_CADS

2. TCS PWRUP/INITIALIZATION
   - TCS PWR – ON (tb-gray)
     * If tb – bp, cycle sw
     * Verify Pnl R1: AUX – ON
     * If no joy, notify MCC

   **PGSC**
   - TCS Self Test
   - Status | Override
     - Shutter: Passed | Off
     - Z Latch: Passed | Off
     - CW Laser: Passed | Off
     - Pulse Laser: Passed | Off

   **TCS OPS**
   - Messages – INITIALIZATION COMPLETE
   - If “Initialization Complete” not received, Record the last message received
   - Macro > Initialization
   - Continue when “Initialization Complete” message received
     * If error msg received during initialization, or
     * “Initialization Complete” not received, √ MCC

   **TCS OPS**
   - Mode: Stby
   - Z Latch: Unlocked
   - CW: Active
   - Pulse: Avail
     * If not in config, √ MCC

3. TIME REFERENCE SELECT
   - **TCS C&DI**
   - Commands > Send TCS Time
     - CAD Clock
     - Enter MET
     - [Send]
   - Messages – ‘TCS Clock has been set’

4. ENABLE AUTO ACQUISITION
   - **TCS C&DI**
   - Config > Automatic > Acquisition
     - [Automatic Acquisition]
     - Update ‘Maximum Range’ for auto acquisition to begin as desired
     - [OK]
   - Inform MCC of range entered
TCS MANUAL ACQUISITION

1. **ACQUIRE**

   PGSC
   
   □ Pulse: Avail
   □ CW: Active

   TCS C&DI
   Macros > ACQUISITION

   Target Acquisition Data
   RANGE > current estimate of range to Target
   AZIMUTH > 0
   ELEVATION > 0

   □ 95% RANGE GATE – (no X)
   [Send]

   TCS OPS
   If first acquisition:
   □ Shutter – Open (after ~22 sec)
   *
   * If shutter fails to open: *
   * Commands > Standby *
   * Commands > Open Shutter *
   * Commands > Acquire *

   □ Mode – Acq

   □ Data – Good (and active tracking data)

   * If TCS not tracking and no RPOP (or Auto Seed Update disabled), *
   * TCS C&DI
   * Commands > Acquire *
   * Update Range estimate and zero AZ & EL *
   * [Send] *

2. **ENABLE AUTO ACQUISITION**

   □ Data – Good (and active tracking data)

   TCS C&DI
   Config > Automatic >
   If Seed Update – (no □)
   Select Seed Update
   [Automatic Acquisition]
   □ Maximum Range (ft): 5000
   [OK]
   Config > Automatic >
   If Acquisition – (no □)
   Select Acquisition
   [Automatic Acquisition]
   □ Maximum Range (ft): 5000
   [OK]
   Config > Automatic >
   □ Initialization – (□)
   □ Seed Update – (□)
   □ Acquisition – (□)
TCS DEACTIVATION

1. SHUTDOWN TCS

PGSC

[ TCS C&DI ]

Macros > SHUTDOWN

* If error msg received during SHUTDOWN, *
* √MCC *

TCS OPS

√Shutter: Closed (takes ~22 sec)

* If shutter fails to close: *
* Commands > Close shutter *

If Final TCS deactivation for mission:

2. SECURE Z AXIS

PGSC

[ TCS C&DI ]

Commands > Lock Z Axis Latch

TCS OPS

√Z Latch: Locked

* If Z Latch fails to lock: *
* If Z Latch: Transit *
* [ TCS C&DI ] *
* Commands > Lock Z Axis Latch *
* Otherwise *
* √MCC *

3. POWERDOWN TCS

L12

TCS PWR – OFF (tb-bp)

* If tb – gray, cycle sw *
* If no joy, notify MCC *

4. SHUTDOWN CADS

PGSC

[ TCS C&DI ]

File > Exit TCS CAD
TRAD FAIL RANGE AND RANGE RATE DETERMINATION

1. Maintain a prime and a backup range and rdot estimate from independent sensor sources
2. Maintain prime and backup RPOP PGSCs
3. Refer to table and notes below for recommended prime/backup source/configuration.

<table>
<thead>
<tr>
<th>Man Phase</th>
<th>TCS Lock (&gt;3 kft)</th>
<th>1200 ft</th>
<th>800 ft</th>
<th>Vbar</th>
<th>15 ft - dock</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOMINAL</td>
<td>1: SV</td>
<td>1: TCS NAV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2: HHL/dt</td>
<td>2: HHL/dt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RADAR</td>
<td>1: HHL/dt</td>
<td>1: TCS NAV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2: SubAng</td>
<td>2: HHL/dt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HHL</td>
<td>1: SV</td>
<td>1: TCS NAV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2: SubAng</td>
<td>2: Raw radar and SubAng</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TCS</td>
<td>1: SV</td>
<td>1: HHL/dt and raw radar Rdot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2: HHL/dt</td>
<td>2: SubAng</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCMMU</td>
<td>1: G33 FLTR</td>
<td>1: HHL/dt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2: HHL/dt or TCS-Pulse (Generic)</td>
<td>2: TCS-Pulse (Generic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: TCS-CW</td>
<td>1: TCS-CW or TCS Auto</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: HHL/dt</td>
<td>2: HHL/dt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PGSC</td>
<td>1: SV, raw radar</td>
<td>1: HHL raw: short pull for mg, long pull for Rdot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2: HHL raw: raw range, Rdot vs ΔR/Δt cue card for Rdot</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nominal notes:
1. If no TCS lock by 1200 ft, start SubAng ops to backup HHL/dt inside 1000 ft.

Radar fail notes:
2. State vector data suspect.

HHL fail notes:
3. Radar data will be unusable at close ranges. The range at which the data becomes unusable is dependent on target size, geometry, and physical characteristics, but can not be accurately predicted. For ISS, the Radar can become too noisy to use at ranges as great as 1000 ft.

TCS fail notes:
4. State vector: G33 COVAR REINIT as desired.
5. Begin gradual transition to HHL/dt and SubAng at ~1500 ft.
6. HHL will not work if the aimpoint surface is closer than 12 ft (5 ft DP-DP).
   Refer to Note 3 (above)

PCMMU fail notes:
7. RPOP state data, TCS NAV, and HHL FLTR are not usable without PCMMU data.
8. RPOP prompts user for orbiter attitude after first TCS/HHL mark. Enter P/Y/R = 90/0/0 (LVLH to Orb Body) and check “Do not prompt for attitude.” Orbiter attitude on RPOP will not be correct until mnvr to Vbar attitude is complete. Until Vbar arrival, do not use RPOP trajectory data other than the data in the Rdot window.
9. TCS pulse laser Rdot may be noisy (range OK). Can manually enter raw TCS range marks into ‘Generic’ on the RPOP Rdot window to calculate Rdot. Monitor TCS pulse/CW status on RPOP or TCS CADS.
10. Begin gradual transition to HHL/dt and TCS raw at ~1500 ft.
11. For TCS AUTO [CNTL/F3], set orbiter attitude [SHIFT/F5] P/Y/R = 90/0/0 (LVLH to Orb Body) and set TCS data frequency to 30 sec [CNTL/F10].

PGSC fail notes:
Refer to note 6 (above)
RNDZ TOOLS REFERENCE DATA

RPOP FUNCTION KEY SUMMARY

RPOP TRAJECTORY DATA KEYS (Columns F1 → F4)

<table>
<thead>
<tr>
<th>Function Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[F1→F4]</td>
<td>PRIME KEY</td>
</tr>
<tr>
<td>(SV, RR, HHL, CCTV or TCS)</td>
<td>Make this Trajectory Prime Trajectory</td>
</tr>
<tr>
<td></td>
<td>– Only one trajectory can be Prime at a time</td>
</tr>
<tr>
<td></td>
<td>– Prime Trajectory has orbiter graphics, predictors, and color-coordinated digital data</td>
</tr>
<tr>
<td>[SHIFT]/[F1→F4]</td>
<td>SHOW/HIDE KEY</td>
</tr>
<tr>
<td>(Show/Hide)</td>
<td>Show or Hide this Trajectory (toggle)</td>
</tr>
<tr>
<td></td>
<td>– Prime Trajectory cannot be hidden</td>
</tr>
<tr>
<td></td>
<td>– Background processing of trajectory continues even when hidden</td>
</tr>
<tr>
<td></td>
<td>(Exception: HHL trajectory data will not prompt for user input when hidden)</td>
</tr>
<tr>
<td>[CTRL]/[F1→F4]</td>
<td>DATA KEY</td>
</tr>
<tr>
<td>(Data)</td>
<td>Configure/input data for trajectory</td>
</tr>
<tr>
<td></td>
<td>– Allows user to configure specific Trajectory Data Source Options</td>
</tr>
<tr>
<td></td>
<td>– Allows user to input manual data</td>
</tr>
<tr>
<td></td>
<td>– Allows user to reconfigure function key to another Trajectory Data Source</td>
</tr>
<tr>
<td></td>
<td>– Duplicate Trajectory Data Source configurations are permitted</td>
</tr>
<tr>
<td></td>
<td>(e.g., HHL could be configured for both F3 and F4, if desired)</td>
</tr>
</tbody>
</table>

**NOTE**
Although duplicate data source configurations are permitted, duplicate automatic data modes (namely, State Vector, RR Auto, TCS Auto and TCS Nav) are not permitted. In such a situation, duplicated auto mode option grayed out in Trajectory Data Source Options dialog box.
**RPOP GENERAL FUNCTION KEYS (Columns F5 → F12)**

<table>
<thead>
<tr>
<th>Key &amp; Modifier</th>
<th>Function</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>[F5]</strong></td>
<td>RDOT WINDOW</td>
<td>Toggles display of Rdot Window</td>
</tr>
<tr>
<td><strong>[SHIFT]/[F5]</strong></td>
<td>ORBITER ATTITUDE</td>
<td>Update orbiter attitude and attitude rate</td>
</tr>
</tbody>
</table>
| **[CTRL]/[F5]** | GUIDANCE | Select guidance cues on demand  
Available options are:  
+Rbar acquisition – provides THC recommendations for acquiring the +Rbar. Includes options for targeting pre-TORVA conditions, pre-RPM conditions, or a pre-RPM stationkeep.  
TORVA – provides THC recommendations for performing the +Rbar to +Vbar transfer  
+Vbar Acquisition – provides THC recommendations for acquiring the +Vbar in preparation for final approach  
Glideslope Approach – provides THC recommendations for flying the final approach along a glideslope  
CW Targeting – given a burn time, transfer time, and desired LVLH position, CW Targeting will provide required THC inputs  
LVLH Velocity Null – provides THC recommendations for nulling LVLH velocities in each direction  
Average Rdot – information for timed approach |
| **[F6]** | SUBTENDED ANGLE | Enter subtended angle in Rdot Window to get range and range rate. Only active when SubAng source active on Rdot Window |
| **[SHIFT]/[F6]** | TARGET ATTITUDE | Update Target attitude and attitude rate |
| **[CTRL]/[F6]** | PCMMU MODE | No PCM mode (displays No PCM)  
Requires orbiter attitude data to be entered manually with each sensor mark  
PCM MODE (displays PCM)  
Orbiter attitude is automatically computed using PCMMU data |
| **[F7]** | VIEW | If Tgt-Centered LVLH, cycle through views: XZ, XY, YZ  
If Orb-Centered LVLH, cycle through views: XZ, XY, YZ, CAM  
View identification displayed upper left-hand corner of Trajectory Display |
| **[SHIFT]/[F7]** | OVERLAY | Cycle through displays of overlays |
| **[F8]** | REFERENCE FRAME | Toggle display between Tgt-Centered LVLH plot and Orb-Centered LVLH plot |
| **[SHIFT]/[F8]** | LO Z | Toggle jet-select between No Low Z and Low Z for making THC “What If” inputs. Displays Low Z |
| **[CTRL]/[F8]** | POINT OF REFERENCE | Cycle through preselected orbiter Point-Of-Reference to Target Point-Of-Reference sets (e.g., CG to CG, Dock Port to Dock Port) |
| **[F9]** | THC CLEAR | Cont next page |
(THC Clr) Clear THC “What if” inputs from the Prime Trajectory

[SHIFT]/[F9] (TrajClr) TRAJECTORY CLEAR
Clear Prime Trajectory history of all but 2 most recent data inputs

[CTRL]/[F9] (Back 1) BACK 1
Delete last data input from the Prime Trajectory

[F10] (Help) HELP
Access on-line help information

[SHIFT]/[F10] (Exit) EXIT
Save output files and exit RPOP program

[CTRL]/[F10] (Config) RPOP CONFIGURATION
Configure following RPOP options:

Debug
Enable serial port I/O debug text to be displayed. Displays Debug

Data Freq...
Change frequency of automatic acceptance (plotting) of PCM data (SV or RR Auto) or TCS data (TCS Auto)

Predictors...
Change number and/or time increment of displayed predictors

Update MET...
Change the mission elapsed time

Altitude...
Change altitude of target vehicle

Comm Ports...
Reconfigure serial ports and/or the DLL

TCS/Refl...
Select TCS ID number (1-2) and reflector ID number (1-15)

Views...
Enable/disable Tgt- and Orb-Centered views

NOTE
Currently displayed view (both Tgt- and Orb-Centered) cannot be disabled

THC “What if”...
Select DAP setting (trans pulse size) to be used for THC “What if” inputs
Options include: Rndz DAP, Prox Ops DAP, and a User-Configurable DAP
RPOP GENERAL FUNCTION KEYS (Columns F5 → F12) (Cont)

[F11] DECLUTTER
Cycle RPOPs display through three different levels of declutter

[F12] RANGE RULER SNAP
Computes range rate based on time between snaps and assumed delta range interval. Feature available only if I-loaded delta range interval has non zero value

[SHIFT]/[F12] RANGE RULER CLEAR
Clears range ruler display from screen. Feature available only if I-loaded delta range interval has non zero value

RPOP KEYSTROKE SUMMARY

[CTRL]/[←] or l Move Vertical axis left
[CTRL]/[→] or r Move Vertical axis right
[CTRL]/[↑] or u Move Horizontal axis up
[CTRL]/[↓] or d Move Horizontal axis down

[CTRL]/[PGUP] Zoom IN on Trajectory Display
[CTRL]/[X]/[PGUP] Zoom IN on X axis only
[CTRL]/[Y]/[PGUP] Zoom IN on Y axis only
[CTRL]/[Z]/[PGUP] Zoom IN on Z axis only

[CTRL]/[PGDN] Zoom OUT on Trajectory Display
[CTRL]/[X]/[PGDN] Zoom OUT on X axis only
[CTRL]/[Y]/[PGDN] Zoom OUT on Y axis only
[CTRL]/[Z]/[PGDN] Zoom OUT on Z axis only

NOTE
Use [SHIFT] in combination with any of above keystrokes in order to scale/move axes in finer increments. Each view may be independently scaled and/or autoscaled

[CTRL]/[HOME] Resume autoscaling and reset scale
[SPACEBAR] Toggle on-screen Function Key Menu ON/OFF

THC “What if” (-Z sense) Keystrokes (Prime Trajectory only)

<table>
<thead>
<tr>
<th></th>
<th>DAP A8</th>
<th>DAP B8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z IN</td>
<td>[SHIFT]/[←]</td>
<td>[→]</td>
</tr>
<tr>
<td>Z OUT</td>
<td>[SHIFT]/[→]</td>
<td>[←]</td>
</tr>
<tr>
<td>X UP</td>
<td>[SHIFT]/[↑]</td>
<td>[↑]</td>
</tr>
<tr>
<td>X DOWN</td>
<td>[SHIFT]/[↓]</td>
<td>[↓]</td>
</tr>
</tbody>
</table>
RPOP TRAJECTORY DATA SOURCE OPTIONS

SV  
STATE VECTOR  
*Options include:*  
 State Vector – Enable automatic acceptance of the Onboard Nav states  
 None – Turn State Vector processing off  
 Config... – Reconfigure Trajectory Data Source for this function key

RR  
RENDEZVOUS RADAR  
*Options include:*  
 Manual – Manually enter Radar RNG, EL and AZ  
 Auto – Enable automatic acceptance of Radar RNG, EL and AZ  
 None – Turn Radar processing off  
 Config... – Reconfigure the Trajectory Data Source for this function key

HHL  
HANDHELD LASER  
Manually select HHL Aim Point, Angle Source, and Angle Source Aim Point  
Manually enter HHL RNG and two Angle Source angles (an in-plane and out-of-plane)  
*Options include:*  
 Lock – Hold the in-plane angle constant (locked) for each HHL mark  
 Lock – Hold the out-of-plane angle constant (locked) for each HHL mark  
 Update Settings – Accept configuration changes to Aim Points, Angle Source, and Lock option without incorporating a trajectory mark  
 Config... – Reconfigure the Trajectory Data Source for this function key

*Angle Source options include:*  
 Fwd CCTV, Aft CCTV, Dock Cam, COAS, Radar, TCS, Other

*NOTE*  
Manual inputs reqd for all angle sources except Radar and TCS. If Radar or TCS selected, angles will be automatically snapped (if available). Other camera is optional, and may be completely specified via I-load

*Aim Point options include:*  
 HHL Aim Pt, Tgt CG, Point of Interest #1, Point of Interest #2, Point of Interest #3

*NOTE*  
HHL Aim Pt is always available and may be completely specified via I-load. Tgt CG is always available Points of Interest 1-3 are optional, and may be completely specified via I-load. For Angle Source Radar, angle aim point is Tgt CG. For Angle Source TCS, angle aim point is current reflector number

CCTV  
CLOSED CIRCUIT TELEVISION CAMERAS  
Manually enter FWD and AFT CCTV tilt angles  
*Options include:*  
 Config... – Reconfigure Trajectory Data Source for this function key

Cont next page
TCS

TRAJECTORY CONTROL SENSOR

Options include:

- Manual – Manually enter TCS RNG, EL and AZ
- Auto – Enable automatic acceptance of TCS RNG, EL and AZ
- Nav – Enable TCS NAV (Kalman Filtering)
  - Display Resids and Ratios
  - Force Measurements
  - Re-Initialize on [OK]
- None – Turn TCS processing off
- Config – Reconfigure the Trajectory Data Source for this function key
HHL REF DATA

Velocity accuracy increases with trigger hold duration:

<table>
<thead>
<tr>
<th>Duration</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5s</td>
<td>±0.15 fps</td>
</tr>
<tr>
<td>1.0s</td>
<td>±0.06 fps</td>
</tr>
<tr>
<td>2.0s</td>
<td>±0.03 fps</td>
</tr>
<tr>
<td>5.0s</td>
<td>±0.01 fps</td>
</tr>
</tbody>
</table>

To verify lock-on (if desired):
1. Push Test Mode button
2. Center red dot on TGT
3. Depress and hold trigger. Pitch on tone proportional to received signal strength
4. Press Range or Velocity button to return to Operational Mode

Error Codes:
E01  Never acquired target because target out of range or target too close
E02  Excessive percentage of total laser pulses in measurement sample unsatisfactory
E03  Excessive number of consecutive laser pulses in measurement sample unsatisfactory

TCS LIMIT DATA

<table>
<thead>
<tr>
<th>TEMPERATURE (degC)</th>
<th>LOW ALERT</th>
<th>HIGH ALERT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW Laser</td>
<td>-40.0</td>
<td>45.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50.0</td>
</tr>
<tr>
<td>APD</td>
<td>-40.0</td>
<td>65.0</td>
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<tr>
<td></td>
<td></td>
<td>70.0</td>
</tr>
<tr>
<td>CPU</td>
<td>-40.0</td>
<td>80.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>85.0</td>
</tr>
<tr>
<td>DC Power</td>
<td>-40.0</td>
<td>80.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>85.0</td>
</tr>
<tr>
<td>Galvos</td>
<td>-40.0</td>
<td>80.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>85.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VOLTAGES</th>
<th>LOW ALERT</th>
<th>HIGH ALERT</th>
</tr>
</thead>
<tbody>
<tr>
<td>5V</td>
<td>4.75</td>
<td>5.25</td>
</tr>
<tr>
<td>5.5V</td>
<td>5.00</td>
<td>6.00</td>
</tr>
<tr>
<td>12V</td>
<td>11.00</td>
<td>12.75</td>
</tr>
<tr>
<td>15V</td>
<td>14.25</td>
<td>15.50</td>
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DOCKING MECHANISM INITIALIZATION

A6L 1. cb ESS 1BC SYS PWR CNTL SYS 1 – cl
  2CA SYS PWR CNTL SYS 2 – cl
  1BC DEP SYS 1 VENT ISOL – cl
  2CA DEP SYS 2 VENT ISOL – cl
  MN A DEP SYS 1 VENT – cl
  B DEP SYS 2 VENT – cl
  MN A,MN B DOCK LT (four) – cl
  MN A,MN B,MN C LOGIC (six) – cl
  √PMA 2/3 GRP 1,GRP 2 HOOKS (eight) – op
  √SYS PWR MN A,MN B (two) – ctr
    √SYS 1,SYS 2 tb (two) – OFF
  √PYRO PWR MN A,MN C (two) – OFF
  √PMA 2/3 HOOKS SYS A,SYS B (two) – ctr
    √GRP 1,2 tb (two) – bp
  √PSU PWR MN A,MN B (two) – OFF
  √LT TRUSS,VEST (four) – OFF

A7L 2. √CONTROL PANEL POWER A,B,C (three) – OFF
    √HEATERS/DCU POWER (three) – OFF
    √APDS POWER Aₚₐₛ,Bₚₐₛ,Cₚₛ (three) – OFF
      √Aₚₛ,Bₚₛ,Cₚₛ lt (three) – lt off
    √STATUS lt (eighteen) – lt off
    √PYROS Aₛ,Bₛ,Cₛ (three) – OFF
      √Aₛ,Bₛ,Cₛ lt (three) – lt off
    √PYRO CIRCUIT PROTECT OFF lt – lt off

A6L 3. SYS PWR MN A,MN B (two) – ON (hold 5 sec)
    √SYS 1,SYS 2 tb (two) – ON
    √VEST DEP VLV SYS 1,SYS 2 VENT (two) – ctr (tb-CL)
      √ISOL (two) – ctr (tb-CL)
    cb ESS 1BC DEP SYS 1 VENT ISOL – op
    2CA DEP SYS 2 VENT ISOL – op
    MN A DEP SYS 1 VENT – op
    B DEP SYS 2 VENT – op
    √VEST DEP VLV SYS 1,SYS 2 VENT tb (two) – bp
      √ISOL tb (two) – bp

ML86B:C cb MNA EXT ARLK HTR VEST Z1/2/3 – cl
DOCKING MECHANISM POWERUP

SM 167 DOCKING STATUS

A6L 1. √SYS PWR SYS 1, SYS 2 tb (two) – ON
    PSU PWR MN A, MN B (two) – ON
    If in Undocking timeline and ODS VEST/PMA HATCH LEAK CHECK complete:
    √VEST DEP VLV SYS 1(SYS 2) VENT – ctr (tb-OP)

A7L 2. HEATERS/DCU POWER (three) – ON
    CRT √HTR/DCU PWR – A/B/C
    √RNG DR BUS – 1/2
    √HKS DR BUS – 1/2
    √DAMPER BUS – 1/2
    √FIXER BUS – 1/2

A7L 3. CONTROL PANEL POWER A, B, C (three) – ON
    CRT √CNTL PNL PWR – A/B/C

A7L 4. APDS POWER A_DS, B_DS, C_DS (three) – ON
    √A_DS, B_DS, C_DS lt (three) – lt on
    CRT √PWR – A/B/C

A7L 5. LAMP TEST pb – push
    √STATUS lt (eighteen) – lt on
    √PYRO CIRCUIT PROTECT OFF lt – lt on

CRT,A7L * If CNTL PNL PWR A(C) tlm blank, and STATUS lts nominal, *
    * tlm failure only >> *
CRT * If CNTL PNL PWR B tlm blank:
    A7L * CONTROL PANEL POWER A(C) – OFF *
    * POWER ON pb – push (√ and report STATUS lts to MCC) *
    * If any STATUS lt on, tlm failure only *
    * CONTROL PANEL POWER A(C) – ON *
### DOCKING MECHANISM POWERDOWN

<table>
<thead>
<tr>
<th>SM 167 DOCKING STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7L 1. STATUS lt (eighteen) – lt off</td>
</tr>
<tr>
<td>2. APDS POWER A&lt;sub&gt;DS&lt;/sub&gt;, B&lt;sub&gt;DS&lt;/sub&gt;, C&lt;sub&gt;DS&lt;/sub&gt; (three) – OFF</td>
</tr>
<tr>
<td>CRT √A&lt;sub&gt;DS&lt;/sub&gt;, B&lt;sub&gt;DS&lt;/sub&gt;, C&lt;sub&gt;DS&lt;/sub&gt; lt (three) – lt off</td>
</tr>
<tr>
<td>3. CONTROL PANEL POWER A, B, C (three) – OFF</td>
</tr>
<tr>
<td>CRT √CNTL PNL PWR A, B, C (three) – blank</td>
</tr>
<tr>
<td>4. HEATERS/DCU POWER (three) – OFF</td>
</tr>
<tr>
<td>CRT √HTR/DCU PWR (three) – blank</td>
</tr>
<tr>
<td>A6L 5. PSU PWR MN A, MN B (two) – OFF</td>
</tr>
<tr>
<td>6. If post-undocking:</td>
</tr>
<tr>
<td>VEST DEP VLV SYS 1(SYS 2) VENT – CL (tb-CL)</td>
</tr>
<tr>
<td>MNA DEP SYS 1 VENT – op</td>
</tr>
<tr>
<td>√MNB DEP SYS 2 VENT – op</td>
</tr>
<tr>
<td>ESS 1BC DEP SYS 1 VENT ISOL – op</td>
</tr>
<tr>
<td>√2CA DEP SYS 2 VENT ISOL – op</td>
</tr>
<tr>
<td>ML86B:C MNA EXT ARLK HTR VEST Z1/2/3 – op</td>
</tr>
<tr>
<td>MNB EXT ARLK HTR VEST Z1/2/3 – cl</td>
</tr>
</tbody>
</table>
DOCKING PREP

SM 167 DOCKING STATUS

A6L 1. LTS TRUSS AFT,FWD (two) – ON
VEST PORT,STBD (two) – ON (if reqd)

A7L 2. POWER ON pb – push
√ON lt – lt on
√RING ALIGNED lt – lt on
√INITIAL POSITION lt – lt on
√HOOKS 1,HOOKS 2 OPEN lt (two) – lt on
√LATCHES CLOSED lt – lt on

CRT √CLUTCH – blank/SLIP

UNDOCKING PREP

A6L 1. LTS TRUSS FWD,AFT (two) – ON (as reqd)
VEST PORT,STBD (two) – ON (if reqd)

A7L 2. POWER ON pb – push
√ON lt – lt on
√RING ALIGNED lt – lt on
√READY TO HOOK lt – lt on
√INTERF SEALED lt – lt on
√HOOKS 1,HOOKS 2 CLOSED lt (two) – lt on
√LATCHES OPEN lt – lt on
√RING FINAL POSITION lt – lt on
DOCKING RING EXTENSION

SM 167 DOCKING STATUS

A7L 1. POWER ON pb – push
   √ON lt – lt on
   √RING ALIGNED lt – lt on
   √HOOKS 1,HOOKS 2 OPEN lt (two) – lt on
   √LATCHES CLOSED lt – lt on
   √RING FINAL POSITION lt – lt on

CRT √CLUTCH – LOCK/blank

A7L 2. APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on

A7L 3. RING OUT pb – push
   0:00
   0:10
   √FINAL POSITION lt – lt off
   CRT
   √DRV CMD – ON
   √FIXERS – ON
   √PETAL POS BASE (three) – incr

A7L * If RING INITIAL POSITION lt failed on (ring stops after 1 sec, *
CRT * and CLUTCH – blank/SLIP): *
A7L * FIXER OFF pb – push *
CRT * FIXERS OFF lt – lt on *
A7L * RING OUT pb – push *
CRT * When PETAL POS BASE (three) = 76 ± 3%: *
A7L * POWER OFF pb – push *
CRT * ON pb – push *
A7L * FIXERS OFF lt – lt off *
CRT * APDS CIRC PROT OFF pb – push *
A7L * CIRCUIT PROTECT OFF lt – lt on *
CRT * RING OUT pb – push *
A7L * After 1 sec: *
CRT * RING DRV CMD – OFF *

* If RING FORWARD POSITION lt failed on (ring stops after *
A7L * 10 sec): *
CRT *
A7L * RING OUT pb – push *
CRT *
A7L * APDS POWER A_{DS},B_{DS},C_{DS} (three) – OFF *
CRT *
A7L * APDS POWER A_{DS},B_{DS},C_{DS} (three) – ON *
CRT *
A7L * CIRC PROT OFF pb – push *
CRT *
A7L * CIRCUIT PROTECT OFF lt – lt on *
CRT *
A7L * When RING INITIAL POSITION lt – lt on: *
CRT *
A7L * RING OUT pb – push *
CRT

Cont next page
3:40 A7L 4. RING INITIAL POSITION lt – lt on
CRT PETAL POS BASE (three): 76 ± 3%
3:50 √ CLUTCH – blank/SLIP

* If CLUTCH – blank/blank:
  √ APDS CIRCUIT PROTECT OFF lt – lt on
  √ RING OUT pb – push (expect 1 sec of drive), wait
  10 sec
CRT √ RING DRV CMD – OFF

* If CLUTCH – LOCK/blank:
CRT √ RING DRV CMD – OFF

* If not CLUTCH – blank/SLIP:
  √ MCC

A7L 5. POWER OFF pb – push
√ STATUS lt (eighteen) – lt off

DOCKING RING RETRACTION (NOT MATED)

[SM 167 DOCKING STATUS]

A7L 1. POWER ON pb – push
√ ON lt – lt on
√ RING ALIGNED lt – lt on
√ INITIAL POSITION lt – lt on
√ HOOKS 1,HOOKS 2 OPEN lt (two) – lt on
√ LATCHES CLOSED lt – lt on
CRT √ CLUTCH – blank/SLIP

0:00 A7L 2. RING IN pb – push
√ INITIAL POSITION lt – lt off
CRT √ CLUTCH – LOCK/blank

A7L * If RING FINAL POSITION lt failed on (ring stops after
  10 sec):
  √ RING IN pb – push

3:40 √ POWER OFF pb – push
CRT STATUS lt (eighteen) – lt off >>

3:40 A7L 3. RING FINAL POSITION lt – lt on
3:50 √ DRV CMD – OFF

A7L 4. POWER OFF pb – push
√ STATUS lt (eighteen) – lt off

8-9 RNDZ/126/FIN
**AIRLOCK FAN ACT AND ODS VOLUME PREP**

**MIDDK**
1. AIRLK FAN A – OFF
2. Disconnect Airlock Fan Inlet duct from Airlock Fan muffler inlet and Aft Middeck floor fitting and strap to Tunnel Extension wall
3. Unstow and install diffuser cap on Aft Middeck floor fitting

**MO13Q**
4. AIRLK FAN A – ON

**EXT A/L**
5. √Airflow at top of external airlock halo and muffler

If in Approach CC perform the following:
6. Unstrap Centerline Camera diffuser flex duct from EXT A/L wall.
   Attach flex duct to camera bracket to direct air flow to window.
   If required, tape diffuser open

**AW18A**
7. LTG FLOOD 1(3,4) – OFF

**MO13Q**
8. AIRLK 2 – OFF/ON

**MIDDK**
9. Close Inner Hatch:
   Position handle to preclosing posn per decal
   Hatch – rotate about hinge and push
   Handle – CCW to LATCH
   Lock lever to LOCKED
10. Equal vlv (two) – OFF, install caps

**MO10W**
11. √14.7 CAB REG INLET SYS 1, SYS 2 (two) vlv – CL
POST DOCKING HATCH LEAK CHECK

NOTE
ISS will concurrently perform a leak check of the PMA2 volume

1. Notify MCC and ISS, “Beginning initial Hatch leak checks”

MO10W 2. √14.7 CAB REG INLET SYS 1, SYS 2 (two) vlv – CL

SM 177 EXTERNAL AIRLOCK

3. Record EXT A/L PRESS: _____ psia
   Record A/L-VEST ΔP: _____ psid

4. Wait 20 min
   * If EXT A/L Press ≤ previously recorded – 0.16 psia
     * Notify MCC-H (possible leakage from EXT A/L)
   * If A/L-VEST ΔP ≤ previously recorded – 0.16 psid
     * Notify MCC-H (possible leakage through Hatches)

AIRLOCK PREP FOR INGRESS – BYPASS CONFIG

Inner Hatch
1. Equal vlv caps (two) – remove
2. Equal vlv (two) – NORM
3. $\sqrt{Hatch} \, \Delta P < 0.2$ psid
4. Open Hatch per decal
5. Equal vlv (two) – OFF, reinstall caps
6. ARLK 2 – ON/OFF
7. ARLK FAN A(B) – OFF

TNL EXT
8. Disconnect bypass duct from Airlock Fan outlet
   Remove diffuser from middeck floor fitting and temp stow
   Connect bypass duct to middeck floor fitting. Unstow, install cap on Airlock Fan outlet

MIDDK
9. As required, LTG FLOOD 1(3,4) – ON

AW18A
10. Unstrap centerline camera diffuser flex duct from camera bracket
    Stow duct along Stbd top of EXT A/L wall (in straps)

11. $\sqrt{Airflow}$ at top of external airlock halo

12. Go to P/TV02 DOCK, DEACTIVATION, step 2 (PHOTO/TV, SCENES)
<table>
<thead>
<tr>
<th>Action</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner Hatch</td>
<td>1. Equal vlv caps (two) – remove</td>
</tr>
<tr>
<td></td>
<td>2. Equal vlv (two) – NORM</td>
</tr>
<tr>
<td></td>
<td>3. √Hatch ΔP &lt; 0.2 psid</td>
</tr>
<tr>
<td></td>
<td>4. Open Hatch per decal</td>
</tr>
<tr>
<td></td>
<td>5. Equal vlv (two) – OFF, reinstall caps</td>
</tr>
<tr>
<td>MO13Q</td>
<td>6. AIRLK 2 – ON/OFF</td>
</tr>
<tr>
<td></td>
<td>7. AIRLK FAN A – OFF</td>
</tr>
<tr>
<td>TNL EXT MIDDK</td>
<td>8. Remove diffuser cap from Aft Middeck floor fitting. Unstow Airlock Fan Inlet duct from Tunnel Extension wall. Attach one end to Airlock Fan muffler inlet. Attach free end to Aft Middeck floor fitting</td>
</tr>
<tr>
<td>MO13Q</td>
<td>9. AIRLK FAN A – ON</td>
</tr>
<tr>
<td>AW18A</td>
<td>10. As required, LTG FLOOD 1(3,4) – ON</td>
</tr>
<tr>
<td>EXT A/L</td>
<td>11. Unstrap Centerline Camera diffuser flex duct from camera bracket</td>
</tr>
<tr>
<td></td>
<td>Stow duct along Stbd top of EXT A/L wall (in straps)</td>
</tr>
<tr>
<td></td>
<td>12. √Airflow at top of external airlock halo</td>
</tr>
<tr>
<td></td>
<td>13. Go to P/TV02 DOCK, DEACTIVATION, step 2 (PHOTO/TV, SCENES)</td>
</tr>
<tr>
<td>Issue</td>
<td>Page</td>
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<tr>
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</tr>
<tr>
<td>POWER FAILED OFF (STATUS LTS OFF)</td>
<td>8-16</td>
</tr>
<tr>
<td>DAMPING FAILED ON</td>
<td>8-17</td>
</tr>
<tr>
<td>CAPTURE LT FAILED ON</td>
<td>8-17</td>
</tr>
<tr>
<td>FIXERS FAILED ON</td>
<td>8-18</td>
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<tr>
<td>OFF LT FAILED ON</td>
<td>8-20</td>
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<tr>
<td>RING FAILS TO DRIVE</td>
<td>8-21</td>
</tr>
<tr>
<td>DRV CMD OFF</td>
<td>8-21</td>
</tr>
<tr>
<td>FINAL POSITION LT FAILED ON</td>
<td>8-21</td>
</tr>
<tr>
<td>FORCE RING ALIGNMENT</td>
<td>8-22</td>
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<tr>
<td>CLUTCH NOT 'LOCK'</td>
<td>8-23</td>
</tr>
<tr>
<td>APDS CIRCUIT PROTECT OFF LT FAILED OFF</td>
<td>8-23</td>
</tr>
<tr>
<td>HOOKS 1(2) OPEN LT FAILED ON</td>
<td>8-23</td>
</tr>
<tr>
<td>NOT CLOSED WITHIN SINGLE MTR TIME</td>
<td>8-24</td>
</tr>
<tr>
<td>READY TO HOOK LT FAILED ON</td>
<td>8-25</td>
</tr>
<tr>
<td>HOOKS 1(2) CLOSED LT FAILED ON</td>
<td>8-25</td>
</tr>
<tr>
<td>LATCHES OPEN LT FAILED OFF</td>
<td>8-26</td>
</tr>
<tr>
<td>APDS POWER FAILED OFF</td>
<td>8-26</td>
</tr>
<tr>
<td>DOCKING MECHANISM DEMATE/REIMATE</td>
<td>8-27</td>
</tr>
<tr>
<td>ODS HOOKS OPEN – CONTINGENCY</td>
<td>8-29</td>
</tr>
<tr>
<td>PMA 2/3 HOOKS OPEN – CONTINGENCY</td>
<td>8-32</td>
</tr>
<tr>
<td>APDS FAILED CAPTURE RECONFIG</td>
<td>8-35</td>
</tr>
<tr>
<td>PMA 2/3 HOOKS CLOSE</td>
<td>8-37</td>
</tr>
<tr>
<td>OPEN</td>
<td>8-39</td>
</tr>
</tbody>
</table>
POWER FAILED OFF (STATUS LTS OFF)

CAUTION
Pre-Contact, if all STATUS lts off, **NO-GO** for docking until power recovered. Initiate VBAR CORRIDOR BACKOUT (CONTINGENCY OPS) while attempting power recovery steps

A7L

1. CONTROL PANEL POWER A – OFF
   POWER ON pb – push
   If expected STATUS lts on:
   Continue in **DOCKING SEQUENCE** (Cue Card), as reqd >>

2. CONTROL PANEL POWER A – ON
   APDS POWER $A_{DS}$ – OFF
   POWER ON pb – push
   If expected STATUS lts on:
   If Undocking:
   Continue in **UNDOCKING OPERATIONS**, as reqd >>
   If Docking:
   Continue in **DOCKING SEQUENCE** (Cue Card) through step 16, then:
   Go to POWER FAILED OFF (STATUS LTS OFF), step 4

3. APDS POWER $A_{DS}$ – ON
   $B_{DS}$ – OFF
   POWER ON pb – push
   If STATUS lt (eighteen) – lt off:
   √MCC >>
   If expected STATUS lts on:
   If Undocking:
   Continue in **UNDOCKING OPERATIONS**, as reqd >>
   If Docking:
   Continue in **DOCKING SEQUENCE** (Cue Card) through step 16, then:
   Go to POWER FAILED OFF (STATUS LTS OFF), step 4

4. APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on
   OPEN LATCHES pb – push
   √LATCHES CLOSED lt – lt off
   APDS POWER $C_{DS}$ – OFF
   $A_{DS},B_{DS}$ (two) – ON
   POWER ON pb – push
   If STATUS lt (eighteen) – lt off:
   APDS POWER $B_{DS}$ – OFF
   $C_{DS}$ – ON
   POWER ON pb – push
   APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on
   Go to **DOCKING SEQUENCE** (Cue Card), step 17
DAMPING FAILED ON

**CAUTION**
Pre-Contact, **NO-GO** for docking if DAMPING – ON. Initiate VBAR CORRIDOR BACKOUT (CONTINGENCY OPS) while attempting to power off dampers

<table>
<thead>
<tr>
<th>SM 167 DOCKING STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PSU PWR MN A, MN B (two) – OFF</td>
</tr>
<tr>
<td>CRT If DAMPING – ON (TLM failure only):</td>
</tr>
<tr>
<td>A6L PSU PWR MN A, MN B (two) – ON</td>
</tr>
<tr>
<td>Continue approach or DOCKING SEQUENCE (Cue Card), as reqd &gt;&gt;</td>
</tr>
</tbody>
</table>

2. PSU PWR MN A – ON

 CRT If DAMPING – ON:
 A6L PSU PWR MN A – OFF
 MN B – ON

 CRT If DAMPING – OFF:
 Pre-Contact:
 Continue Approach
 Post-Capture, wait 5 sec then:
 A6L PSU PWR MN A (MN B) – ON
 Continue in DOCKING SEQUENCE (Cue Card), with the following change:
 After step 3:
 PSU PWR MN A (MN B) – OFF >>

3. PSU PWR MN A, MN B (two) – OFF

 Pre-Contact:
 Continue Approach
 Post-Capture, wait 5 sec then:
 PSU PWR MN A, MN B (two) – ON
 Continue in DOCKING SEQUENCE (Cue Card), starting in step 8

CAPTURE LT FAILED ON

**CAUTION**
Pre-Contact, **NO-GO** for docking if DAMPING – ON. Initiate VBAR CORRIDOR BACKOUT (CONTINGENCY OPS) while attempting to power off dampers

<table>
<thead>
<tr>
<th>SM 167 DOCKING STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>If Pre-Contact:</td>
</tr>
<tr>
<td>CRT If DAMPING – OFF:</td>
</tr>
<tr>
<td>Continue Approach &gt;&gt;</td>
</tr>
<tr>
<td>If DAMPING – ON:</td>
</tr>
<tr>
<td>A6L PSU PWR MN A, MN B (two) – OFF</td>
</tr>
<tr>
<td>Continue Approach</td>
</tr>
<tr>
<td>Post-Capture (no physical separation):</td>
</tr>
<tr>
<td>PSU PWR MN A, MN B (two) – ON</td>
</tr>
<tr>
<td>Continue in DOCKING SEQUENCE (Cue Card), as reqd</td>
</tr>
</tbody>
</table>
**FIXERS FAILED ON**

**CAUTION**
Pre-Contact, **NO-GO** for docking if RING FIXERS – ON. Initiate VBAR CORRIDOR BACKOUT (CONTINGENCY OPS) while attempting to power off fixers

<table>
<thead>
<tr>
<th>SM 167 DOCKING STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A7L</strong></td>
</tr>
<tr>
<td><strong>CRT</strong></td>
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<td><strong>A7L</strong></td>
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<tr>
<td><strong>A7L</strong></td>
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<td><strong>CRT</strong></td>
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<td><strong>CRT</strong></td>
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<td><strong>A7L</strong></td>
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<td><strong>A7L</strong></td>
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<tr>
<td><strong>A7L</strong></td>
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<tr>
<td><strong>A6L</strong></td>
</tr>
<tr>
<td><strong>CRT</strong></td>
</tr>
</tbody>
</table>

**DISABLE DAMPING**

4. When no relative motion [PETAL POS BASE (three) not changing for 60 sec]:

| **A6L** | PSU PWR MN A,MN B (two) – OFF |
| **A7L** | APDS POWER $A_{DS},B_{DS},C_{DS}$ (three) – ON |
| | POWER ON pb – push |

Cont next page
COMMAND CLUTCH TO LOCK

CRT 5. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   If PETAL POS BASE (three) not within 5% of each other:
      √MCC
   A7L  RING IN pb – push
        POWER ON pb – push
   A6L  PSU PWR MN A,MN B (two) – ON
   CRT  √DAMPING – OFF
        √CLUTCH – LOCK/blank
   A6L  PSU PWR MN A,MN B (two) – OFF

RETRACT RING

A7L  6. RING IN pb – push
     APDS POWER A₃₅,B₃₅,C₃₅ (three) – OFF
0:00  A6L  PSU PWR MN A,MN B (two) – ON
     CRT  √RING DRV CMD – ON [PETAL POS BASE (three) – decr]
0:05  A6L  PSU PWR MN A,MN B (two) – OFF
     A7L  APDS POWER A₃₅,B₃₅,C₃₅ (three) – ON
     POWER ON pb – push

EXTEND RING

CRT 7. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   A7L  APDS CIRC PROT OFF pb – push
        √CIRCUIT PROTECT OFF lt – lt on
   RING OUT pb – push
   APDS POWER A₃₅,B₃₅,C₃₅ (three) – OFF
0:00  A6L  PSU PWR MN A,MN B (two) – ON
     CRT  √RING DRV CMD – ON [PETAL POS BASE (three) – incr]
0:05  A6L  PSU PWR MN A,MN B (two) – OFF
     A7L  APDS POWER A₃₅,B₃₅,C₃₅ (three) – ON
     POWER ON pb – push

8. If RING ALIGNED lt – lt off:
   √MCC
   A6L  PSU PWR MN A,MN B (two) – ON
     Go to DOCKING SEQUENCE (Cue Card), step 8
FIXERS OFF LT FAILED ON

**SM 167 DOCKING STATUS**

If performing DOCKING RING EXTENSION, 8-8:

1. If RING FIXERS – ON during ring drive:
   - Continue in DOCKING RING EXTENSION, 8-8 >>

2. FIXER OFF pb – push
   - POWER OFF pb – push
   - ON pb – push
   - If FIXERS OFF lt – lt off:
     - Continue in DOCKING RING EXTENSION, 8-8 >>

3. APDS CIRC PROT OFF pb – push
   - \( \sqrt{\text{CIRCUIT PROTECT OFF lt – lt on}} \)
   - RING OUT pb – push

CRT When PETAL POS BASE (three) = 76 ± 3%:

4. APDS POWER ADS,BDS,CDS (three) – OFF
   - Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F) to drive slip clutch to SLIP

CRT

5. Go to DOCKING SEQUENCE (Cue Card), step 8

FIXERS OFF LT FAILED OFF

**SM 167 DOCKING STATUS**

1. POWER OFF pb – push
   - ON pb – push
   - FIXER OFF pb – push
   - If FIXERS OFF lt – lt on:
     - Continue in DOCKING SEQUENCE (Cue Card), as reqd >>

2. If not CLUTCH – LOCK/blank
   - PSU PWR MN A,MN B (two) – OFF
   - RING IN pb – push
   - POWER ON pb – push
   - 0:00 PSU PWR MN A,MN B (two) – ON
   - 0:05 \( \sqrt{\text{CLUTCH – LOCK/blank}} \)

3. PSU PWR MN A,MN B (two) – OFF
   - RING IN pb – push
   - APDS POWER A\(_{DS},B_{DS},C_{DS}\) (three) – OFF – ON
   - 0:00 PSU PWR MN A,MN B (two) – ON (ring will begin to drive in this step)
   - 0:05 \( \sqrt{\text{PETAL POS BASE (three) – decr}} \)

4. PSU PWR MN A,MN B (two) – OFF
   - APDS CIRC PROT OFF pb – push
   - \( \sqrt{\text{CIRCUIT PROTECT OFF lt – lt on}} \)
   - RING OUT pb – push
   - APDS POWER A\(_{DS},B_{DS},C_{DS}\) (three) – OFF – ON
   - 0:00 PSU PWR MN A,MN B (two) – ON (ring will begin to drive in this step)
   - 0:05 \( \sqrt{\text{PETAL POS BASE (three) – incr}} \)

5. Go to DOCKING SEQUENCE (Cue Card), step 8
RING FAILS TO DRIVE

<table>
<thead>
<tr>
<th>SM 167 DOCKING STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7L 1. POWER ON pb – push</td>
</tr>
<tr>
<td>APDS CIRC PROT OFF pb – push</td>
</tr>
<tr>
<td>√CIRCUIT PROTECT OFF lt – lt on</td>
</tr>
<tr>
<td>FIXER OFF pb – push</td>
</tr>
<tr>
<td>√FIXERS OFF lt – lt on</td>
</tr>
<tr>
<td>2. RING OUT pb – push</td>
</tr>
<tr>
<td>CRT If PETAL POS BASE (three) incr:</td>
</tr>
<tr>
<td>A7L POWER ON pb – push</td>
</tr>
<tr>
<td>√MCC</td>
</tr>
<tr>
<td>CRT 3. If PETAL POS BASE (three) not incr:</td>
</tr>
<tr>
<td>If RING DRV CMD – ON:</td>
</tr>
<tr>
<td>√POWER OFF pb – push</td>
</tr>
<tr>
<td>ON pb – push</td>
</tr>
<tr>
<td>Go to CLUTCH NOT ‘LOCK’ &gt;&gt;</td>
</tr>
<tr>
<td>CRT Go to RING DRV CMD – OFF:</td>
</tr>
<tr>
<td>Go to RING DRV CMD OFF</td>
</tr>
</tbody>
</table>

RING DRV CMD OFF

<table>
<thead>
<tr>
<th>SM 167 DOCKING STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7L 1. POWER OFF pb – push</td>
</tr>
<tr>
<td>ON pb – push</td>
</tr>
<tr>
<td>If STATUS lt (eighteen) – lt off:</td>
</tr>
<tr>
<td>CONTROL PANEL POWER A – OFF</td>
</tr>
<tr>
<td>POWER ON pb – push</td>
</tr>
<tr>
<td>If STATUS lt (eighteen) – lt off:</td>
</tr>
<tr>
<td>Go to step 3</td>
</tr>
<tr>
<td>Continue in DOCKING SEQUENCE (Cue Card), as reqd &gt;&gt;</td>
</tr>
<tr>
<td>2. APDS POWER A(_D) – OFF</td>
</tr>
<tr>
<td>RING IN pb – push</td>
</tr>
<tr>
<td>CRT If RING DRV CMD – OFF:</td>
</tr>
<tr>
<td>A7L APDS POWER A(_D) – ON</td>
</tr>
<tr>
<td>C(_D) – OFF</td>
</tr>
<tr>
<td>RING IN pb – push</td>
</tr>
<tr>
<td>CRT Go to step 3</td>
</tr>
<tr>
<td>A7L POWER ON pb – push</td>
</tr>
<tr>
<td>Continue in DOCKING SEQUENCE (Cue Card) through step 16, then:</td>
</tr>
<tr>
<td>APDS POWER A(_D) (C(_D)) – ON</td>
</tr>
<tr>
<td>OPEN LATCHES pb – push</td>
</tr>
<tr>
<td>After 5 sec:</td>
</tr>
<tr>
<td>√LATCHES OPEN lt – lt on</td>
</tr>
<tr>
<td>APDS POWER A(_D) (C(_D)) – OFF</td>
</tr>
<tr>
<td>Go to DOCKING SEQUENCE (Cue Card), step 18 &gt;&gt;</td>
</tr>
<tr>
<td>3. If free drift, comm, and power level constraints permit (√MCC):</td>
</tr>
<tr>
<td>Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F) to complete docking &gt;&gt;</td>
</tr>
<tr>
<td>4. Go to FAILED CAPTURE (VBAR APPROACH, Cue Card) to undock</td>
</tr>
</tbody>
</table>
RING FINAL POSITION LT FAILED ON

SM 167 DOCKING STATUS
Continue in DOCKING SEQUENCE (Cue Card), as reqd, with the following changes:

In step 8, after the ring stops (10 sec after having previously pushed the RING IN pb):
A7L RING IN pb – push

In step 11, to stop ring drive
POWER ON pb – push

CRT In step 18, when PETAL POS BASE (three) = 5 ± 3% and not changing for 10 sec:
A7L POWER OFF pb – push

FORCE RING ALIGNMENT

A7L 1. APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on
2. FIXER OFF pb – push
   √FIXERS OFF lt – lt on
0:00 3. RING OUT pb – push
CRT √DRV CMD – ON [PETAL POS BASE (three) – incr]
   √FIXERS – OFF
0:05 √CLUTCH – LOCK/blank

A7L √RING INITIAL POSITION lt – lt on (√off at ~0:30)
* If RING FORWARD POSITION lt failed on (ring stops after 10 sec): *
* RING OUT pb – push *
* Within 10 sec: *
* APDS POWER A_{DS},B_{DS},C_{DS} (three) – OFF *
* APDS POWER A_{DS},B_{DS},C_{DS} (three) – ON *
* CIRC PROT OFF pb – push *
* √CIRCUIT PROTECT OFF lt – lt on *

CRT * When PETAL POS BASE (any) = 92%: *
A6L * PSU PWR MN A,MN B (two) – OFF *
CRT * When PETAL POS BASE (three) not changing for 30 sec: *
A6L * PSU PWR MN A,MN B (two) – ON *
CRT * When PETAL POS BASE (three) = 98%: *
A7L * RING OUT pb – push *
* Go to step 7 *

CRT 4. When PETAL POS BASE (any) = 92%:
A7L POWER ON pb – push

CRT 5. When PETAL POS BASE (three) not changing for 30 sec:
A7L RING OUT pb – push

0:00 6. √RING FORWARD POSITION lt – lt on [PETAL POS BASE (three) = 98%]

0:10 CRT 7. √RING DRV CMD – OFF
A7L √FIXERS OFF lt – lt off
   √RING ALIGNED lt – lt on [PETAL POS RING (three) 50 ± 1%] and [PETAL POS BASE (three) within 1%]

8. Return to DOCKING SEQUENCE (Cue Card), step 8
CLUTCH NOT ‘LOCK’

SM 167 DOCKING STATUS

CRT If no ring motion when RING DRV CMD – ON

A7L 1. APDS CIRC PROT OFF pb – push
     √CIRCUIT PROTECT OFF lt – lt on
     FIXER OFF pb – push
     √FIXERS OFF lt – lt on
     RING OUT pb – push
     After 10 sec:
     POWER OFF pb – push
     ON pb – push

CRT If CLUTCH – LOCK/blank:
     Continue in DOCKING SEQUENCE (Cue Card), as reqd >>

A7L 2. RING IN pb – push
     After 10 sec:
     POWER ON pb – push

CRT If CLUTCH – LOCK/blank:
     Continue in DOCKING SEQUENCE (Cue Card), as reqd >>

3. If free drift, comm, and power level constraints permit (√MCC):
   Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F) to complete docking

APDS CIRCUIT PROTECT OFF LT FAILED OFF

SM 167 DOCKING STATUS

CRT If APDS CIRC PROT – ON:

A7L POWER OFF pb – push
     ON pb – push
     APDS CIRC PROT OFF pb – push

A7L If APDS CIRCUIT PROTECT OFF lt – lt on or

CRT APDS CIRC PROT – OFF:
     Continue sequence as required >>
     Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F)
     for RING OUT, OPEN HOOKS, OPEN LATCHES, and UNDOCKING pb commands

HOOKS 1(2) OPEN LT FAILED ON

NOTE
The following procedure should be performed immediately after DOCKING SEQUENCE (Cue Card) completed or prior to undocking as applicable

A7L 1. POWER ON pb – push
     APDS POWER ADS – OFF
     If HOOKS 1(2) OPEN lt – lt off:
     Go to nominal UNDOCKING OPERATIONS per nominal mission timeline with
     APDS POWER ADS – OFF >>

2. Prior to nominal undocking:
   Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F) to open affected hooks
HOOKS 1(2) NOT CLOSED WITHIN SINGLE MTR TIME

SM 167 DOCKING STATUS

1. If no hook motion when commanded:
   A7L  APDS POWER A_{DS} – OFF
       CLOSE HOOKS pb – push

2. If no hook motion after 10 sec:
   A7L  APDS POWER A_{DS} – ON
       B_{DS} – OFF
       CLOSE HOOKS pb – push

   CRT  If Hook Pos increasing after 10 sec:
        Continue in DOCKING SEQUENCE (Cue Card) with the
        following change:
        After step 16:
        A7L  APDS POWER A_{DS} (B_{DS}) – ON >>

3. If other hook gang closed:
   Continue in DOCKING SEQUENCE (Cue Card), as reqd
   After DOCKING SEQUENCE (Cue Card) complete, go to PMA 2/3
   HOOKS CLOSE, 8-37, to secure interface with 12 hooks >>

4. If neither hook gang closed:
   \sqrt{MCC for IFM capability}
   Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A
   THRU F) and PMA 2/3 HOOKS CLOSE, 8-37, as reqd, to secure
   interface with 12 hooks >>

5. If no IFM capability or time does not permit IFM:
   \sqrt{APDS CIRC PROT OFF pb – push
       \sqrt{CIRCUIT PROTECT OFF lt – lt on
       OPEN HOOKS pb – push
   CRT  \sqrt{HK1,HK2 POS (two) – decr
   A7L  \sqrt{HOOKS 1,HOOKS 2 OPEN lt (two) – lt on
   0:00  \sqrt{RING OUT pb – push
   CRT  \sqrt{PETAL POS BASE (three) – incr
   3:40 A7L  \sqrt{RING INITIAL POSITION lt – lt on
   Go to FAILED CAPTURE (VBAR APPROACH, Cue Card) to undock
**READY TO HOOK LT FAILED ON**

1. Immediately prior to step 4 in **DOCKING SEQUENCE** (Cue Card):
   A7L  
   **APDS POWER A\textsubscript{DS} – OFF**
   If READY TO HOOK lt – lt off:
   - If HOOKS 1(2) OPEN lt – lt off:
   - : APDS CIRC PROT OFF pb – push
   - : \sqrt{CIRCUIT PROTECT OFF lt} – lt on
   - : OPEN HOOKS pb – push
   - L \sqrt{HOOKS 1,HOOKS 2 OPEN lt (two)} – lt on
   - Continue in **DOCKING SEQUENCE** (Cue Card), as reqd, with the
   - following change:
   - After hooks begin to drive closed in step 10:
   - L
   \[ \text{APDS POWER A\textsubscript{DS} – ON} \]

2. **APDS POWER A\textsubscript{DS} – ON**
   Continue in **DOCKING SEQUENCE** (Cue Card), as reqd, with the following changes:
   - Immediately after RING IN pb – push in step 4:
     APDS CIRC PROT OFF pb – push
     \sqrt{CIRCUIT PROTECT OFF lt} – lt on
     OPEN HOOKS pb – push
   - CRT \sqrt{HK1(2) POS decreasing to 5%}
   - Immediately after RING IN pb – push in step 8:
   A7L  
   APDS CIRC PROT OFF pb – push
   \sqrt{CIRCUIT PROTECT OFF lt} – lt on
   OPEN HOOKS pb – push
   CRT \sqrt{HK1(2) POS decreasing to 5%}
   - When PETAL POS BASE (three) \leq 7%:
   A7L  
   CLOSE HOOKS pb – push

**HOOKS 1(2) CLOSED LT FAILED ON**

A7L  
1. **APDS POWER A\textsubscript{DS} – OFF**

2. If HOOKS 1(2) CLOSED lt – lt off:
   3. If Pre-Contact:
      APDS POWER A\textsubscript{DS} – ON
      Continue Approach
   4. Post-Capture, continue in **DOCKING SEQUENCE** (Cue Card). If affected
      hooks do not close in step 10:
      APDS POWER A\textsubscript{DS} – OFF
      CLOSE HOOKS pb – push
   5. Continue in **DOCKING SEQUENCE** (Cue Card) with the following
      change:
      After step 13:
      \[ \text{APDS POWER A\textsubscript{DS} – ON} \]

6. If HOOKS 1(2) CLOSED lt – lt on:
   APDS POWER A\textsubscript{DS} – ON
   Continue in **DOCKING SEQUENCE** (Cue Card). If affected hooks do
   not close in step 10:
   After **DOCKING SEQUENCE** (Cue Card) complete:
   Go to APDS DIRECT DRIVE USING BOB (**IFM, PROCEDURES
   A THRU F**), to secure the interface with 12 hooks
LATCHES OPEN LT FAILED OFF

**SM 167 DOCKING STATUS**

CRT 1. If CAP LAT IND – OP/blank:
   Continue in **DOCKING SEQUENCE** (Cue Card)  >>

A7L 2. √APDS POWER A_{DS}, B_{DS}, C_{DS} (three) – ON
   √A_{DS}, B_{DS}, C_{DS} lt (three) – lt on
   CIRC PROT OFF pb – push
   CIRCUIT PROTECT OFF lt – lt on
   OPEN LATCHES pb – push

A7L, CRT 3. If LATCHES OPEN lt – lt on or CAP LAT IND – OP/blank:
   Continue in **DOCKING SEQUENCE** (Cue Card)  >>

   3. Continue in **DOCKING SEQUENCE** (Cue Card), deleting step 18, then:
      On MCC GO:
      Go to 2.109 CAPTURE LATCH MANUAL RELEASE, HATCH OPENING AND DUCT INSTALL (JOINT OPS, INGRESS STATION)

APDS POWER FAILED OFF

**SM 167 DOCKING STATUS**

A7L If any APDS POWER A_{DS}, B_{DS}, C_{DS} lt off:

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated capture latch cannot be driven open, resulting in inability to separate interfaces once the structural interfaces are within 3 inches of each other</td>
</tr>
</tbody>
</table>

Post-Capture:
   Continue in **DOCKING SEQUENCE** (Cue Card), deleting steps 17 and 18

   On MCC GO:
   Go to 2.109 CAPTURE LATCH MANUAL RELEASE, HATCH OPENING AND DUCT INSTALL (JOINT OPS, INGRESS STATION)
DOCKING MECHANISM DEMATE/REMAKE

NOTE
This procedure assumes vestibule leak check failed, or both ODS hook gangs jammed simultaneously. Docking ring will recapture PMA petals, hooks will be driven open, interface will be separated, and second mating attempt will be performed. Procedure assumes DOCKING SEQUENCE (Cue Card) completed.

Successful completion of this procedure ends with Shuttle resuming attitude control.

1. Perform steps 1 and 2 of ANY ATTITUDE SEPARATION, (CONTINGENCY OPS), 5-23

SM 167 DOCKING STATUS

RECAPTURE PMA PETALS
A7L

2. POWER ON pb – push
   0:00 CLOSE LATCHES pb – push
   √LATCHES OPEN lt – lt off
   0:05 √CLOSED lt – lt on

3. APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on
   FIXER OFF pb – push
   √FIXERS OFF lt – lt on
   0:00 RING OUT pb – push
   √FINAL POSITION lt – lt off
   0:20

4. When CAPTURE lt – lt on:
   POWER OFF pb – push
   ON pb – push
   √CAPTURE lt – lt off
   0:00

5. RING IN pb – push
   0:10 POWER ON pb – push
   √RING FINAL POSITION lt – lt off
   CRT
   √DRV CMD – OFF
   A7L
   √LATCHES CLOSED lt – lt on

WARNING
Vehicle separation may occur when ODS hooks opened if RING FINAL POSITION lt is ON or LATCHES CLOSED lt is OFF. Be prepared to pick up in ANY ATTITUDE SEPARATION (CONTINGENCY OPS), step 4.

OPEN ODS HOOKS
6. APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on
   0:00 OPEN HOOKS pb – push
   √HOOKS 1,HOOKS 2 CLOSED lt (two) – lt off
   2:20 √OPEN lt (two) – lt on

Cont next page
EXTEND RING TO INITIAL POSITION FOR INTERFACE SEPARATION:

0:00
7. RING OUT pb – push
   CRT √DRV CMD – ON
   A7L √INTERF SEALED lt – lt off

3:40
   √RING INITIAL POSITION lt – lt on
   CRT √DRV CMD – OFF
   √PETAL POS BASE = 76 ± 3%

8. Interface clear of debris or other obstruction

RETRACT RING FOR SECOND MATING ATTEMPT:

0:00 A7L
9. RING IN pb – push
   CRT √DRV CMD – ON [PETAL POS BASE (three) - decr]
   √CLUTCH – LOCK/blank

3:15 A7L
   √READY TO HOOK lt – lt on

≤1:30
   √HOOKS 1,HOOKS 2 OPEN lt (two) – lt off

2:20
   √HOOKS 1,HOOKS 2 CLOSED lt (two) – lt on

10. √APDS CIRCUIT PROTECT OFF lt – lt on

0:00
   RING OUT pb – push
   CRT √DRV CMD – ON

0:10 A7L
   POWER ON pb – push
   CRT √RING DRV CMD – OFF

0:00 A7L
11. OPEN LATCHES pb – push
    √LATCHES CLOSED lt – lt off

0:05
    √OPEN lt – lt on

0:00
12. RING IN pb – push

0:10
    √FINAL POSITION lt – lt on

0:20 CRT
13. POWER OFF pb – push
    √STATUS lt (eighteen) – lt off

14. Perform DOCKING MECHANISM POWERDOWN, 8-6, if reqd, then:

A6U
15. Perform TERMINATE RNDZ OPS 22A, 4-22, step 1

16. Return to FLIGHT PLAN
ODS Hooks Open – Contingency

NOTE
Procedure assumes PMA 2/3 hooks have not been closed at any time during the mission, and either ODS hooks could not be opened nominally or ODS hooks were driven full open and physical separation did not occur. If PMA 2/3 hooks have been closed at any point during the mission, go to PMA 2/3 Hooks Open – Contingency, 8-32.

To undock, the crew will start in the Any Attitude Separation (AAS), 5-23, to prep for undocking, then transition to this procedure. Once in this procedure, steps 3-6 will recapture the PMA petals in preparation for firing the ODS hook pyros. Steps 7-8 re-open the ODS hooks. The capture latches maintain the connection between the two vehicles. Steps 9-11 will discharge the active hook pyros. When the active docking ring is extended in step 12, separation is expected at the interface between the fixed shuttle APDS structural ring and the fixed PMA structural ring. Vehicles maintain a physical connection via the active docking ring until the capture latches are opened after returning to the AAS procedure in step 20. If there is no separation in step 12, the passive hook pyros are discharged in steps 14-16. Interface separation is attempted again in step 17. As in step 12, the vehicles will maintain a physical connection via the active docking ring capture latches. In step 20, the crew will transition back to the AAS procedure where the capture latches will be opened and the actual vehicle separation performed.

Procedure also assumes that an EVA crew is prepared to immediately perform the 96 Bolt EVA if ODS pyros are discharged and physical separation does not occur.

1. Perform steps 1 and 2 of Any Attitude Separation (Contingency Ops), 5-23

A7L

2. Power On pb – push

SM 167 Docking Status

Recapture PMA Petals
3. Close Latches pb – push
√Latches Open lt – lt off
√Closed lt – lt on

4. APDS Circ Prot Off pb – push
√Circuit Protect Off lt – lt on
Fixer Off pb – push
√Fixers Off lt – lt on
Ring Out pb – push
√Final Position lt – lt off

5. When Capture lt – lt on:
   Power Off pb – push
   On pb – push
   √Capture lt – lt off

0:00
6. Ring In pb – push
Cont next page
0:10  POWER ON pb – push
√ RING FINAL POSITION lt – lt off
CRT  \( √ \) DRV CMD – OFF
A7L  \( √ \) LATCHES CLOSED lt – lt on

**WARNING**
Vehicle separation may occur when ODS hooks opened or pyros discharged if RING FINAL POSITION lt is ON or LATCHES CLOSED lt is OFF. Be prepared to pick up in ANY ATTITUDE SEPARATION, (CONTINGENCY OPS) step 4, 5-23

**RE-OPEN CLOSED HOOKS**
A7L  7. APDS CIRC PROT OFF pb – push
√ CIRCUIT PROTECT OFF lt – lt on
OPEN HOOKS pb – push

A7L  8. When good HOOKS 1(2) OPEN lt on
CRT and jammed HK2(1) POS not decr:
A7L  POWER OFF pb – push
ON pb – push

**DISCHARGE ACTIVE HOOK PYROS**
A6L  9. PYRO PWR MN A,MN C (two) – ON
A7L  PYROS \( A_p,B_p,C_p \) (three) – ON
\( √ \) \( A_p,B_p,C_p \) lt (three) – lt on
PYRO CIRC PROT OFF pb – push
\( √ \) CIRCUIT PROTECT OFF lt – lt on

A7L  10. ACT HOOKS FIRING pb – push

A6L  11. PYRO CIRC PROT ON pb – push
\( √ \) CIRCUIT PROTECT OFF lt – lt off
PYROS \( A_p,B_p,C_p \) (three) – OFF
\( √ \) \( A_p,B_p,C_p \) lt (three) – lt off

A6L  PYRO PWR MN A,MN C (two) – OFF

**EXTEND RING TO INITIAL POSITION FOR INTERFACE SEPARATION**
A7L  12. APDS CIRC PROT OFF pb – push
\( √ \) CIRCUIT PROTECT OFF lt – lt on
0:00  RING OUT pb – push
\( √ \) INTERF SEALED lt – lt off
CRT If interface separates [PETAL POS BASE (three) incr after 20 sec]:
   Go to step 19

**RECONFIGURE AND DISCHARGE PASSIVE HOOK PYROS**
A7L  13. POWER ON pb – push
A6L  PSU PWR MN A,MN B (two) – OFF
A7L  RING IN pb – push
APDS POWER \( A_{DS},B_{DS},C_{DS} \) (three) – OFF
\( √ \) \( A_{DS},B_{DS},C_{DS} \) – ON
A6L  PSU PWR MN A,MN B (two) – ON
CRT When PETAL POS BASE (three) = ~6% and not decr:
A7L  POWER ON pb – push

Cont next page
14. PYRO PWR MN A,MN C (two) – ON
15. PAS HOOKS FIRING pb – push

16. PYRO CIRC PROT ON pb – push

A6L 14. PYRO PWR MN A,MN C (two) – OFF

A7L 17. APDS CIRCUIT PROTECT OFF lt – lt on

0:00
RINg OUT pb – push
√INTERF SEALED lt – lt off

CRT If interface separates [PETAL POS BASE (three) incr after 20 sec]:
Go to step 19

RECONFIGURE AND PREPARE FOR 96 BOLT EVA

A7L 18. POWER ON pb – push
RING IN pb – push

CRT When PETAL POS BASE (three) = ~6% and not decr:
A7L  POWER OFF pb – push
Perform DOCKING MECHANISM POWERDOWN, 8-6, then:
Go to 96 BOLT EVA TIMELINE (EVA, ORB CONT EVA) >>

~3:20
19. √RING INITIAL POSITION lt – lt on

CRT √DRV CMD – OFF
√PETAL POS BASE (three) = 76 ± 3%

20. Go to step 3 of ANY ATTITUDE SEPARATION (CONTINGENCY OPS),
5-23. Expect no spring assisted separation
PMA 2/3 HOOKS OPEN – CONTINGENCY

NOTE
Procedure assumes PMA 2/3 hooks could not be opened nominally or ODS hooks were driven fully open and physical separation did not occur and PMA 2/3 were closed at some point during the mission.

To undock, the crew will start in the ANY ATTITUDE SEPARATION (AAS), 5-23, to prep for undocking, then transition to this procedure. Once in this procedure, steps 3-6 will recapture the PMA petals in preparation for firing the ODS hook pyros. Steps 7-9 re-open the ODS hooks. The capture latches maintain the connection between the two vehicles. Step 10 commands the ring out to verify that the initial problem still exists before firing the pyros. When the active docking ring is extended in step 10, separation is expected at the interface between the fixed shuttle APDS structural ring and the fixed PMA structural ring. Vehicles maintain a physical connection via the active docking ring until the capture latches are opened after returning to the AAS procedure in step 23. Steps 12-14 will discharge the passive hook pyros. Interface separation is attempted again in step 15. As in step 10, the vehicles will maintain a physical connection via the active docking ring capture latches. If there is no separation in step 15, the active hook pyros are discharged in steps 17-19. Interface separation is attempted again in step 20. As in step 10, the vehicles will maintain a physical connection via the active docking ring capture latches. In step 23, the crew will transition back to the AAS procedure where the capture latches will be opened and the actual vehicle separation performed.

Procedure also assumes that an EVA crew is prepared to immediately perform the 96 BOLT EVA if ODS pyros are discharged, and physical separation does not occur

1. Perform steps 1 and 2 of ANY ATTITUDE SEPARATION (CONTINGENCY OPS), 5-23

A7L 2. POWER ON pb – push

SM 167 DOCKING STATUS

RECAPTURE PMA PETALS
3. CLOSE LATCHES pb – push
   √LATCHES OPEN lt – lt off
   √CLOSED lt – lt on

4. APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on
   FIXER OFF pb – push
   √FIXERS OFF lt – lt on
   RING OUT pb – push
   √FINAL POSITION lt – lt off

5. When CAPTURE lt – lt on:
   √CAPTURE lt – lt off

0:00 6. RING IN pb – push
0:10    POWER ON pb – push
   √RING FINAL POSITION lt – lt off
   CRT
   √DRV CMD – OFF
   A7L √LATCHES CLOSED lt – lt on

Cont next page
WARNING
Vehicle separation may occur when ODS hooks opened or pyros discharged if RING FINAL POSITION it is ON or LATCHES CLOSED it is OFF. Be prepared to pick up in ANY ATTITUDE SEPARATION,(CONTINGENCY OPS), step 4, 5-23

OPEN ODS HOOKS
7. APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on
0:00

8. OPEN HOOKS pb – push
   √HOOKS 1,HOOKS 2 CLOSED lt (two) – lt off
   CRT √HK1,HK2 POS (two) < 92% and decr
2:20 A7L
9. √HOOKS 1,HOOKS 2 OPEN lt (two) – lt on

ATTEMPT TO EXTEND RING TO INITIAL POSITION FOR INTERFACE SEPARATION
0:00 A7L
10. RING OUT pb – push
   √INTERF SEALED lt – lt off
   CRT If interface separates [PETAL POS BASE (three) incr after 20 sec]:
       Go to step 22

RECONFIGURE AND DISCHARGE PASSIVE HOOK PYROS
A7L
11. POWER ON pb – push
    A6L PSU PWR MN A,MN B (two) – OFF
    A7L RING IN pb – push
       APDS POWER A<sub>DS</sub>,B<sub>DS</sub>,C<sub>DS</sub> (three) – OFF
       – ON
    A6L PSU PWR MN A,MN B (two) – ON
    CRT When PETAL POS BASE (three) = ~6% and not decr:
       A7L POWER ON pb – push
       A6L 12. PYRO PWR MN A,MN C (two) – ON
       A7L PYROS A<sub>P</sub>,B<sub>P</sub>,C<sub>P</sub> (three) – ON
          √A<sub>P</sub>,B<sub>P</sub>,C<sub>P</sub> lt (three) – lt on
          PYRO CIRC PROT OFF pb – push
             √CIRCUIT PROTECT OFF lt – lt on
       13. PAS HOOKS FIRING pb – push
14. PYRO CIRC PROT ON pb – push
    √CIRCUIT PROTECT OFF lt – lt off
    PYROS A<sub>P</sub>,B<sub>P</sub>,C<sub>P</sub> (three) – OFF
    √A<sub>P</sub>,B<sub>P</sub>,C<sub>P</sub> lt (three) – lt off
    A6L PYRO PWR MN A,MN C (two) – OFF

REATTEMPT EXTENDING RING TO INITIAL POSITION FOR INTERFACE SEPARATION
A7L
15. √APDS CIRCUIT PROTECT OFF lt – lt on
0:00
   RING OUT pb – push
   √INTERF SEALED lt – lt off
   CRT If interface separates [PETAL POS BASE (three) incr after 20 sec]:
       Go to step 22

Cont next page
RECONFIGURE AND DISCHARGE ACTIVE HOOK PYROS

A7L 16. POWER ON pb – push
A6L PSU PWR MN A,MN B (two) – OFF
A7L RING IN pb – push
   APDS POWER A<sub>DS</sub>,B<sub>DS</sub>,C<sub>DS</sub> (three) – OFF
   – ON
A6L PSU PWR MN A,MN B (two) – ON
CRT When PETAL POS BASE (three) = ~6% and not decr:
A7L POWER ON pb – push

A6L 17. PYRO PWR MN A,MN C (two) – ON
A7L PYROS A<sub>P</sub>,B<sub>P</sub>,C<sub>P</sub> (three) – ON
   √A<sub>P</sub>,B<sub>P</sub>,C<sub>P</sub> It (three) – It on
   PYRO CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF It – It on

18. ACT HOOKS FIRING pb – push

19. PYRO CIRC PROT ON pb – push
   √CIRCUIT PROTECT OFF It – It off
   PYROS A<sub>P</sub>,B<sub>P</sub>,C<sub>P</sub> (three) – OFF
   √A<sub>P</sub>,B<sub>P</sub>,C<sub>P</sub> It (three) – It off
A6L PYRO PWR MN A,MN C (two) – OFF

REATTEMPT EXTENDING RING TO INITIAL POSITION FOR INTERFACE SEPARATION

A7L 20. √APDS CIRCUIT PROTECT OFF It – It on
   0:00 RING OUT pb – push
   √INTERF SEALED It – It off
CRT If interface separates [PETAL POS BASE (three) incr after 20 sec]:
   Go to step 22

RECONFIGURE AND PREPARE FOR 96 BOLT EVA

A7L 21. POWER ON pb – push
   RING IN pb – push
CRT When PETAL POS BASE (three) = ~6% and not decr:
A7L POWER ON pb – push
   Perform DOCKING MECHANISM POWERDOWN, 8-6, then:
   Go to 96 BOLT EVA TIMELINE (EVA, ORB CONT EVA) >>

FINAL PREPARATION FOR VEHICLE SEPARATION

~3:20 A7L 22. √RING INITIAL POSITION It – It on
CRT √DRV CMD – OFF
   √PETAL POS BASE (three) = 76 ± 3%

23. Go to step 3 of ANY ATTITUDE SEPARATION (CONTINGENCY OPS),
5-23. Expect no spring assisted separation
APDS FAILED CAPTURE RECONFIG

SM 167 DOCKING STATUS

1. If LATCHES OPEN lt – lt on:
   0:00 CLOSE LATCHES pb – push
   √LATCHES OPEN lt – lt off
   0:05 √CLOSED lt – lt on

2. √APDS CIRCUIT PROTECT OFF lt – lt on

3. FIXER OFF pb – push
   √FIXERS OFF lt – lt on
   0:00 RING OUT pb – push
   0:05 √CLUTCH – LOCK/blank
   A7L √RING INITIAL POSITION lt – lt on (for ~16 sec), then lt off

   * If RING FORWARD POSITION lt failed on (ring stops after 10 sec):
   * RING OUT pb – push
   * Within 10 sec:
   * APDS POWER A DS,B DS,C DS (three) – OFF
   * APDS POWER A DS,B DS,C DS (three) – ON
   * CIRC PROT OFF pb – push
   * √CIRCUIT PROTECT OFF lt – lt on
   * √RING INITIAL POSITION lt – lt on (for ~16 sec), then lt off
   * When PETAL POS BASE (three) = 98 ± 2%:
   * RING OUT pb – push
   * After 10 sec:
   * CRT √RING DRV CMD – OFF

1:15 A7L 4. √RING FORWARD POSITION lt – lt on
   √ALIGNED lt – lt on
   √FIXERS OFF lt – lt off
   CRT √PETAL POS BASE (three): 98 ± 2%
   0:00 A7L √CLUTCH – LOCK/blank
   A7L √RING FORWARD POSITION lt – lt off
   1:15 √INITIAL POSITION lt – lt on (for ~16 sec), then lt off

   * If RING FINAL POSITION lt failed on (ring stops after 10 sec):
   * RING IN pb – push
   * √FORWARD POSITION lt – lt off
   * √INITIAL POSITION lt – lt on (for ~16 sec), then lt off
   * When PETAL POS BASE (three) = 5 ± 3% and not decr:
   * POWER ON pb – push

6. √RING FINAL POSITION lt – lt on
   5:00 CRT √DRV CMD – OFF

0:00 A7L 7. APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on
   RING OUT pb – push
   CRT √CLUTCH – LOCK/blank
   0:10 A7L √RING FINAL POSITION lt – lt off

Cont next page
* If RING INITIAL POSITION lt failed on (ring stops after 1 sec, and Clutch drives to SLIP):
  * FIXER OFF pb – push
  * √FIXERS OFF lt – lt on
  * RING OUT pb – push

CRT
* When PETAL POS BASE (three) = 76 ± 3%:
  * POWER OFF pb – push
  * POWER ON pb – push
  * √FIXERS OFF lt – lt on
  * APDS CIRC PROT OFF pb – push
  * √CIRCUIT PROTECT OFF lt – lt on
  * RING OUT pb – push
  * After 1 sec:

A7L
* RING DRV CMD – OFF

* If RING FORWARD POSITION lt failed on (ring stops after 10 sec):
  * RING OUT pb – push
  * Within 10 sec:
    * APDS POWER A_DS,B_DS,C_DS (three) – OFF
    * APDS POWER A_DS,B_DS,C_DS (three) – ON
    * CIRC PROT OFF pb – push
    * √CIRCUIT PROTECT OFF lt – lt on
  * When RING INITIAL POSITION lt on:
    * RING OUT pb – push

3:40

8. √RING INITIAL POSITION lt – lt on

CRT
* PETAL POS BASE (three) – 76 ± 3%
* √CLUTCH – blank/SLIP

* If CLUTCH – blank/blank:
  * APDS CIRCUIT PROTECT OFF lt – lt on
  * RING OUT pb – push (expect 1 sec of drive),
  * wait 10 sec

A7L
* √RING DRV CMD – OFF

* If CLUTCH – LOCK/blank:
  * √RING INITIAL POSITION lt – lt on
  * √FIXERS OFF lt – lt off
  * APDS CIRCUIT PROTECT OFF lt – lt on
  * RING OUT pb – push (expect 1 sec of drive),
  * wait 10 sec
  * √RING DRV CMD – OFF

CRT
* If not CLUTCH – blank/SLIP:
  * √MCC

A7L
9. POWER OFF pb – push
* STATUS lt (eighteen) – lt off
PMA 2/3 HOOKS CLOSE

**CAUTION**
Procedure assumes one ODS Hook Gang has failed and one PMA 2/3 Hook Gang can be used to recover a total of 12 hooks. ODS to PMA 2/3 interface must be hard mated, as verified by the ODS X3/X4 connector mate indications, in order to provide PMA 2/3 active hook control and tlm through the interface X-connectors.

**NOTE**
PMA2/3 Active Hooks 1(2) engage ODS Passive Hooks 2(1). Therefore, if ODS Active Hooks 1(2) is failed, it is preferrable to close PMA Active Hooks 2(1).

---

**SM 167 DOCKING STATUS**

<table>
<thead>
<tr>
<th>CRT</th>
<th>1. √</th>
<th>ODS CONN X3,X4 (two) – ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>A6L</td>
<td>2. √</td>
<td>cb PMA 2/3 GRP 1,2 HOOKS (eight) – op</td>
</tr>
<tr>
<td></td>
<td></td>
<td>√PMA 2/3 HOOKS SYS A,SYS B (two) – ctr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>√GRP 1 tb – bp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>√GRP 2 tb – bp</td>
</tr>
</tbody>
</table>

TO CLOSE HOOKS 1, PERFORM STEPS 3 THRU 6

3. cb PMA 2/3 GRP 1 HOOKS SYS A OP,CL (two) – cl
   B OP,CL (two) – cl
   √PMA 2/3 HOOKS GRP 1 tb – OP

<table>
<thead>
<tr>
<th>CRT</th>
<th>√HK1 IND OP – 1,2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>√IND CL – blank</td>
</tr>
<tr>
<td></td>
<td>√HK CLS 1/3/5, 7/9/11 (two) – blank</td>
</tr>
</tbody>
</table>

* If either IND CL present, hooks may operate single motor. If both IND CL present, hooks may not drive: *

<table>
<thead>
<tr>
<th>CRT</th>
<th>√MCC</th>
</tr>
</thead>
</table>

4. PMA 2/3 HOOKS SYS A,SYS B (two) – CL
   √GRP 1 tb – bp

<table>
<thead>
<tr>
<th>CRT</th>
<th>√HK1 CMD CL – 1,2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>√IND OP – blank</td>
</tr>
</tbody>
</table>

5. PMA 2/3 HOOKS GRP 1 tb – CL
   √HK1 IND CL – 1,2
   √CMD CL – blank
   √HK CLS 1/3/5, 7/9/11 (two) – CL

6. PMA 2/3 HOOKS SYS A,SYS B (two) – ctr
   cb PMA 2/3 GRP 1 HOOKS SYS A OP,CL (two) – op
   B OP,CL (two) – op

Cont next page
TO CLOSE HOOKS 2, PERFORM STEPS 7 THRU 10

7. cb PMA 2/3 GRP 2 HOOKS SYS A OP, CL (two) – cl
   B OP, CL (two) – cl
   √PMA 2/3 HOOKS GRP 2 tb – OP
   CRT √HK2 IND OP – 1,2
       √CL – blank
       √HK CLS 2/4/6, 8/10/12 (two) – blank

   * If either IND CL present, hooks may operate single
   * If both IND CL present, hooks may not drive:
   * √MCC

0:00 A6L 8. PMA 2/3 HOOKS SYS A, SYS B (two) – CL
   √GRP 2 tb – bp
   CRT √HK2 CMD CL – 1,2
       √IND OP – blank

2:20 A6L 9. PMA 2/3 HOOKS GRP 2 tb – CL
   CRT √HK2 IND CL – 1,2
       √CMD CL – blank
       √HK CLS 2/4/6, 8/10/12 (two) – CL

A6L 10. PMA 2/3 HOOKS SYS A, SYS B (two) – ctr
   cb PMA 2/3 GRP 2 HOOKS SYS A OP, CL (two) – op
   B OP, CL (two) – op
PMA 2/3 HOOKS OPEN

CAUTION
ODS to PMA 2/3 interface must remain hard mated by at least one gang of ODS hooks through entire procedure in order to provide PMA 2/3 active hook control and tlm through the interface X-connectors.

SM 167 DOCKING STATUS

A6L 1. √cb PMA 2/3 GRP 1,2 HOOKS (eight) – op
     √PMA 2/3 HOOKS SYS A,SYS B (two) – ctr (tb-bp)
     √GRP 1 tb – bp
     √GRP 2 tb – bp

TO OPEN HOOKS 1, PERFORM STEPS 2 THRU 5
2. cb PMA 2/3 GRP 1 HOOKS SYS A OP,CL (two) – cl
   B OP,CL (two) – cl
   √PMA 2/3 HOOKS GRP 1 tb – CL
   CRT
   √HK1 IND CL – 1,2
   √OP – blank
   √HK CLS 1/3/5, 7/9/11 (two) – CL

   * If either IND OP present, hooks may operate single  *
   * motor. If both IND OP present, hooks may not drive.  *

0:00 A6L 3. PMA 2/3 HOOKS SYS A,SYS B (two) – OP
   √GRP 1 tb – bp
   CRT
   √HK1 CMD OP – 1,2
   √IND CL – blank
   √HK CLS 1/3/5, 7/9/11 (two) – blank

2:20 A6L 4. √PMA 2/3 HOOKS GRP 1 tb – OP
   CRT
   √HK1 IND OP – 1,2
   √CMD OP – blank

   * If PMA 2/3 HOOKS fail to drive, or do not reach end-of-travel after single motor drive time (~4:40):  *
   * 8-32  *

A6L 5. PMA 2/3 HOOKS SYS A,SYS B (two) – ctr
       cb PMA 2/3 GRP 1 HOOKS SYS A OP,CL (two) – op
       * cb PMA 2/3 GRP 1 HOOKS SYS B OP,CL (two) – op
       * Perform PMA 2/3 HOOKS OPEN – CONTINGENCY,  *
       * 8-32  *

       cb PMA 2/3 GRP 1 HOOKS SYS A OP,CL (two) – op
       B OP,CL (two) – op

Cont next page
TO OPEN HOOKS 2, PERFORM STEPS 6 THRU 9

6. cb PMA 2/3 GRP 2 HOOKS SYS A OP, CL (two) – cl
   B OP, CL (two) – cl
   √PMA 2/3 HOOKS GRP 2 tb – CL
   CRT
   √HK2 IND CL – 1,2
   √IND OP – blank
   √HK CLS 2/4/6, 8/10/12 (two) – CL

   * If either IND OP present, hooks may operate single motor. If both IND OP present, hooks may not drive *

0:00 A6L 7. PMA 2/3 HOOKS SYS A, SYS B (two) – OP
   √GRP 2 tb – bp
   CRT
   √HK2 CMD OP – 1,2
   √IND CL – blank
   √HK CLS 2/4/6, 8/10/12 (two) – blank

2:20 A6L 8. √PMA 2/3 HOOKS GRP 2 tb – OP
   CRT
   √HK2 IND OP – 1,2
   √CMD OP – blank

   * If PMA 2/3 HOOKS fail to drive, or do not reach end-of-travel after single motor drive time (~4:40): *

A6L
   * cb PMA 2/3 GRP 2 HOOKS SYS A OP, CL (two) – op *
   * cb PMA 2/3 GRP 2 HOOKS SYS B OP, CL (two) – op *
   * Perform PMA 2/3 HOOKS OPEN – CONTINGENCY, *
   * 8-32 *

9. PMA 2/3 HOOKS SYS A, SYS B (two) – ctr
   cb PMA 2/3 GRP 2 HOOKS SYS A OP, CL (two) – op
   B OP, CL (two) – op
<table>
<thead>
<tr>
<th>Reference Data</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>APDS Failure/Impact Matrix</td>
<td>8-42</td>
</tr>
<tr>
<td>(TLM)</td>
<td>8-45</td>
</tr>
</tbody>
</table>
**APDS FAILURE/IMPACT MATRIX**

<table>
<thead>
<tr>
<th>APDS Status lt</th>
<th>APDS FAILURE</th>
<th>IMPACT</th>
<th>OFF NOMINAL PROCEDURE (IF APPLICABLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER ON pb</td>
<td>Failed ON (m)</td>
<td>Continuous PWR ON will inhibit ring, damping, and fixer commands. Relays may overheat preventing future powerup. [Detectable only during powerup or ring drive operations]</td>
<td>RING DRV CMD OFF</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>If all STATUS lts are off, loss of all logic power to APDS. Docking system cannot be operated</td>
<td>POWER FAILED OFF (STATUS LTS OFF)</td>
</tr>
<tr>
<td>APDS CIRCUIT PROTECT OFF</td>
<td>Failed ON (m)</td>
<td>RING OUT, OPEN LATCHES, OPEN HOOKS, and UNDOCKING pb commands are enabled</td>
<td>APDS CIRCUIT PROTECT OFF LT FAILED OFF</td>
</tr>
<tr>
<td>RING ALIGNED</td>
<td>Failed ON (m)</td>
<td>Prime alignment cue lost. Use CRT RING ALIGN and PETAL POS BASE 1,2,3 indications as backup. Erroneous ind possible with significant pitch motion (sensors rotated 360°)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Prime alignment cue lost. Use CRT RING ALIGN and PETAL POS BASE 1,2,3 indications as backup</td>
<td></td>
</tr>
<tr>
<td>RING INITIAL POSITION</td>
<td>Failed ON (s)</td>
<td>Ring will only drive for 1 sec with RING OUT pb commands. Slip clutch will drive alternately between the SLIP and LOCK positions</td>
<td>Starred blocks in the DOCKING RING EXTENSION and DOCKING MECHANISM DEMATE/REMATE</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>INITIAL CONTACT lt disabled. Slip clutch will not drive to SLIP</td>
<td>APDS DIRECT DRIVE USING BOB required to drive slip clutch</td>
</tr>
<tr>
<td>FIXERS OFF</td>
<td>Failed ON (m)</td>
<td>IFM may be required to drive clutch to SLIP if failure occurs during ring extension. During docking, only centering springs maintain alignment during ring retraction</td>
<td>FIXERS OFF LT FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Unable to inhibit fixer operation during manual ring drive</td>
<td>FIXERS OFF LT FAILED OFF</td>
</tr>
<tr>
<td>HOOKS 1(2) OPEN</td>
<td>Failed ON (s)</td>
<td>Logic prevents hooks from driving open</td>
<td>HOOKS 1(2) OPEN LT FAILED ON [UNDOCKING]</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Hooks will not stop driving at Open position</td>
<td></td>
</tr>
<tr>
<td>LATCHES CLOSED</td>
<td>Failed ON (s)</td>
<td>If ring retraction to Final Position is attempted, ring will stall against capture latches if latches are failed closed. No impact if latches open on SPEC 167</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>No impact to nominal sequence. [May not be able to recapture, if reqd, if capture latches are not closed. Multiple failures reqd to inadvertently drive a latch motor open]</td>
<td></td>
</tr>
</tbody>
</table>
### APDS FAILURE/IMPACT MATRIX (Cont)

<table>
<thead>
<tr>
<th>APDS Status It</th>
<th>APDS FAILURE</th>
<th>IMPACT</th>
<th>OFF NOMINAL PROCEDURE (IF APPLICABLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNDOCK COMPLETE</td>
<td>Failed ON (s)</td>
<td>If light comes on when APDS CIRC PROT OFF pb is pressed, hooks may be continuously commanded open.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>No impact. Indication is not used by any logic</td>
<td></td>
</tr>
<tr>
<td>INITIAL CONTACT</td>
<td>Failed ON (s)</td>
<td>One contact cue disabled. RING ALIGNED lt, and CRT RING ALIGN and PETAL POS BASE 1,2,3 indications, may be used as contact indications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>One contact cue disabled. [Not detectable prior to contact]</td>
<td></td>
</tr>
<tr>
<td>CAPTURE</td>
<td>Failed ON (m)</td>
<td>Auto sequence may be active (dampers, fixers, ring/hook drive). May be unable to reset dampers. Potential Shuttle/PMA 2/3 mechanism damage if no damping or damping failed on</td>
<td>CAPTURE LT FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Auto Sequence may be inactive; no active damping resulting in excessive relative motion</td>
<td>Must use visual cues (no sep) and DAMPING indication to verify capture</td>
</tr>
<tr>
<td>RING FORWARD POSITION</td>
<td>Failed ON (s)</td>
<td>Ring will only drive out for 10 sec at a time</td>
<td>Starrred blocks in affected procedures</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Ring will continue to drive at Forward Position until terminated by a PWR On/Off reset</td>
<td>READY TO HOOK LT FAILED ON</td>
</tr>
<tr>
<td>READY TO HOOK</td>
<td>Failed ON (s)</td>
<td>Hooks will begin driving closed with RING IN pb command</td>
<td>Manual CLOSE HOOKS pb command required to drive hooks closed per starred block on DOCKING SEQUENCE (Cue Card)</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Auto hook drive disabled. Ring will not stop driving at In-Between Hooks position</td>
<td></td>
</tr>
<tr>
<td>INTERF SEALED</td>
<td>Failed ON (s)</td>
<td>No impact to APDS operations. Indication is not used by any logic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>No impact to APDS operations. Indication is not used by any logic</td>
<td></td>
</tr>
<tr>
<td>HOOKS 1(2) CLOSED</td>
<td>Failed ON (s)</td>
<td>Logic prevents associated hooks from driving closed</td>
<td>HOOKS 1(2) CLOSED LT FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Hooks will not stop driving when closed position reached</td>
<td>HOOKS 1(2) NOT CLOSED WITHIN SINGLE MTR TIME if hooks not verified closed via CRT</td>
</tr>
<tr>
<td>LATCHES OPEN</td>
<td>Failed ON (s)</td>
<td>Ring will drive in once CAPTURE is achieved, or immediately if CAPTURE already present</td>
<td>LATCHES OPEN LT FAILED OFF</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>If Latches failed closed, ring will stall against Latches if Ring commanded to Final Position</td>
<td></td>
</tr>
<tr>
<td>RING FINAL POSITION</td>
<td>Failed ON (s)</td>
<td>During ring retraction, ring will only drive 10 sec 1st time. After 2nd Ring In command, ring will not stop driving at In-Between Hooks position and/or Final Position</td>
<td>RING FINAL POSITION LT FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>During Ring retraction to Final Position, ring will not stop driving at Final Position</td>
<td></td>
</tr>
</tbody>
</table>
## APDS FAILURE/IMPACT MATRIX (Cont)

<table>
<thead>
<tr>
<th>APDS Status It</th>
<th>APDS FAILURE</th>
<th>IMPACT</th>
<th>OFF NOMINAL PROCEDURE (IF APPLICABLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>APDS POWER</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A_{DS}, B_{DS}, C_{DS}</td>
<td>Failed ON (s)</td>
<td>One logic bus remains powered. Still at least two failures from any inadvertent ops</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>Loss of one capture latch motor. Next failure results in loss of all APDS avionics logic</td>
<td>APDS POWER FAILED OFF</td>
</tr>
<tr>
<td><strong>A6L SYSTEM POWER</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A(B) tb</td>
<td>Failed OFF (s)</td>
<td>Loss of redundancy to APDS logic busses, Control Panel Power busses, and PMA hook power. Loss of some docking lights and vestibule depress valves capability</td>
<td></td>
</tr>
<tr>
<td><strong>PYROS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A_{p}, B_{p}, C_{p}</td>
<td>Failed ON (s)</td>
<td>One Pyro logic bus powered. Still more than two failures from charging pyros</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>Loss of Pyro logic redundancy</td>
<td></td>
</tr>
<tr>
<td><strong>PYRO CIRCUIT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROTECT OFF</td>
<td>Failed ON (m)</td>
<td>Possible loss of Pyro charge/fire inhibits</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Loss of capability to arm/fire Pyros</td>
<td></td>
</tr>
</tbody>
</table>
## APDS FAILURE/IMPACT MATRIX (TLM)

<table>
<thead>
<tr>
<th>APDS TLM</th>
<th>APDS FAILURE</th>
<th>IMPACT</th>
<th>OFF NOMINAL PROCEDURE (IF APPLICABLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damping</td>
<td>Failed ON (s)</td>
<td>Mechanism may not have compliance on contact; load capability may be exceeded. Failed-on dampers slow ring drive to about single motor drive time</td>
<td>Damping failed on</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>No impact for single failure. If all dampers failed, large rates/alignments may cause mechanism to hit hard stops, exceeding its load capability</td>
<td></td>
</tr>
<tr>
<td>Ring Fixers</td>
<td>Failed ON (s)</td>
<td>Mechanism may not have compliance on contact; load capability may be exceeded</td>
<td>Fixers failed on</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>No impact for single fixer failure. For multiple failure case, alignment may be lost during ring retraction. [Detectable only during ring drive operations]</td>
<td></td>
</tr>
<tr>
<td>Clutch – Slip</td>
<td>Failed ON (s)</td>
<td>If slip clutch locking mechanism failed in SLIP, resistance created by dampers and/or pusher springs will load actuator sufficiently to prevent ring motion</td>
<td>APDS direct drive using BOB required to drive slip clutch to LOCK</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>Must verify clutch in SLIP prior to contact</td>
<td></td>
</tr>
<tr>
<td>Clutch – Lock</td>
<td>Failed ON (s)</td>
<td>Must verify clutch in SLIP prior to contact, otherwise mechanism may not have compliance on contact; load capability may be exceeded</td>
<td>APDS direct drive using BOB required to drive slip clutch to SLIP</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>If slip clutch locking mechanism failed in SLIP, resistance created by dampers and/or pusher springs will load ring actuator sufficiently to prevent ring motion</td>
<td></td>
</tr>
<tr>
<td>Cap Man Rel</td>
<td>Failed OP (s)</td>
<td>If latch is released, may be unable to draw interfaces together</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed ON (s)</td>
<td>One logic bus remains powered. Still at least two failures from any inadvertent ops</td>
<td></td>
</tr>
<tr>
<td>Cntl Pnl Pwr</td>
<td>Failed OFF (s)</td>
<td>Loss of pb command redundancy. CNTL PNL PWR A will remove power from columns 1 &amp; 3 of the STATUS light matrix. CNTL PNL PWR C will remove power from columns 2 and 4 of the STATUS lights matrix. (Pyro pbs are not affected)</td>
<td>Next failure may require APDS Direct Drive IFM to complete docking or separate, or require manual capture latch release</td>
</tr>
<tr>
<td>Ring DR Bus 1(2)</td>
<td>Failed OFF (s)</td>
<td>Loss of ring drive motor 1(2)</td>
<td></td>
</tr>
<tr>
<td>HKS DR Bus 1(2)</td>
<td>Failed OFF (s)</td>
<td>Loss of hook drive motor 1(2) [Affects both Hooks 1 &amp; 2]</td>
<td></td>
</tr>
<tr>
<td>Damper Bus 1(2)</td>
<td>Failed OFF (s)</td>
<td>BUS 1 (MN A): Dampers 1,2 failed. BUS 2 (MN B): Damper 3 failed</td>
<td></td>
</tr>
<tr>
<td>Fixer Bus 1(2)</td>
<td>Failed OFF (s)</td>
<td>BUS 1 (MN A): Fixers 1,2 failed. BUS 2 (MN B): Fixers 3,4,5 failed</td>
<td></td>
</tr>
</tbody>
</table>
CUE CARD CONFIGURATION

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   (Back) ............................................................................................................. CC 9-6
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RCS BURN (+X, -X, Multi-axis)

1. GNC, OPS 202 PRO
   RCS SEL, ITEM 4 – (*)

2. If onboard computed burn:
   √TIG and TGT PEG 7 ΔVs per Final solution
   Guidance option is LAMBERT
   If ground computed burn:
   √TGT data per Burn Pad (reload WT as reqd)

   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC

3. If +X burn:
   DAP: A/AUTO/ALT(B/ALT as reqd)
   MNVR – ITEM 27 EXEC (*)
   If RR ops:
   KU – AUTO TRK
   GNC 33 REL NAV
   INH Angles – ITEM 24 EXEC (*)

TIG-0:30

4. FLT CNTLR PWR – ON
   DAP TRANS: as reqd
   If Multi-axis:
   DAP: A/AUTO/PRI
   If +X or -X:
   DAP: A/INRTL/PRI

TIG

5. If VGO Z is neg, Z,X,Y seq;
   otherwise, X,Y,Z
   THC: Trim VGOs < 0.2 fps
   FLT CNTLR PWR – OFF
   DAP: ALT
   DAP TRANS: PULSE/PULSE/PULSE
   GNC, OPS 201 PRO

6. If +X burn:
   DAP: A/AUTO(B/AUTO/ALT as reqd)
   If RR ops, when ATT ERR < 30 deg:
   KU – GPC
   √KU TRACK tb – gray
   GNC 33 REL NAV
   AUTO Angles – ITEM 23 EXEC (*)

7. When in attitude:
   DAP: A/AUTO/VERN(ALT)

(reduced copy)
RENDEZVOUS PRPLT PAD

When L or R RCS QTY < 1:
I'CNCT: 2 OMS to RCS (ORB PKT, RCS)

When G23 OMS/RCS QTY > 4:
I'CNCT TK SWITCH: (ORB PKT, RCS)

When G23 OMS/RCS QTY > 6:
I'CNCT RETURN (ORB PKT, RCS)

When L or R RCS QTY < 7:
or when FRCS QTY < 8:
DAP: NO LO Z

When L or R RCS QTY < 9:
or when FRCS QTY < 10:

If prior to Ti:
Do not perform Ti
If after Ti, but prior to TORVA init (+X burns to start TORVA are complete):
Go to RNDZ BREAKOUT (CONTINGENCY OPS), 5-18
If during TORVA:
Go to SHUTTLE NOSE IN-PLANE BREAKOUT (CONTINGENCY OPS), 5-16
If stable on +VBAR:
Go to VBAR BREAKOUT (CONTINGENCY OPS), 5-14
1. CONFIGURE KU FOR RR TGT ACQ

**GNC 33 REL NAV**

- **CRT**
  - SV SEL, ITEM 4 – FLTR
  - INH RNG, ITEM 18 – (*)
  - RDOT, ITEM 21 – (*)
  - Angles, ITEM 24 – (*)

- **KU ANT ENA** – ITEM 2 EXEC (*)

- **GNC I/O RESET**

- **A2**
  - DIGI-DIS sel – R/RDOT

- **A1U**
  - KU PWR – STBY
  - MODE – RDR PASSIVE
  - RDR OUTPUT – HI
  - CNTL – PNL (wait 3 sec)
  - PWR – ON

- **KU SEL – GPC >>**

2. AUTO TRK ACQ

- **KU SEL – AUTO TRK**
- SLEW – as reqd (as seen in COAS)
  - EL, AZ angles < 30 deg
- **KU SEARCH – SEARCH** (tb-gray)

- **Repeat slew and search as reqd**
- If acquisition not successful, **\MCC >>**

3. RR NAVIGATION

**GNC 33 REL NAV**

- **CRT**
  - RADAR, ITEM 13 – (*)
  - * If RATIO > 1.0: *
  - * \MCC *

- **FLTR TO PROP** – ITEM 8 EXEC (*)

- **AUT RNG** – ITEM 17 EXEC (*)

- **RDOT** – ITEM 20 EXEC (*)

- **Angles** – ITEM 23 EXEC (*)

- **KU ANT ENA** – ITEM 2 (no *)

4. CONFIGURE KU FOR COMM

**GNC 33 REL NAV**

- **CRT**
  - INH RNG – ITEM 18 (*)
  - RDOT – ITEM 21 (*)
  - Angles – ITEM 24 (*)

- **KU ANT ENA** – ITEM 2 (no *)

- **A1U**
  - KU PWR – STBY
  - MODE – COMM

- **A2**
  - DIGI-DIS sel – EL/AZ

---

(reduced copy)
<table>
<thead>
<tr>
<th>CG to CG RNG (ft)</th>
<th>RPM &amp; CONT TORVA RDOT (ft/s)</th>
<th>MCC ZT w/ RPM (h:mm:ss)</th>
<th>DAP</th>
<th>EVENT</th>
<th>NO-RPM RDOT (ft/s)</th>
<th>HHL RNG (ft) (to ISS CG)</th>
<th>Raw TCS RNG (ft) (Ref #2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>-3.0</td>
<td>0:27:00</td>
<td>A/B/B</td>
<td>AUTO/VERN (PRI)</td>
<td>2.6</td>
<td>1690</td>
<td>1698</td>
</tr>
<tr>
<td>1700</td>
<td>-2.4</td>
<td>0:29:10</td>
<td>-2.2</td>
<td></td>
<td>1490</td>
<td>1490</td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td>-2.1</td>
<td>0:31:10</td>
<td>-2.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>-1.3</td>
<td>0:36:10</td>
<td>-1.5</td>
<td>MCC UPDATE: Go for RPM, Go to proceed inside 600 ft</td>
<td>990</td>
<td>985</td>
<td></td>
</tr>
<tr>
<td>900</td>
<td>-1.1</td>
<td>0:37:10</td>
<td>-1.3</td>
<td>If Go for RPM, report to ISS: 10 min to RPM start 600 ft, AU/ADI ATT – LHLH</td>
<td>890</td>
<td>885</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>-0.9</td>
<td>0:38:10</td>
<td>-0.8</td>
<td>Null ISS rates in C/L camr</td>
<td>590</td>
<td>586</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>-0.6</td>
<td>0:41:10</td>
<td>-0.8</td>
<td>If Go for RPM, perform RPM SETUP</td>
<td>490</td>
<td>486</td>
<td></td>
</tr>
<tr>
<td>650</td>
<td>-0.4</td>
<td>0:42:30</td>
<td>-0.8</td>
<td>Report to ISS: Range 650 ft</td>
<td>640</td>
<td>636</td>
<td></td>
</tr>
<tr>
<td>620</td>
<td>-0.4 &lt; Rdotti &lt; -0.3</td>
<td>1:00:00</td>
<td>-0.8</td>
<td>Null ISS rates in C/L camr</td>
<td>610</td>
<td>606</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>-0.3 &lt; Rdotti &lt; -0.2</td>
<td>1:00:30</td>
<td>-0.7</td>
<td>If reqd: stationkeep at 600-620 ft until RPM window opens</td>
<td>590</td>
<td>586</td>
<td></td>
</tr>
<tr>
<td>580</td>
<td>-0.2 &lt; Rdotti &lt; -0.1</td>
<td>1:00:45</td>
<td>-0.7</td>
<td>If Go for RPM, perform nominal RPM actions per APPROACH cue card</td>
<td>570</td>
<td>566</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>-0.7</td>
<td>0:56:00</td>
<td>-0.8</td>
<td>Perform RBAR PITCH MNVR [B]</td>
<td>590</td>
<td>586</td>
<td></td>
</tr>
<tr>
<td>550</td>
<td>-0.6</td>
<td>0:57:45</td>
<td>-0.7</td>
<td>When Lock On Occurs: KU OPS step 3 (cue card)</td>
<td>540</td>
<td>536</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>-0.4</td>
<td>0:59:30</td>
<td>-0.7</td>
<td>Reload DAP A9</td>
<td>490</td>
<td>486</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>0.0 to -0.1</td>
<td>1:10:00</td>
<td>-0.5</td>
<td>START PHOTOS</td>
<td>390</td>
<td>384</td>
<td></td>
</tr>
<tr>
<td>350-350 (DP-DP)</td>
<td>-0.2</td>
<td>1:10:30</td>
<td>-0.5</td>
<td>End Photos</td>
<td>355</td>
<td>355</td>
<td></td>
</tr>
</tbody>
</table>

**RBAR PITCH MNVR [B]**

If no-go to proceed inside 600 ft, perform CONTINGENCY 600 FT TORVA [C]

**CONTINGENCY 600 FT TORVA [C]**

If Go for RPM, perform nominal RPM actions per APPROACH cue card

Continue APPROACH cue card with the following deltas:

- Initiate TORVA at range 700 ft Rdotti: -0.3 ft/s (alternate range 650 ft Rdotti: -0.1 ft/s)
- Maintain RNG > 600 ft (CG-GG) until VBAR arrival
- On VBAR, stationkeep RNG 630-530 (DP-DP), maintain ISS in C/L camr FOV

On MCC GO, perform CONFIGURE FOR DOCKING [D] and VBAR APPROACH (Cue Card)

**CONFIGURE FOR DOCKING [D]**

Perform AIRLOCK FAN ACT AND ODYS VOLUME PREP (APDS), 8-10

Perform DOCKING MECHANISM POWERUP (APDS), 8-5

Perform DOCKING PREP (APDS), 8-7

---

* Raw TCS Range assumes ISS in docking attitude

---

(reduced copy)
<table>
<thead>
<tr>
<th>Interface</th>
<th>RDOT (ft/s)</th>
<th>MC2 ET</th>
<th>DAP</th>
<th>EVENT</th>
<th>HHL RNG (to Node 2) (ft)</th>
<th>Raw TCS RNG* (Ref #1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>-0.20</td>
<td>1:15:00</td>
<td>(\forall) LO Z</td>
<td>MCC UPDATE: Go for docking</td>
<td>257</td>
<td>255</td>
</tr>
<tr>
<td></td>
<td>±0.05</td>
<td>(-34.00)</td>
<td></td>
<td>Maintain ISS docking target within 8 deg Corridor</td>
<td>HHL Report</td>
<td>HHL Report</td>
</tr>
<tr>
<td>(170 ± 10)</td>
<td>(0.00)</td>
<td>1:21:30</td>
<td>DAP: B</td>
<td>Note: DAP A allowed for ±X and ±Z THC</td>
<td>177</td>
<td>175</td>
</tr>
<tr>
<td>170</td>
<td>-0.20</td>
<td>(-27.30)</td>
<td></td>
<td>If reqd, THC: as reqd to null Rdot and perform</td>
<td>HHL Report</td>
<td>HHL Report</td>
</tr>
<tr>
<td></td>
<td>±0.05</td>
<td></td>
<td></td>
<td>VBAR stationkeeping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>-0.15</td>
<td>1:26:30</td>
<td></td>
<td>Perform CONFIGURE KU FOR COMM (Cue Card, KU OPS)</td>
<td>117</td>
<td>115</td>
</tr>
<tr>
<td></td>
<td>±0.05</td>
<td>(-21.30)</td>
<td></td>
<td>Note: DAP A allowed for ±X and -Z THC (in)</td>
<td>HHL Report</td>
<td>HHL Report</td>
</tr>
<tr>
<td>75</td>
<td>-0.10</td>
<td>1:30:30</td>
<td>A10,B10</td>
<td>GNC 23 RCS - ITEM 1 EXEC (*)</td>
<td>82</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>±0.05</td>
<td>(-18.30)</td>
<td>DAP: B</td>
<td>(Maintain through contact)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(\forall) CS PWL - ITEM 1 EXEC (*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>JET DES F2F - ITEM 35 EXEC (*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F3F - ITEM 33 EXEC (*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3U ± 5</td>
<td>0.0</td>
<td>1:38:00</td>
<td>A10,B10</td>
<td>5° Corridor</td>
<td>32-42</td>
<td>30-40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-11.00)</td>
<td>DAP: B</td>
<td>If Flyout Reqd:</td>
<td>HHL Report</td>
<td>HHL Report</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>THC: ±Z (out) as reqd to null RDOT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Perform AUTO ANGULAR FLYOUT (Cue Card)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>outside 25 ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Review FAILED CAPTURE, steps 1 thru 3,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CAUTION (Cue Card, DOCKING SEQUENCE)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(\forall) A7L Panel Config</td>
<td></td>
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<td></td>
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<td>Set EVENT TIMER for CAPTURE (counting up from 00:00)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>-0.07</td>
<td>1:43:00</td>
<td></td>
<td>5° Corridor</td>
<td>37</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>±0.02</td>
<td>(-06.00)</td>
<td></td>
<td>THC: as reqd to establish RDOT = -0.07 ± 0.02 fps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Report to MCC and ISS: Initiating final approach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>↑</td>
<td>1:44:00</td>
<td></td>
<td>Maintain GNC 23 RCS through contact</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>-0.10</td>
<td>1:47:20</td>
<td>No LO Z</td>
<td>ARM PCT</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>±0.03</td>
<td>(-10.40)</td>
<td></td>
<td>FZ(F4) SPD/B/THROT pb – AUTO</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– ridiculously high</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-0.10</td>
<td>1:48:30</td>
<td></td>
<td>Maintain 3 inch lateral alignment cylinder</td>
<td>N/A</td>
<td>8</td>
</tr>
<tr>
<td>CONTACT</td>
<td>or ~2 in</td>
<td>1:49:00</td>
<td></td>
<td>PCT (SPARE pb)</td>
<td>N/A</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>-0.10</td>
<td>(00:00)</td>
<td></td>
<td>CAPTURE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>±0.03</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

* Raw TCS Range assumes ISS in docking attitude

** CAPTURE **

** MS **

START EVENT TIMER = 00:00:00

** A7L **

\(\forall\) CAPTURE II-It on

Notify ISS and MCC-H: “Capture Confirmed”

** DAP **

\(\forall\) ISS in FREE DRIFT (ISS indicator lights flashing)

- IF NO INDICATION OF ISS FREE
- DRIFT AT CAPTURE + 65 SEC
- Go to FAILED CAPTURE

When capture confirmed and ISS in FREE

** A6U **

FLT CNTRLR PWR OFF

Perform TCS DEACTIVATION (RNDZ TOOLS), 7-20

Go to DOCKING SEQUENCE (Cue Card)

** FAILED CAPTURE **

1. APDS CIRC PROT OFF pb – push

\(\forall\) CIRCUIT PROTECT OFF II – It on

OPEN LATCHES pb – push

\(\forall\) LATCHES CLOSED II – It off

OPEN It – It on

2. \(\forall\) DAP: NO LO Z

- IF VERN FAIL:
- DAP: PRI

If petals clear:

DAP: A(B)/LVLH

3. THC: ±Z (out) to establish 0.1 fps opening rate

\(\forall\) DAP: B(LVLH)

If ISS in FREE DRIFT:

Use ISS CG as corridor reference

Maintain 8 degree corridor

Inform MCC-H and ISS: Failed Capture

Maintain opening rate of at least 0.1 fps

4. Go to VBAR CORRIDOR BACKOUT, CONTINGENCY

OPS: 5-12
C/L CAMERA TARGET ALIGNMENT (+VBAR)

### PITCH (P)

**ITEM 15**

Target Displaced DOWN
(Cross Displaced UP)

$P = _____$

Target Displaced UP
(Cross Displaced DOWN)

$P = _____$

3. $PITCH = 179 - P = _____(A)$

5. $PITCH = PITCH - P = _____(D)$

### ROLL (R)

**ITEM 16**

Rotated CW

$R = _____$

Rotated CCW

$R = _____$

3. $YAW = 360 - R = _____(B)$

5. $YAW = YAW - R = _____(E)$

### YAW (Y)

**ITEM 17**

Target Displaced RIGHT
(Cross Displaced LEFT)

$Y = _____$

Target Displaced LEFT
(Cross Displaced RIGHT)

$Y = _____$

3. $OM = 0 + Y = _____(C)$

5. $OM = OM + Y = _____(F)$
AUTO ANGULAR FLYOUT

**CAUTION**
AUTO ANGULAR FLYOUT must be completed by RNG = 10 ft

1. **RECORD ANGULAR MISALIGNMENT**
   \( \checkmark \) DAP: A10, B10
   Read error from ISS centerline target
   PITCH ________ (P)
   YAW ________ (Y)
   ROLL ________ (R)
   Report misalignment to MCC
   If all axes within 1.0 deg of zero, no mnvr reqd >>

2. **CALCULATE UNIV PTG INPUTS**
   Use diagrams in TARGET ALIGNMENT (Cue Card) to determine UNIV PTG inputs for step 3

3. **EXECUTE ALIGNMENT MNVR**
   \( \checkmark \) GNC UNIV PTG
   \( \checkmark \) TGT ID +2
   \( \checkmark \) BODY VECT +5
   PITCH +(A)
   YAW +(B)
   OM +(C)
   TRK – ITEM 19 EXEC (CUR-*)

   When mnvr cplt,
   4. **RECORD REMAINING ANGULAR MISALIGNMENT**
      Record error from ISS centerline target:
      PITCH ________ (P)
      YAW ________ (Y)
      ROLL ________ (R)
      If all axes within 1.0 deg of zero, no additional mnvr reqd >>

   Otherwise,
   5. **REPEAT ALIGNMENT**
      a. Calculate UNIV PTG inputs:
         Use diagrams in TARGET ALIGNMENT (Cue Card) to determine UNIV PTG inputs for step 5b
      b. Execute alignment MNVR
         \( \checkmark \) GNC UNIV PTG
         \( \checkmark \) TGT ID +2
         \( \checkmark \) BODY VECT +5
         PITCH +(D)
         YAW +(E)
         OM +(F)
         TRK – ITEM 19 EXEC (CUR-*)
If following failures occur during final approach (< 30 ft), NO-GO for docking. Initiate Corridor Backout. Then proceed with APDS OFF-NOMINAL procedures (APDS)

<table>
<thead>
<tr>
<th>POWER Failed OFF (All STATUS lts OFF)</th>
<th>DAMPING tm Failed ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPTURE lt Failed ON</td>
<td>FIXERS tm Failed ON</td>
</tr>
</tbody>
</table>

CAUTION
If any Docking Sequence command occurs out of order or if any STATUS lt functions erroneously:

- A7L POWER OFF pb – push
- ON pb – push

Proceed with APDS OFF-NOMINAL procedures (APDS)

**Event Time**

**Contact/Capture/Damping**

**SM 167 DOCKING STATUS**

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td>A7L 1. CAPTURE lt – lt on (expect RING INITIAL POSITION lt off)</td>
</tr>
<tr>
<td>0:05</td>
<td>CRT 2. DAMPING – ON</td>
</tr>
</tbody>
</table>

**Disable and Release Dampers**

3. When no relative motion [PETAL POS BASE (three) not changing for 60 sec]:
   - A7L POWER ON pb – push
   - CRT DAMPING – OFF

4. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   - A7L FIXER OFF pb – push
   - FIXERS OFF lt – lt on
   - 0:00 CRT DRV CMD – ON [PETAL POS BASE (three) – decr]
   - CLUTCH – LOCK/blank

5. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   - A7L POWER ON pb – push
   - CRT RING DRV CMD – OFF

6. On MCC GO [PETAL POS BASE (three) not changing for 30 sec]:
   - A7L APDS CIRC PROT OFF pb – push
   - CIRCUIT PROTECT OFF lt – lt on
   - 0:00 CRT DRV CMD – ON [PETAL POS BASE (three) – incr]

7. POWER OFF pb – push
   - ON pb – push
   - FIXERS OFF lt – lt off
   - CRT RING DRV CMD – OFF
Retract Ring

A7L,CRT 8. On MCC GO (RING ALIGNED lt on and [PETAL POS BASE (three) not changing] for 30 sec):

0:00 A7L RING IN pb – push
CRT √DRV CMD – ON [PETAL POS BASE (three) – decr]
√FIXERS – ON
√CLUTCH – LOCK/blank

CRT,A7L * If PETAL POS BASE (three) > 20 % and RING ALIGNED lt off: *
A7L * POWER ON pb – push *
* Wait for ring alignment (up to 30 min) *
A7L,CRT * When RING ALIGNED lt on and [PETAL POS BASE (three) *
* not changing] for 30 sec: *
A7L * RING IN pb – push *

3:15 A7L 9. READY TO HOOK lt – lt on
CRT √PETAL POS BASE (three) ≤ 7%

Close Hooks

0:00 A7L √HOOKS 1,HOOKS 2 OPEN lt (two) – It off
CRT √HK1,HK2 DRV CMD (two) – ON
√POS (two) ≥ 5% & incr
* If HK1(2) DRV CMD – OFF or HK1(2) POS not incr: *
A7L √CLOSE HOOKS pb – push *
* If HOOKS 1(2) CLOSED lt failed ON: *
* Perform HOOKS 1(2) CLOSED LT FAILED ON, 8-25 *

0:20 CRT √RING DRV CMD – OFF
* If RING DRV CMD – ON 20 sec after hooks begin *
* driving in step 10: *
A7L * POWER ON pb – push *

≤ 1:30 A7L 12. √INTERF SEALED lt – lt on (expect intermittent lt initially)

2:20 CRT √HOOKS 1,HOOKS 2 CLOSED lt (two) – lt on
√HK1,HK2 POS (two) = 92 - 93%
√IND (two) = blank/CL
√ODS INDIV HK CL (twelve) – CL

Load Relieve Capture Latches (Extend Ring)

A7L 14. APDS CIRC PROT OFF pb – push
√CIRCUIT PROTECT OFF lt – lt on

0:00 15. RING OUT pb – push
CRT √DRV CMD – ON

0:10 A7L 16. POWER ON pb – push
CRT √RING DRV CMD – OFF

Open Capture Latches

0:00 A7L 17. OPEN LATCHES pb – push
√LATCHES CLOSED lt – lt off
0:05 √OPEN lt – lt on

Retract Ring to FNL POS

0:00 18. RING IN pb – push
CRT √DRV CMD – ON [PETAL POS BASE (three) – decr]
√FIXERS – ON
0:10 A7L √FINAL POSITION lt – lt on
CRT √PETAL POS BASE (three) = 5 ± 3%
0:20 √RING DRV CMD – OFF

Power Off

A7L 19. POWER OFF pb – push
√STATUS lt (eighteen) – lt off

20. Go to TERMINATE RNDZ OPS 22A, 4-22 >>
### STOPWATCH RDOT CONVERSION

<table>
<thead>
<tr>
<th>TIME BETWEEN 1 FT MARKS (SEC)</th>
<th>RANGE RATE (FT/SEC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.50</td>
</tr>
<tr>
<td>3</td>
<td>0.33</td>
</tr>
<tr>
<td>4</td>
<td>0.25</td>
</tr>
<tr>
<td>5</td>
<td>0.20</td>
</tr>
<tr>
<td>5.5</td>
<td>0.18</td>
</tr>
<tr>
<td>6</td>
<td>0.17</td>
</tr>
<tr>
<td>6.5</td>
<td>0.15</td>
</tr>
<tr>
<td>7</td>
<td>0.14</td>
</tr>
<tr>
<td>7.5</td>
<td>0.13</td>
</tr>
<tr>
<td>8</td>
<td>0.125</td>
</tr>
<tr>
<td>8.5</td>
<td>0.12</td>
</tr>
<tr>
<td>9</td>
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</tr>
<tr>
<td>10</td>
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</tr>
<tr>
<td>11</td>
<td>0.09</td>
</tr>
<tr>
<td>12</td>
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<td>16</td>
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<td>18</td>
<td>0.056</td>
</tr>
<tr>
<td>20</td>
<td>0.050</td>
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</tbody>
</table>

**NOTE**

HHL SPECS state that the HHL will not work if the aimpoint surface is closer than 12 ft from the HHL unit; therefore, no HHL use should be expected at an HHL range less than 12 ft (5 ft interface-to-interface).
### RDOT vs DELTA RNG/DELTA TIME

<table>
<thead>
<tr>
<th>Delta T (m:ss)</th>
<th>1000</th>
<th>800</th>
<th>600</th>
<th>500</th>
<th>400</th>
<th>300</th>
<th>250</th>
<th>200</th>
<th>150</th>
<th>100</th>
<th>50</th>
<th>25</th>
<th>10</th>
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<tbody>
<tr>
<td>0:45</td>
<td>8.9</td>
<td>6.7</td>
<td>5.6</td>
<td>4.4</td>
<td>3.3</td>
<td>2.2</td>
<td>1.1</td>
<td>0.56</td>
<td>0.22</td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>4.0</td>
<td>3.0</td>
<td>2.0</td>
<td>1.0</td>
<td>0.50</td>
<td>0.20</td>
<td></td>
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</tr>
<tr>
<td>0:55</td>
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<td>7.3</td>
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<td>4.5</td>
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<td>2.7</td>
<td>1.8</td>
<td>0.91</td>
<td>0.45</td>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1:00</td>
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<td>7.1</td>
<td>5.7</td>
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<td>3.6</td>
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<td>7.5</td>
<td>6.3</td>
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<td>1.9</td>
<td>1.3</td>
<td>0.63</td>
<td>0.31</td>
<td>0.13</td>
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<td>6.7</td>
<td>5.6</td>
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<td>2.2</td>
<td>1.7</td>
<td>1.1</td>
<td>0.56</td>
<td>0.28</td>
<td>0.11</td>
</tr>
<tr>
<td>1:40</td>
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<td>6.0</td>
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<td>0.25</td>
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<tr>
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<td>6.4</td>
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<td>1.8</td>
<td>1.4</td>
<td>0.91</td>
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<td>2:00</td>
<td>8.3</td>
<td>6.7</td>
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<td>3.3</td>
<td>2.5</td>
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<td>1.3</td>
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<td>0.42</td>
<td>0.21</td>
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<tr>
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<td>5.0</td>
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<td>1.8</td>
<td>1.4</td>
<td>1.1</td>
<td>0.71</td>
<td>0.36</td>
<td>0.18</td>
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<tr>
<td>2:20</td>
<td>6.3</td>
<td>5.0</td>
<td>4.4</td>
<td>3.8</td>
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<td>0.16</td>
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<td>2:40</td>
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<td>2.2</td>
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<td>0.8</td>
<td>0.56</td>
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<tr>
<td>3:00</td>
<td>5.6</td>
<td>4.4</td>
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<td>2.8</td>
<td>2.2</td>
<td>1.7</td>
<td>1.4</td>
<td>1.1</td>
<td>0.8</td>
<td>0.56</td>
<td>0.28</td>
<td>0.14</td>
</tr>
</tbody>
</table>

### NOTE:
If RPOP is available, use RPOP subtended angle function.
## GPC/MDM FAILURE RESPONSE DURING RNDZ

### NOTES

1. Perform appropriate ORB PKT procedure in parallel with IMMEDIATE ACTIONS on card as soon as practical.
2. Use this card during Rndz T/L thru MC4 burn (if RR FAIL PROCEDURES, thru RR fail correction burn)
3. GPC assignments assume 1233 NBAT
4. Do NOT restring for Non-Universal I/O Errors. Otherwise, a restring for GPC 1,2,3 fails will recover everything (see expected restring below)
5. If any GNC GPC fails, VERNs ↓
6. If IMUs not commfaulted, THC's are normally GO
7. Loss of FF2, FF4, FA3, and FA4 do not impact Rndz (unless other failures)

<table>
<thead>
<tr>
<th>GPC</th>
<th>MDM</th>
<th>IMMEDIATE ACTION</th>
<th>MAJOR IMPACT</th>
</tr>
</thead>
</table>
| GPC1    | FF1 | 1. If -Z ST NAV, INH ST to NAV  
          |     | 2. If -Z ST not recovered:  
          |     | Use -Y ST, if reqd  
          |     | 1. C3 DAP lights latched (go out with MDM pwr fail)  
          |     | 2. -Z ST ↓  
          | FA1 | DAP: ALT/AUTO  
          |     | VERNs ↓  |
| GPC2    | FA2 | DAP: ALT/AUTO  
          |     | VERNs ↓  |
| Man OMS Shutdown | FF3 | 1. DAP: ALT/AUTO  
          |     | 2. If RR NAV, INH RR to NAV  
          |     | 3. If -Y ST NAV, INH ST to NAV  
          |     | 4. If RR not recovered:  
          |     | Work RR FAIL procedures  
          |     | 1. VERNs ↓  
          |     | 2. RR → NAV/RPOP ↓  
          |     | (Panel A2 OK)  
          |     | 3. A6 DAP lights latched (go out with MDM pwr fail)  
          |     | 4. -Y ST ↓  
          |     | 5. Also for loss of GPC3:  
          |     | R OMS GMBL PRI/SEC ↓  |
| GPC3    | Loss of Aft DAP |  |  |
| GPC4    | PL  | If Ku breaks lock:  
          |     | Ku sel – AUTO TRK  
          |     | 1. GPC Ku ptg ↓, slew in AUTO TRK if Ku breaks lock  
          |     | 2. No Ku self-test  |

* Expect this NBAT if GPC fail

### MALFUNCTION

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RNDZ-7a/126/O/A
TOP
BACK OF ‘GPC/MDM FAILURE RESPONSE DURING RNDZ’

RNDZ REF DATA

FF1
F MANF 1 JETS
C3 DAP LTS
IMU 1
-Z STRK
L OMS GMBL PRI ENA
L ADI sw, ATT REF
A THC contact 1
L A RHC channel 1
PNL 03 F,L R LCS OX QTY
PNL 03 F,L R LCS LOW QTY

FF2
F MANF 2 JETS
IMU 2
L OMS GMBL SEC ENA
F ADI sw, ATT REF
A THC contact 2
A RHC P,Y channel 2
L RHC channel 2
R RHC channel 1

FF3
VERNS
F MANF 4 JETS
A6 DAP LTS
IMU 3
RR \rightarrow NAV/RPOP
Y STRK
R OMS GMBL SEC ENA
A ADI sw, ATT REF
A THC contact 3
L A RHC channel 3
PNL 03 R LCS LOW QTY
PNL 03 F,L LCS FU QTY

FF4
F MANF 3 JETS
R OMS GMBL PRI ENA
R A RHC Roll channel 2
R RHC channel 3
PL1
GKC PU PTG
KU self-test

FA1
VERNS
L R MANF 1 JETS
L OMS GMBL PRI

FA2
VERNS
L R MANF 3 JETS
L OMS GMBL SEC

FA3
VERNS
L R MANF 2 JETS
R OMS GMBL SEC

FA4
VERNS
L R MANF 4 JETS
R OMS GMBL PRI

MDM OA1(0A2)
L(R) OMS DEORB ONLY

DSC OF2
VERNS \& F MANF 3,4 RM
F RCS OX, FU QTY

DSC OF4
VERNS \& L MANF 1,2 RM
F RCS OX QTY

DSC OL1
VERNS \& L MANF 1,2 RM
L RCS DEORB ONLY

DSC OL2
VERNS \& L MANF 1,2 RM
R RCS OX QTY

DSC OR1
VERNS \& R MANF 1,2 RM
R RCS DEORB ONLY

DSC OR2
VERNS \& R MANF 1,2 RM
R RCS OX QTY

DSC OA2
VERNS RM

CNTL AB1
PLB LTS (Fwd-P, Aft-S, Bulkhead)
L ADI ATT REF
CCTV CONTR UNIT PRI

CNTL AB2
F MANF 1 JETS
L ADI switches, ATT REF

CNTL AB3
C3 DAP ROT, TRANS pbs

CNTL BC1
VERNS
PLB LTS (Fwd-S, Mid-P)
R ADI ATT REF
CCTV CONTR UNIT SEC

CNTL BC2
VERNS
F MANF 2 JETS
A6 DAP ROT, TRANS pbs (PCT)
R ADI switches, ATT REF

CNTL BC3
C3 DAP ROT, TRANS pbs

CNTL CA1
PLB LTS (Aft-P, Mid-S)
OVHD DOCK, RMS SPOT LTS
A ADI ATT REF

CNTL CA2
F MANF 3 JETS
A6 DAP ROT, TRANS pbs (PCT)
A ADI switches, ATT REF

CNTL CA3
F MANF 4 JETS

MAIN A
FPC1: MCIU
FLC1: F MANF 1 JETS
AC1B: PNL O3 RCS/OMS QTY
FWD EVENT TIMER

APC4:
APC1: VERNS
L OMS GMBL PRI
R OMS GMBL SEC

ALC1: VERNS
O14: -Z STRK
AFT EVENT TIMER
O14/A8: RMS PRI PWR

R14: CCTV CAM-C,D
CCTV CONTR UNIT PRI

MPC1:APDS RING DAMP 1,2
APDS HK, RING MTR 1
RMS PRI PWR
OVHD DOCK, RMS LTS
PLB LTS (Fwd-P, Aft-S)

MAIN B
FPC2:
FLC2: F MANF 2 JETS
AC2C: PNL A2 DIGITALS

APC5:
APC2: VERNS
L OMS GMBL SEC

ALC2: VERNS
O15: -Y STRK
FWD EVENT TIMER

O15/A8: RMS B/J PWR
R14: KU COMM \& RR
CCTV CAM-A, RMS
CCTV MON-2
CCTV CONTR UNIT SEC
VPU (C/L CAM CMDS)

MPC2: KU COMM \& RR
APDS RING DAMP 3
APDS HK, RING MTR 2
RMS B/J PWR
PLB LTS (Fwd-S, Mid-P, Bulkhead)

MPC3: CCTV CAM-B
CABIN TV UTILITY PORT

ESS 2CA
TCS

CABIN PL (Flt Specific)
CCTV C/L CAM

RNDZ-7b/126/O/A

TOP
BACK OF ‘GPC/MDM FAILURE RESPONSE DURING RNDZ’
Note: Fabricate As Transparency

C/L CAMERA

CORRIDOR AND ALIGNMENT

CTVC 40.0 DEG HFOV - CORRIDOR
CTVC FULL ZOOM - ALIGNMENT
Note: Fabricate As Transparency

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Use Bottom/Back Of ISS Ring

Use Top/Front Of ISS Ring

CTVC FULL NO ZOOM

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Note: Fabricate As Transparency

C/L CAMERA

ZOOM CALIBRATION (RING READY FOR DOCK)

CTVC AT HFOV = 40.0 DEG

RNDZ-10a/126/O/A
FLIGHT

H-FOV

40 deg

0  5 10 15 20 25 30 35

20 deg

0  3 6 9 12 15 18 20

10 deg

0  1 2 3 4 5 6 7 8 9 10

SUB ANG RULER
Note: Fabricate As Transparency

CTVC 40.0 DEG HFOV - CORRIDOR
CTVC FULL ZOOM - ALIGNMENT
RCS FAILURE RESPONSE DURING PROX OPS

**CASE** | IMMEDIATE ACTIONS/PROCEDURES REFERENCE | FLT RULES | RPM | R<250
--- | --- | --- | --- | ---
2FxD | * DO NOT PERFORM LOW Z +Z (BRAKING) PULSES * | NO-GO | NO-GO
* If during RPM, * | * DAP: FREE *
* FLT CNTLR PWR – OFF * | * \mcc for further actions *
* If on Vbar and RNG > 75 ft, * | * DAP: No LOW Z *
* DAP: B/VERN(PRI) * | * DAP: AUTO *
* THC: +Z (out) at 10 sec intervals as reqd to * | * establish 0.1 fps opening *
* if RNG < 75 ft, * | * \dap: No LOW Z *
* DAP: B/VERN(PRI) * | * DAP: AUTO *
* THC: +Z (out) as reqd to establish 0.1 fps opening * | * Do not perform PCT *
NOTE: DAP disables ±Y translation | Perform LOSS OF BOTH FxD JETS (SAME SIDE) (CONTINGENCY OPS), 5-39

VERN | DAP: PRI/AUTO | GO | GO | Perform LOSS OF VRCS (CONTINGENCY OPS), 5-41
Y | NOTE: DAP disables ±Y translation | NO-GO | NO-GO | Perform LOSS OF FORWARD SIDE-FIRING JETS (CONTINGENCY OPS), 5-37
+X | Do not perform LOW Z +Z (braking) pulses | NO-GO | GO | Perform DEGRADED +X TRANSLATION (CONTINGENCY OPS), 5-35
-X | Perform DEGRADED -X TRANSLATION (CONTINGENCY OPS), 5-36 | GO | GO | Perform LOSS OF ONE FxD JET (CONTINGENCY OPS), 5-38
1FxD | Review IMMEDIATE ACTIONS for 2FxD CASE | NO-GO | GO | Perform LOSS OF ONE FxD JET (CONTINGENCY OPS), 5-38

**Note 1:** Use this card during Rndz T/L after MC4 burn (if RR FAIL PROCEDURES, after RR fail correction burn)
**Note 2:** If multiple cases apply, perform cases in order
**Note 3:** Perform appropriate ORB PKT procedure in parallel with IMMEDIATE ACTIONS on card as soon as practical

**TOP**
### RCS/DPS/EPS Failure Impacts

<table>
<thead>
<tr>
<th>DPS GPC</th>
<th>MDM</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>DC SUBBUS</th>
<th>MAIN</th>
<th>CNTL</th>
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<tr>
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<td>F1L</td>
<td>F1U</td>
<td>F1D</td>
<td>FLC1</td>
<td>FPC1</td>
<td>MN A DA1</td>
<td>AB2</td>
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<td>F4U</td>
<td>F4D</td>
<td>F5L</td>
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<tr>
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<tr>
<th>CASE</th>
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<th>+X</th>
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<th>VERN</th>
<th>VERN</th>
<th>1 JET</th>
<th>CASE</th>
<th>2 JETS</th>
</tr>
</thead>
</table>

1. For RCS failures, strike aff jet(s). For DPS/EPS failures, strike all jets in same row(s) as aff GPC/MDM/bus.
2. For each group with failed jet(s), read down to 1 JET or 2 JETS as appropriate to determine applicable case.
3. Refer to reverse side for appropriate procedures and flight rule impacts for each applicable case.
4. If 1 JET, read down to 2 JETS to determine case for next worse failure, then read back up to determine which RCS/DPS/EPS failures can result in next worse failure. Review IMMEDIATE ACTIONS for next worse failure.