Rendezvous

STS-133

Mission Operations Directorate
Flight Dynamics Division

Final
July 15, 2010

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas
MISSION OPERATIONS DIRECTORATE

RENEDEVOUS
STS-133

FINAL
July 15, 2010

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NOTE
This checklist is the controlling crew document for the ISS-ULF-5 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.

Timeline pages assume an FD3 rendezvous and undocking on FD10. Lighting is based on planned rendezvous altitude of 205 nm. Targeting I-Loads are based on 210 nm.
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<td>RANGING CHARTS</td>
<td>6-13</td>
</tr>
<tr>
<td>COAS SUBTENDED ANGLES (DEG) VS RANGE (FT)</td>
<td>6-14</td>
</tr>
</tbody>
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### FLIGHT RULES SUMMARY

#### RNDZ/PROX OPS BREAKOUT PROCEDURES OVERVIEW

<table>
<thead>
<tr>
<th>RANGE BREAKOUT REQD</th>
<th>BREAKOUT PROCEDURE AND SUMMARY</th>
</tr>
</thead>
<tbody>
<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 V\(_s\) differ by no more than the 'final-ground' limits for each axis

## RNDZ Burn Engine Selection Guidelines

<table>
<thead>
<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>
</tbody>
</table>
# RNDZ FAILURE/RESPONSE SUMMARY

<table>
<thead>
<tr>
<th>FAILURE</th>
<th>RESPONSE</th>
</tr>
</thead>
<tbody>
<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)</td>
<td>Breakout per overview on 1-2</td>
</tr>
<tr>
<td>Or Orbiter systems malfunctions require breakout</td>
<td></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 ↓</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</td>
</tr>
<tr>
<td>or PRCS ROT, any axis ↓</td>
<td>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>or AFT THC (-Z sense), &gt; 1 TX contact ↓</td>
<td></td>
</tr>
<tr>
<td>all TY contacts ↓</td>
<td></td>
</tr>
<tr>
<td>all TZ contacts ↓</td>
<td></td>
</tr>
<tr>
<td>or AFT RHC, all channels, any axis ↓</td>
<td></td>
</tr>
<tr>
<td>or &lt; 2 IMUs</td>
<td></td>
</tr>
<tr>
<td>Both Left Aft firing jets ↓</td>
<td>Continue Approach, per DEGRADED +X TRANSLATION (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>or Both Right Aft firing jets ↓</td>
<td></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 ↓</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>or Both Forward Left firing jets ↓</td>
<td></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>
ISS AT CENTER OF ROTATING LVLH REFERENCE FRAME

-50 -100 -150 -200 -250 kft

MC4 MC3 MC2 MC1 Ti NC

Vbar

10 20 30 40

Rbar

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
ORBIT POST Ti PROFILE

ISS AT CENTER OF ROTATING LVLH REFERENCE FRAME

<table>
<thead>
<tr>
<th>PET</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td>Ti BURN</td>
</tr>
<tr>
<td>0:05</td>
<td>RR NAV (OR S TRK NAV, IF REQD)</td>
</tr>
<tr>
<td>0:20</td>
<td>MC1 BURN</td>
</tr>
<tr>
<td>~0:31</td>
<td>OOP NULL BURN</td>
</tr>
<tr>
<td>0:36</td>
<td>SUNSET</td>
</tr>
<tr>
<td>~0:50</td>
<td>MC2 BURN</td>
</tr>
<tr>
<td>~1:07</td>
<td>MC3 BURN</td>
</tr>
<tr>
<td>~1:12</td>
<td>SUNRISE</td>
</tr>
<tr>
<td>~1:17</td>
<td>MC4 BURN, START MANUAL PHASE</td>
</tr>
</tbody>
</table>
### TERMINAL PHASE, RPM, AND TORVA

<table>
<thead>
<tr>
<th>MC2 ET (h:mm)</th>
<th>Range (ft) CG - CG</th>
<th>Rdot (fps)</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 0:27</td>
<td>2000</td>
<td>-3.0</td>
<td>MANUAL PHASE TAKEOVER (POST-MC4)</td>
</tr>
<tr>
<td>0:29</td>
<td>1700</td>
<td>-2.4</td>
<td></td>
</tr>
<tr>
<td>2 0:31</td>
<td>1500</td>
<td>-2.1</td>
<td></td>
</tr>
<tr>
<td>3 0:36</td>
<td>1000</td>
<td>-1.3</td>
<td>TRANSITION TO LOWZ</td>
</tr>
<tr>
<td>0:37</td>
<td>900</td>
<td>-1.1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></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>800</td>
<td>-0.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>700</td>
<td>-0.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>650</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>5 0:46</td>
<td>620</td>
<td>0.0</td>
<td>STATIONKEEP TO AVOID SHADOWING IF REQUIRED</td>
</tr>
<tr>
<td>6 1:00</td>
<td>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</td>
<td>-0.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>580</td>
<td>-0.15</td>
<td></td>
</tr>
<tr>
<td>7 1:11</td>
<td>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</td>
<td>-0.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>-0.4</td>
<td></td>
</tr>
</tbody>
</table>
# VBAR APPROACH

<table>
<thead>
<tr>
<th>MC2 ET (h:mm)</th>
<th>Range (ft)</th>
<th>Rdot (fps)</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1:25</td>
<td>320</td>
<td>-0.20</td>
</tr>
<tr>
<td>1:42</td>
<td>110</td>
<td>-0.15</td>
<td></td>
</tr>
<tr>
<td>1:46</td>
<td>75</td>
<td>-0.10</td>
<td>TRANSITION TO NORMZ, LOAD DAP A10/B10, CONFIGURE FOR SINGLE -X JET</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>

ISS-Centered LVLH Frame

EARTH

+RBAR (FT)

RPM
800
1200
1600
2000

+VBAR (FT)

Graphical representation of VBAR approach with relevant coordinates and timing details.
UNDOCKING, TORS/TORF, AND FINAL SEPARATION

<table>
<thead>
<tr>
<th>UNDOCKET (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 2</td>
<td>UNDOCKING AT MIDNIGHT-2 MIN; DAP B/ALT MODE TO LVLH; MAINTAIN CORRIDOR</td>
</tr>
<tr>
<td>0:01</td>
<td></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></td>
<td>50</td>
<td>RESELECT -X JETS</td>
</tr>
<tr>
<td>2 0:07</td>
<td>75</td>
<td>TRANSITION TO LOWZ</td>
</tr>
<tr>
<td>3 0:29</td>
<td>&gt;400</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 TORF BETWEEN 600 AND 700 FT; THEN PERFORM SEP 1]</td>
</tr>
<tr>
<td>[1:15]*</td>
<td>[CG-CG]</td>
<td></td>
</tr>
<tr>
<td>4 0:57</td>
<td>&gt;2000</td>
<td>SEP2: 1.5 FPS -X, NORMZ POSGRADE BURN</td>
</tr>
<tr>
<td>[1:43]*</td>
<td>[CG-CG]</td>
<td></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

**ENABLE RENDEZVOUS NAV [5B]**

- 00:45

PET

\mcc
\dps config for Undocking Ops - STRING 1233

CONFIGURE FOR SEPARATION [5A]

When in undock attitude;
DAP: B/AUTO/VERN

MCC UPDATE

**ORB SV**
**TGT SV**
Covar Matrix

MCC UPDATE

Undocking Time [4A]

**ENABLE RENDEZVOUS NAV [5B]**

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

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

Perform DOCKING MECHANISM POWERUP (APDS), 8-5
UNDOCKING PREP (APDS), 8-7

Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZ TOOLS), 7-2

\mcc
\dps config for Undocking Ops - STRING 1233

CONFIGURE FOR SEPARATION [5A]

When in undock attitude;
DAP: B/AUTO/VERN

MCC UPDATE

**ORB SV**
**TGT SV**
Covar Matrix

MCC UPDATE

Undocking Time [4A]

**ENABLE RENDEZVOUS NAV [5B]**

- 00:40

\a12

**ENABLE RENDEZVOUS NAV [5B]**

- 00:35

- 00:30

- 00:25

- 00:20

- 00:15

\mcc
\dps config for Undocking Ops - STRING 1233

CONFIGURE FOR SEPARATION [5A]

When in undock attitude;
DAP: B/AUTO/VERN

MCC UPDATE

**ORB SV**
**TGT SV**
Covar Matrix

MCC UPDATE

Undocking Time [4A]

**CONFIGURE FOR SEPARATION [5A]**

**GNC 20 DAP CONFIG**

**CRT**

\dps config: A12, B12

**DAP: LO Z**

**DAP: A/AUTO/VERN**

**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 \[+ 5\]
P \[+ 0\]
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 \[\Delta V\]
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 [5B]**

- 00:25

**ENABLE RENDEZVOUS NAV [5B]**

- 00:20

**ENABLE RENDEZVOUS NAV [5B]**

- 00:15

- 00:10

**ENABLE RENDEZVOUS NAV [5B]**

- 00:05

**ENABLE RENDEZVOUS NAV [5B]**

- 00:00

**ENABLE RENDEZVOUS NAV [5B]**

- 00:45

**ENABLE RENDEZVOUS NAV [5B]**

- 00:40

**ENABLE RENDEZVOUS NAV [5B]**

- 00:35

**ENABLE RENDEZVOUS NAV [5B]**

- 00:30

**ENABLE RENDEZVOUS NAV [5B]**

- 00:25

**ENABLE RENDEZVOUS NAV [5B]**

- 00:20

**ENABLE RENDEZVOUS NAV [5B]**

- 00:15

**ENABLE RENDEZVOUS NAV [5B]**

- 00:10

**ENABLE RENDEZVOUS NAV [5B]**

- 00:05

**ENABLE RENDEZVOUS NAV [5B]**

- 00:00

**ENABLE RENDEZVOUS NAV [5B]**

- 00:45

**ENABLE RENDEZVOUS NAV [5B]**

- 00:40

**ENABLE RENDEZVOUS NAV [5B]**

- 00:35

**ENABLE RENDEZVOUS NAV [5B]**

- 00:30

**ENABLE RENDEZVOUS NAV [5B]**

- 00:25

**ENABLE RENDEZVOUS NAV [5B]**

- 00:20

**ENABLE RENDEZVOUS NAV [5B]**

- 00:15

**ENABLE RENDEZVOUS NAV [5B]**

- 00:10

**ENABLE RENDEZVOUS NAV [5B]**

- 00:05

**ENABLE RENDEZVOUS NAV [5B]**

- 00:00

**ENABLE RENDEZVOUS NAV [5B]**

- 00:45

**ENABLE RENDEZVOUS NAV [5B]**

- 00:40

**ENABLE RENDEZVOUS NAV [5B]**

- 00:35

**ENABLE RENDEZVOUS NAV [5B]**

- 00:30

**ENABLE RENDEZVOUS NAV [5B]**

- 00:25

**ENABLE RENDEZVOUS NAV [5B]**

- 00:20

**ENABLE RENDEZVOUS NAV [5B]**

- 00:15

**ENABLE RENDEZVOUS NAV [5B]**

- 00:10

**ENABLE RENDEZVOUS NAV [5B]**

- 00:05

**ENABLE RENDEZVOUS NAV [5B]**

- 00:00
UNDOCKING OPERATIONS [6A]

1. PREP FOR UNDOCKING
When MCC-H and ISS issue GO for Undocking:

GNC 33 REL NAV

CRT
ORB TO TGT - ITEM 10 EXEC

O14, All DDU cbs (six) - cl
O15,
O16:E

A6U FLT CNTLR PWR – ON

SSP2 DRAGNEYE PWR - ON (tb - gray)

2. RECONFIGURE DAP

(GNC UNIV PTG)
When ATT and RATES in limits:

ATT ERR (Each Axis)  ≤ 1.0 deg
RATE:
ROLL, YAW  ≤ 0.020 deg/sec
PITCH  -0.085 ≤ RATE ≤ -0.045 deg/sec

-03:00 >

DAP: FREE
O14:F, Pri RJD DRIVER (eight) - ON
O15:F, O16:F

(GNC 20 DAP CONFIG)

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

3. COMMAND UNDOCKING

SM 167 DOCKING STATUS

A7L
* If HOOKS 1(2) OPEN lt failed on:
* APDS POWER Aos - OFF (√Aos and failed ltts off)
APDS CIRC PROT OFF pb - push
√CIRCUIT PROTECT OFF lt - lt on

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

CRT
* 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

At physical sep +1:00:

DAP: VERN(ALT)
THC: +Z (out) pulses at 10 sec intervals to build to 0.15 fps
Record time (mm:ss) of VERN select or last pulse: ______ : ______

At last pulse TIG+2:00 and when RNG > 30 ft (DP-DP):

[SM 167 DOCKING STATUS]

GNC 23 RCS

CRT
√RCS FWD – ITEM 1 EXEC (+)
JET DES 2F – ITEM 35 EXEC (no *)
F1F – ITEM 31 EXEC (no *)

Perform TCS MANUAL ACQUISITION, step 2 (RNDZ TOOLS), 7-19

When RNG = 50 ft (DP-DP):

A7L
√STATUS lt (eighteen) - lt off
GO TO SEP/FLYAROUND [6A]

5. POWER OFF

POWER OFF pb - push
√STATUS lt (eighteen) - lt off
UNDOCKING / SEPARATION TIMELINE

MCC: GO FOR UNDOCKING

UNDOCK COMPLETE

MCC UPDATE
GO for Undocking
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 ✓+ 90 (--RBAR)
     Y ✓+ 0
     OM ✓+ 0
     ERR TOT – ITEM 23 (*)
     TRK – ITEM 19 EXEC (CUR - *)

If no flyaround, Go to SEP BURNS [8B]
If flyaround, Go to FLYAROUND [9A]

**SEP BURNS [8B]**

1. **SEP 1**
   - DAP TRANS: NORM/PULSE/PULSE
     THC: +X (up) 6 sec (1.5 fps)
   - DAP TRANS: +A/AUTO/VERN(PR)
     FLT CNTLR PWR – OFF
     Inform MCC when SEP complete
     Record Radial Burn TIG _____/______:______

   - GNC 2 TIME
     Set GNC TIMER counting to final burn (Radial Burn TIG + 28 min)

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

3. **SEP 2**
   - MCC for final burn direction
     At final burn TIG:
     If posigrade final sep burn
       | Aft THC: –X (down) 6 sec (1.5 fps)
     If retrograde final sep burn
       | Aft THC: +X (up) 12 sec (3.0 fps)
     DAP TRANS: PULSE/PULSE/PULSE
     FLT CNTLR PWR – OFF
     Inform MCC when SEP complete

   Go to TERMINATE SEP OPS [8C]

**TERMINATE SEP OPS [8C]**

If KU MODE – RDR PASSIVE
   Perform KU OPS, step 4 (Cue Card)
   GNC 33 REL NAV
   CRT RNDZ NAV ENA - ITEM 1 EXEC (no *)
   GNC 20 DAP CONFIG
     Config DAP A, B to A1, B1
   A6L LIGHTS TRUSS FWD, AFT (two) - OFF
     VESTIBULE PORT, STBD (two) - OFF
   SSP2 DRAGNEYE PWR - OFF (tb - bp)

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

   Go to FLIGHT PLAN
FLYAROUND

1. 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)

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

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

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

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

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

7. When flyaround complete (in +Vbar attitude),
   Go to SEP BURNS (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

650 FT CG-CG
HHL RANGE CONVERSION

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

1. Refl #3 becomes less visible as Orbiter YLV= position becomes more positive (into the page)
2. Flyaround range is 600 – 700 ft
3. Arrays, radiators, manipulators, and other structures are not shown for clarity of the TCS reflector information.
4. Refl #5 on PMA 3 points out of plane.
UNDOCKING / SEPARATION TIMELINE

INITIAL RADAR ACQ  10A

[SM ANTENNA]

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
- CNTRL - 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
### FINAL ORBIT MANEUVER PAD FOR NH

<table>
<thead>
<tr>
<th>OMS BOTH</th>
<th>L</th>
<th>2</th>
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</thead>
<tbody>
<tr>
<td>R</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>RCS SEL</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>TV ROLL</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>TRIM LOAD</td>
<td>P</td>
<td>6</td>
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<td>LY</td>
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<td>TIG</td>
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</table>

### OMS GMBL CK:

- L PRI
- L SEC
- R PRI
- R SEC
- NONE

### RCS I’CNCT:

- L OMS → RCS
- R OMS → RCS
- NONE

### DOWN MODE OPTIONS:

- 2 OMS → 1 OMS
- 1 OMS → RCS
- NONE

### ORBIT BURN MONITOR

- CRIT BURN
- NON-CRIT BURN

### NOTES

- OMS HE REG TEST:  
  - NONE

- -X RCS BURNS:
  - BURN ATT
  - LVLH ATT

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

---

3-3

RNDZ/133/FIN
### FINAL ORBIT MANEUVER PAD FOR NC

<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>
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**Burn Attitude**

- **R** 24
- **P** 25
- **Y** 26

**ΔVTOT**

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<tr>
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**ΔVTOT**

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**Trim Load**

- **P** 6
- **LY** 7
- **RY** 8

**WT** 9

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**TIG** 10

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**ΔVX** 19

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**ΔVY** 20

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**ΔVZ** 21

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**ΔVT**

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**ΔVT**

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**RCS I’CNCT:**

- L OMS → RCS
- R OMS → RCS
- NONE

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<tr>
<th>OMS GMBL CK:</th>
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<tr>
<td>R SEC</td>
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</table>

**RCS SEL:**

- 1 OMS BOTH
- 2 OMS
- 3
- 4 RCS SEL
- 5 TV ROLL

**LvlH Att:**

<table>
<thead>
<tr>
<th>GPC</th>
<th>L OP</th>
<th>CL</th>
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<tr>
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<td>A</td>
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<td>B</td>
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**GPC FILL-INS**

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**Crit Burn**

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**Burn Attitude**

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<tr>
<th>GPC</th>
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<td>P</td>
<td>15</td>
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<td></td>
<td>Y</td>
<td>16</td>
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<td>OM</td>
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**Burn Attitude**

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**LvlH Att**

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**LvlH Att**

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**Down Mode Options:**

- 2 OMS → 1 OMS
- 1 OMS → RCS
- NONE

**Orbit Burn Monitor**

<table>
<thead>
<tr>
<th>GPC FILL-INS</th>
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<tr>
<td>CRIT BURN</td>
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<td>NON-CRIT BURN</td>
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**Max TIG Slip**

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**Do Not Update TIG**

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**Notes**

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3-5

RNDZ/133/FIN
## ORBIT MANEUVER PAD FOR ___________

### BURN ATT

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

### OMS GMBL CK:

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

### ORBIT BURN MONITOR

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

### DOWN MODE OPTIONS:

- 2 OMS → 1 OMS
- 1 OMS → RCS
- NONE

### ORBIT MANEUVER MONITOR

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

### NOTES

- 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

### TV ROLL

- +X
- -X
- MULTI-AXIS

### TRIM LOAD

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

### OMS BOTH

| 1 |

### TIG

| 10 |

### NOTES

- GPC L OP CL
- GPC R OP CL
- NONE

### DO NOT UPDATE TIG

3-9

RNDZ/133/FIN
RENDEZVOUS TIMELINE
AFT FLT STATION CONFIG FOR RNDZ

O14,16: √cb MNA,C DDU AFT (two) - cl

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

R13
√KU ANT - GND

A1U
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

CRT
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
RCS 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**

- **-03:00**
  - CDR: AFT FLT STATION CONFIG FOR RNDZ [4A]
  - PLT: RNDZ OPS INITIALIZATION [5A]

- **-02:55**
  - MCC UPDATE
  - Final NH Burn Pad, 3-3 (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)

- **-02:50**
  - MS: Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZTOOLS), 7-2

- **-02:45**
  - MS: Perform SSP1 OIU PWR - OIU 1 ON (tb-UP)
  - SSV OUTRATE - 3

- **-02:36**

- **-02:30**

**RENDEZVOUS TIMELINE**

**MCC UPLINK**

- TFL 192
- CONFIG 763

**RNDZOPS INITIALIZATION**

- 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 - (+)
  - INH GPS to G&C, ITEM 33 - (+)
  - NAV, ITEM 36 - (+)
**RENDEZVOUS TIMELINE**

**PET**

- **02:30**
  - A7(B7)
  - TIG – 5 min

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

- **02:20**

- **02:15**
  - PLT ENABLE RENDEZVOUS NAV [7A]
  - MS \^PGSCs setup per PGSC Usage Chart (if available) or UTILITY OUTLET PLUG-IN
  - PLAN ORBIT CONFIGURATION (REF DATA FS, UTIL PWR)
  - PLT, On RPOP PGSCs:
    - MS Perform RPOP INITIALIZATION (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

- **02:10**

- **02:05**

- **02:00**

**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

**MCC UPDATE**

- Final NC Burn Pad, 3-5
RENDEZVOUS TIMELINE

CDR: LOAD TARGET TRACK [9A]

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

CDR: LOAD TARGET TRACK [9A]

NOTE
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
STAR TRK NAV
IMU DES [10A], 4-10

LOAD TARGET TRACK [9A]

√DAP: A/LVLH/VERN(ALT)

GNC UNIV PTG

CRT
CNCL - ITEM 21 EXEC
TGT ID + 1

BODY VECT +3 (-Z) +4
P +90 +0
Y +0 +280.57
OM +0 +30

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

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

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

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

CDR: INITIATE TARGET TRACK [9B]

PLT: TARGET NCC BURN [11A] (Preliminary), 4-11

TIG – 5 MIN

NC TIG

TIG – 5 MIN

A7(B7)

-02:00

-01:55

-01:50

-01:45

-01:40

-01:35

-01:30
1. **CONFIG FOR STRK NAV**

   √DAP: A/AUTO/VERN(ALT)
   Turn down cabin lights to optimize viewing through –Z COAS/overhead window
   IMU for Deselect _____ (If no comm, use IMU 1 for deselect)

   **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

2. **INITIAL MEASUREMENT EVALUATION**

   **GNC 22 S TRK/COAS_CNTL**
   When S PRES - (+), continue

   **GNC 33 REL NAV**
   Monitor RESID V and H each NAV cycle for at least
   four consecutive cycles (~30 sec)
   Record init RESID V = _____ _____ _____ _____
   H = _____ _____ _____ _____

   If RESID V or H changes by > 0.05 each cycle:
   **GNC 22 S TRK/COAS_CNTL**
   –Z(–Y) BREAK TRK - ITEM 8(7) EXEC
   Repeat Step 2

   If RESID V or H > 0.6:
   **GNC 22 S TRK/COAS_CNTL**
   –Z(–Y) BREAK TRK - ITEM 8(7) EXEC
   When S PRES - (+), if RESID V or H still > 0.6 and stable:
   Perform S TRK NAV - HIGH INITIAL RESID (CONTINGENCY OPS), 5-8

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 *
RENDEZVOUS TIMELINE

4-11 RNDZ/133/FIN

TARGET NCC BURN

PLT STAR TRACKER NAV (10A)

MCC UPDATE
Nav Selected IMU

When NAV converged (SV UPDATES small and stable):

CDR TARGET NCC BURN (11A) (Intermediate)

If no comm

If \( \Delta V_T > 6 \) fps:

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

If \( \Delta V_T > 4 \) fps:

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

TIG – 10 min \( \Delta \)MCC for burn type

\( \Delta V_X \)
\( \Delta V_Y \)
\( \Delta V_Z \)
\( \Delta V_T \)

PRELIMINARY
INTERMEDIATE
FINAL
GROUND
FINAL - GROUND LIMITS

\( (0.8) \)
\( (1.6) \)
\( (2.3) \)
### -Z Axis Target Track

![image](image.png)

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

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

TARGET TI BURN

When NAV converged (SV UPDATES small and stable):
PLT  TARGET TI BURN  (Intermediate)

RR NAVIGATION

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

IF Y STRK TRACK

When:
GNC 33 REL NAV
NAV RNG < 150 KFT:
MS  KU OPS, step 1 (Cue Card)

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)

TTB

When RR RNG < 135 KFT:
PLT  Perform RR NAVIGATION

IF Y STRK TRACK

When:
GNC 33 REL NAV
NAV RNG < 150 KFT:
MS  KU OPS, step 1 (Cue Card)

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)

TTB

When NAV converged (SV UPDATES small and stable):
PLT  TARGET TI BURN  (Intermediate)

RR NAVIGATION

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

IF Y STRK TRACK

When:
GNC 33 REL NAV
NAV RNG < 150 KFT:
MS  KU OPS, step 1 (Cue Card)

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)
## Rendezvous Timeline

### Ti Burn Solutions

<table>
<thead>
<tr>
<th></th>
<th>PREL FLTR</th>
<th>INTER FLTR</th>
<th>FINAL FLTR</th>
<th>GND</th>
<th>PROP (if Reqd)</th>
<th>FINAL - GROUND LIMITS</th>
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</thead>
<tbody>
<tr>
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</tbody>
</table>

- Final Ti Burn Pad, 3-7
RENDEZVOUS TIMELINE

\[4\]-15

\[133\]/FIN

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

MCC UPDATE
GO for Ti

PET

A7(B7)

-00:30

-00:25

-00:20

-00:15

-00:10

-00:05

-00:00

- Ti TIG

MCC for burn type. If no comm:
\[\text{if } \Delta T > 6\text{, at TIG-17:}\]
\[\text{Perform RNDZ OMS BURN (CONTINGENCY OPERATIONS), 5-4}\]
\[\text{if } 4 \leq \Delta T \leq 6\text{, at TIG-17:}\]
\[\text{Perform } +X\text{ RCS burn, RCS BURN (Cue Card)}\]
\[\text{if } \Delta T < 4\text{, at TIG-5:}\]
\[\text{Perform multi-axis RCS burn, RCS BURN (Cue Card)}\]

\[\text{if GO for Ti not received by TIG – 5 min or RNDZ DELAY called by MCC}\]
\[\text{CDR Perform Ti DELAY BURN (CONTINGENCY OPS), 5-27}\]

\[\text{If Ti is } -X\text{ RCS burn, Perform RENDEZVOUS } -X\text{ RCS BURN (CONTINGENCY OPS), 5-32}\]

\[\text{TIG – 5 min}\]
If Ti is multi-axis burn, Perform RNDZ OMS BURN (CONTINGENCY OPERATIONS), 5-4

\[\text{MCC UPDATE}\]
Ti Final Ground Soln, Ti DELAY Soln, 3-7

\[\text{MCC UPDATE}\]
GO for Ti

\[\text{Target Ti BURN (15A) (Final)}\]

\[\text{CRT OPS 202 PRO}\]
\[\text{GNC ORBIT MNVR EXEC}\]
Load Eng Sel, TVR, WT and Trims for Ti per Final Ti Burn Pad
\[\text{LOAD - ITEM 22 EXEC}\]
\[\text{GNC 33 REL NAV}\]
\[\text{SV SEL correct}\]
\[\text{GNC 34 ORBIT TGT}\]
TGT NO - ITEM 1 + 10 EXEC
\[\text{GNC 33 REL NAV}\]
\[\text{SV SEL correct}\]
\[\text{GNC 34 ORBIT TGT}\]
TGT NO - ITEM 1 + 10 EXEC
\[\text{ Ti TIG } = \text{ BASE TIME}\]
\[\Delta T = \pm 0.9\]
\[\Delta X = \pm 0.9\]
\[\Delta Y = \pm 0.9\]
\[\Delta Z = \pm 1.8\]

\[\text{COMPUTE Ti – ITEM 28 EXEC}\]
Record solution in PAD

\[\text{FINAL SOLUTION}\]
If > 40 marks in current sensor pass and
\[\text{SV UPDATE POS < 0.5 for the last 4 marks:}\]
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. \(\Delta V\)s

\[\text{PET} - 00:30\\A7(B7)\]
RENDEZVOUS TIMELINE

POST Ti NAV 16A

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

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

\GNC 22 S TRK/COAS_CNTL\n\CRT \sqrt{Z} TGT TRK - ITEM 6 EXEC (+)

\IF RR FAIL\n\IF –Z Star Tracker:\n\sqrt{–Z} TGT TRK ATT, then:\n\Perform STAR TRACKER NAV [10A]\n\IF COAS NAV:\n\sqrt{–Z} TGT TRK ATT, then:\n\Perform COAS NAVIGATION (CONTINGENCY OPS), 5-10\n\IF –Y Star Tracker:\n\GNC UNIV PTG\nTGT ID + 1
BODY VECT + 4
P \sqrt{+ 0}
Y \sqrt{+ 280.57}
OM + 90
\DAP: BI/AUTO/ALT
\TRK - ITEM 19 EXEC
\When MNVR cmplt:\n\DAP: A/AUTO/VERN(ALT)
\Perform STAR TRACKER NAV [10A]
When MNVR to att cmpnt:

CDR	POST Ti NAV [16A]

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

PLT 

TARGET MC 1 BURN [17A] (Intermediate)

When Y = 0:

PLT 

MANUAL OUT-OF-PLANE NULL [19A]

TARGET MC 1 BURN [17A]

CRT

\`SV SEL correct

[TGT NO - ITEM 1 + 11 EXEC

\`TGT Set data:

\`T1 TIG = MC1 BURN SOLUTION TIG

EL + 0

\`T + 56.9

\`X + 0.9

\`Y + 0

\`Z + 1.8

COMPUTE T1 - ITEM 28 EXEC

Record solution in PAD

TARGET MC 2 [17B] (Preliminary)

CRT

\`SV SEL correct

[TGT NO - ITEM 1 + 12 EXEC

\`TGT Set data:

\`T1 TIG = MC2 BURN SOLUTION TIG

EL + 29.07

\`T + 27.0

\`X + 0.9

\`Y + 0

\`Z + 1.8

COMPUTE T1 - ITEM 28 EXEC

Record solution in PAD

NOTE

If TGT EL ANG Alarm, \`V still valid for current TIG,

TIG slip limits still apply

Record solution in PAD
**TARGET MC 2 BURN** (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** (Final)

CRT

`SV SEL correct`

**GNC 34 ORBIT TGT**

TGT NO - ITEM 1 + 12 EXEC

**COMPUTE T1** - ITEM 28 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

`TIG Set data:
  T1 TIG = BASE TIME
  EL + 0
  ∆T + 27.0
  ∆X - 0.9
  ∆Y + 0
  ∆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

---

**MC 2 BURN SOLUTION**

PRELIMINARY

<table>
<thead>
<tr>
<th>ΔVX</th>
<th>ΔVY</th>
<th>ΔVZ</th>
<th>ΔVT</th>
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<tbody>
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INTERMEDIATE

<table>
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<th>ΔVX</th>
<th>ΔVY</th>
<th>ΔVZ</th>
<th>ΔVT</th>
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<tbody>
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</table>

FINAL

<table>
<thead>
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<th>ΔVX</th>
<th>ΔVY</th>
<th>ΔVZ</th>
<th>ΔVT</th>
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<tbody>
<tr>
<td>+0.0</td>
<td>± (0.4)</td>
<td>+0.0</td>
<td>± (0.2)</td>
</tr>
<tr>
<td>+0.9</td>
<td>± (2.5)</td>
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</table>

MEAN ± (3σ VARIATION)

TIG

<table>
<thead>
<tr>
<th>TIG SLIP (COMPUTED-NOM)</th>
</tr>
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<tbody>
<tr>
<td>PREL</td>
</tr>
<tr>
<td>INTER</td>
</tr>
<tr>
<td>FINAL</td>
</tr>
<tr>
<td>NOMINAL</td>
</tr>
</tbody>
</table>

---

**END S TRK NAV** (Intermediate)

CRT

**GNC 33 REL NAV**

**GNC 21 IMU ALIGN**

IMU DES - ITEM 7(8,9) EXEC (no *)

---

**–Z AXIS TARGET TRACK** (Final)

CRT

**GNC UNIV PTG**

`TGT ID`

BODY VECT + 3 (–Z)

OM + 0

C3

**DAP**: B/AUTO/ALT

**TRK** - ITEM 19 EXEC (CUR - *)

When MNVR cmplt,

**DAP**: A/AUTO/VERN(ALT)

---

**NIGHTTIME STRK OPS** (Final)

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** (Final), steps 2 and 3
RENDZVOUS TIMELINE

**PET**

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

00:35
- A7(B7)
- IF S TRK NAV
- At sunset – 2 minutes:
- CDR Perform LATE RR NAV [20E]

00:40
- MS Perform 6.105 SSOR ACTIVATION, step 3 (SODF: JOINT OPS, COMM/DATA)
- On RPOP PGSC:
  - Perform TCS ACTIVATION, steps 2-4 (RNDZ TOOLS), 7-18
    (Set AUTO ACQ to 10,000 ft)
  - MS SSP2 DRAGNEYE PWR - ON (tb - gray)

00:45
- MS When RNG < 30,000 ft:
  - SSOR comm check with ISS

00:50
- MS Perform 6.105 SSOR ACTIVATION, step 3 (SODF: JOINT OPS, COMM/DATA)
  - On RPOP PGSC:
    - Perform TCS ACTIVATION, steps 2-4 (RNDZ TOOLS), 7-18
      (Set AUTO ACQ to 10,000 ft)
  - MS SSP2 DRAGNEYE PWR - ON (tb - gray)

00:55
- IF Y S TRK TRACK
- PLT END STAR TRACKER NAV [18C]
- WHEN RNG < 30,000 ft:
  - SSOR comm check with ISS

01:00
- IF S TRK NAV,
- PLT END STAR TRACKER NAV [18C]

**MC2 ET**

00:10
- PLT TARGET MC 2 BURN [18A] (Intermediate)

00:10
- PLT TARGET MC 2 BURN [18B] (Final)

00:55
- PLT TARGET MC 3 BURN [19B] (Preliminary)

**Manual Out-of-Plane Null**

**TARGET MC 3**

**MC 3 BURN SOLUTION**

**TIG:**

<table>
<thead>
<tr>
<th>PRELIMINARY</th>
<th>FINAL</th>
<th>MEAN ± (3σ VARIATION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔVX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔVY</td>
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<td>ΔVZ</td>
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</tr>
<tr>
<td>ΔVT</td>
<td></td>
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</tbody>
</table>
RENDEZVOUS TIMELINE

MC 4 BURN SOLUTION

TIG / : : :

PRELIMINARY FINAL
\[ \Delta V_x ( ) ( ) , \]
\[ \Delta V_y ( ) ( ) , \]
\[ \Delta V_z ( ) ( ) , \]
\[ \Delta V_T ( ) , \]

MEAN ± 3σ VARIATION
\[ +1.3 ± (1.3) , \]
\[ -0.1 ± (0.6) , \]
\[ +0.9 ± (2.2) . \]

TARGET MC 4 BURN [20A]

CRT √ SV SEL correct


GNC 34 ORBIT TGT
TGT NO - ITEM 1 + 14 EXEC
√ TGT Set data:
\[ T_1 TIG = BASE TIME + 0:00:27:00 , \]
\[ EL + 0 , \]
\[ ΔT + 13.0 , \]
\[ ΔX + 0 , \]
\[ ΔY + 0 , \]
\[ ΔZ + 0.6 , \]

COMPUTE T1 - ITEM 28 EXEC

Record solution in PAD

ESTABLISH RBAR [20C]

A6U FLT CNTLR PWR - ON


GNC UNIV PTG

CRT TRK - ITEM 19 EXEC (CUR - +)

DAP: A/AUTO/VERN (PRI)

THC: as reqd to control TGT motion in COAS

RADAR FAIL PROCEDURE [20D]

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


GNC UNIV PTG

√ SENSE - -Z

DAP: A/LVLH(PRI)

√ COAS for TGT vertical position

THC: +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/VERN (PRI)

Inform MCC of TGT vertical position in COAS and number of pulses performed

Following radar fail X correction,

THC: 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:

A6U DAP: A/AUTO/VERN (PRI)

THC: as reqd to stabilize and maintain TGT docking port between 0 and 10 deg high in COAS

At 2000 ft:

Perform APPROACH (Cue Card)

CONFIG FOR RBAR [20B]

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

GNC UNIV PTG

TGT ID + 2

BODY VECT + 5

P + 270

Y + 0

OM + 0

Do not initiate Target Track until ESTABLISH RBAR [20C]

LATE RADAR NAV [20E]

GNC 33 REL NAV

CRT FLTR TO PROP - ITEM 8 EXEC

SV SEL, ITEM 4 - PROP

√ RR - ITEM 13 EXEC (+)

AUTO RNG - ITEM 17 EXEC (+)

RDOT - ITEM 20 EXEC (+)

Angles - ITEM 23 EXEC (+)

Go to RADAR FAIL PROCEDURE [20D]

RENDERED TIMELINE

4-20

RNDZ/133/FIN
**RENDEZVOUS TIMELINE**

- **01:00 A7(B7)**
  - **PET**
  - **MC2 ET**
  - **00:10** IF NO RR INTO NAV
    - CDR Go to RADAR FAIL PROCEDURES [20D]

- **01:05**
  - **A8(B8)**
  - TIG – 3 min
    - PLT TARGET MC3 BURN [19B] (Final)
    - Perform RCS BURN (Cue Card)
    - MC 3 TIG

- **01:10**
  - **00:20**
    - MS Begin HHL operations
    - PLT TARGET MC 4 BURN [20A] (Preliminary)
    - CDR CONFIG FOR RBAR [20B]

- **01:15**
  - **00:25**
    - CREW REPORT
      - ISS tally-ho
    - HHL REPORT
      - R and Rdot
    - TIG – 3 min
      - PLT TARGET MC 4 [20A] (Final)
      - Perform RCS BURN (Cue Card)

- **01:20**
  - **00:30**
    - HHL REPORT
      - R and Rdot
    - TIG – 3 min
      - CDR ESTABLISH RBAR [20C]

- **01:25**
  - **00:35**
    - Manual Trajectory Control
    - Perform APPROACH (Cue Card)

- **01:30**
  - **00:40**
TERMINATE RNDZ OPS

1. ORBITER CONFIG FOR MATED ATTITUDE CONTROL

<table>
<thead>
<tr>
<th>PLT</th>
<th>O14:F,</th>
<th>Pri RJD LOGIC, DRV/ER (sixteen) – OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O15:F,</td>
<td>RJDA 1A L2/R2 MANF DRIVER – ON</td>
</tr>
<tr>
<td></td>
<td>O16:F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>O14:E,</td>
<td>All DDU cbs (six) – op</td>
</tr>
<tr>
<td></td>
<td>O15:E,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>O16:E</td>
<td></td>
</tr>
<tr>
<td>CDR</td>
<td>A6U</td>
<td>√FLT CNTLR PWR - OFF</td>
</tr>
<tr>
<td>PLT</td>
<td>CRT</td>
<td>[GNC 23 RCS]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCS F – ITEM 1 EXEC (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JET DES F1L – ITEM 9 EXEC (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3L – ITEM 11 EXEC (+)</td>
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<tr>
<td></td>
<td></td>
<td>F2R – ITEM 13 EXEC (+)</td>
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<tr>
<td></td>
<td></td>
<td>F4R – ITEM 15 EXEC (+)</td>
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<tr>
<td></td>
<td></td>
<td>F1U – ITEM 17 EXEC (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3U – ITEM 19 EXEC (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F2U – ITEM 21 EXEC (+)</td>
</tr>
</tbody>
</table>

[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

<table>
<thead>
<tr>
<th>CRT</th>
<th>√DAP: LO Z</th>
</tr>
</thead>
</table>
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

<table>
<thead>
<tr>
<th>MS</th>
<th>A6L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LTS TRUSS FWD, AFT (two) - OFF</td>
</tr>
<tr>
<td></td>
<td>VEST PORT, STBD (two) - OFF</td>
</tr>
</tbody>
</table>

Exit RPOP - [Shift][F10]
Perform HAND-HELD LIDAR STOW (RNDZ TOOLS), 7-14
~Z COAS - OFF

RENDZVOUS TIMELINE
CONTINGENCY OPS

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RNDZ OMS BURN

1. OMS BURN PREP
   C2 Install OMS2/ORBIT OMS BURNS (Cue Cards) (two) and ORBIT BURN MONITOR (Cue Cards) (two) (F6,F8)

   CRT1
       \DAP config A7,B7
       GNC, OPS 202 PRO

       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 $\Delta$Vs 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

   CRT1 INH Angles – ITEM 24 EXEC (*)

   1: GNC 33 REL NAV

   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**

- **1: GNC UNIV PTG**
- Desired UNIV PTG load active

**C3**

**DAP: B/AUTO/ALT**

If RR ops, when ATT ERR < 30 deg:

**A1U**

- KU sel – GPC
- KU TRACK tb – gray
- **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
   
   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
   
   \( \sqrt{\text{For debris near TGT position}} \)
   
   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:
   
   \( \sqrt{\text{For debris near TGT line-of-sight}} \)
   
   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. \( \sqrt{\text{MCC for S TRK status}} \)
   
   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

2. 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 (*)
NOTE
Do not execute MC1 or Out-Of-Plane null
Prior COAS cal reqd to perform COAS NAV
VERNs 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
\( \sqrt{\text{SENSE: } -Z} \)
\( \sqrt{\text{DAP: } B7/\text{AUTO/VERN(ALT)}} \)

CRT
COAS: SIGHT MODE \(-\text{ITEM 22 EXEC (*)} \)
\( \sqrt{\text{REQD ID \(-\text{ITEM 21 +1 EXEC}}} \)
\( \sqrt{\text{POS \(-Z\): ITEM 27 (*)}} \)

<table>
<thead>
<tr>
<th>GNC 22 STRK/COAS CNTL</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>GNC 33 REL NAV</th>
</tr>
</thead>
</table>
| INH Angles \(-\text{ITEM 24 EXEC (*)}} \)
\( \sqrt{\text{SV SEL, ITEM 4 \(-\text{FLTR}}} \)
If TGT NOT in COAS FOV:
| \( \sqrt{\text{MCC}} \)
If TGT in COAS FOV:
| FLTR TO PROP \(-\text{ITEM 8 EXEC}} \)
| COAS \(-\text{ITEM 14 EXEC (*)}} \)

Upon MCC uplink of COVARIANCE MATRIX,
COVAR REINIT \(-\text{ITEM 16 EXEC}} \)

2. COAS MARKS
A6U
FLT CNTLR PWR \(-\text{ON}} \)
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 \(-\text{push}} \)

<table>
<thead>
<tr>
<th>GNC 33 REL NAV</th>
</tr>
</thead>
</table>
If X and Y RESID magnitudes \( \geq 1.0} \):
| \( \sqrt{\text{MCC}} \)
If X and Y RESID magnitudes < 1.0:
| FOR \(-\text{ITEM 25 EXEC}} \)
\( \sqrt{\text{SV UPDATE \(-\text{non-zero (within 8 sec), then}} \)
| \(-0.0 \text{ (after 8 sec more)}} \)

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/\text{AUTO/VERN(ALT)}} \)
FLT CNTLR PWR \(-\text{OFF}} \)

CRT
COAS: DES \(-\text{ITEM 25 EXEC (*)}} \)

Resume rendezvous timeline
BACKOUT/BREAKOUTS
VBAR 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 *)
   F1F – ITEM 31 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
CAUTION

Constraints for use:
Orbiter on ± 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 ±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 *)
   F1F – ITEM 31 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 ±X and ±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 ±VBAR
   If Rdot negative (closing on the target):
       THC: +Z (out) to null closing rate (Rdot ≥ 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} \text{ 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
   GNC 23 RCS
   RCS F – ITEM 1 EXEC (*)
   JET DES F2F – ITEM 35 EXEC (no *)
   F1F – ITEM 31 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 +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
   - **FLT CNTLR PWR – ON**

At TIG, THC: Trim VGOs ≤ 0.2 fps

   - **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]
   \( \sqrt{RCS \text{ SEL} – \text{ITEM 4} (*)} \)
   Set TIG to current time
   TGT PEG 7 \( \Delta \text{VX} – \text{ITEM 19} -3 \text{ EXEC} \)
   \( \Delta \text{VY} – \text{ITEM 20} +0 \text{ EXEC} \)
   \( \Delta \text{VZ} – \text{ITEM 21} +0 \text{ EXEC} \)
   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
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
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
RCS FWD – ITEM 1 EXEC (*)
JET DES F2F – ITEM 35 EXEC (no *)
F1F – ITEM 31 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 \( \leq 0.12 \text{ deg/sec per axis} \)
  APDS ring relative misalignment < 5\(^\circ\) 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
   A6U
   DAP: FREE
   SENSE: -Z
   AFT ADV 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 F1F
   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 \(-0.12 \leq \text{ROLL}, \text{PITCH}, \text{YAW RATE} \leq 0.12\)
  - APDS CIRC PROT OFF pb – push
  - √CIRCUIT PROTECT OFF lt – lt on
  - OPEN LATCHES pb – push
  - √LATCHES CLOSED lt – lt off
  - √OPEN lt – lt on

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

4. INITIAL SEPARATION SEQUENCE
Perform UNDOCKING OPERATIONS [6A], 2-6, step 3

3. COMMAND SEPARATION
Perform UNDOCKING PREP (APDS), 8-7

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

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

4. INITIAL SEPARATION SEQUENCE
Perform UNDOCKING OPERATIONS [6A], 2-6, step 3

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-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
  - √RCS FWD – ITEM 1 EXEC (*)
  - JET DES F2F – ITEM 35 EXEC (no *)
  - F1F – ITEM 31 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 INITIAL 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**
     $\sqrt{VGO Z \geq 0}$
   Do not maneuver to burn attitude
   - At TIG:
     $\sqrt{RNG > 1500 \text{ ft} (CG-CG)}$
     - **A6U**: FLT CNTLR PWR – OFF
     - **DAP ROT**: DISC/DISC/DISC
     - **F6**: FLT CNTLR PWR – ON
     - **THC**: trim VGOs $\leq 0.2$ fps
     - **FLT CNTLR PWR** – OFF
   Record Out-of-Plane Burn TIG ___ / ___ : ___ : ___
   Cont next page
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 $+2.70$ EXEC
     - If $\Delta V_Y$ from Out-of-Plane burn (step 4) was negative:
       - TV ROLL – ITEM 5 $+0$ 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 $+90$ EXEC
     - If $\Delta V_Y$ from Out-of-Plane burn (step 4) was negative:
       - TV ROLL – ITEM 5 $+270$ 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, 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
   
   If Ti Delay executed because no comm:
   
   Add 0/01:32:00 to BASE TIME for subsequent delay rev
   
   See LOSS OF COMM, 5-31

   **NOTE**
   
   Ti Delay breakout is a 1.5 fps posigrade burn
   
   at the next Ti point
   
   Perform RNDZ BREAKOUT, 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: -1:25, 4-11

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

### Preliminary

| $\Delta V_X$ | ( ) | . | ( ) |
| $\Delta V_Y$ | ( ) | . | ( ) |
| $\Delta V_Z$ | ( ) | . | ( ) |
| $\Delta V_T$ | . | . | . |

### Intermediate

| $\Delta V_X$ | ( ) | . | ( ) |
| $\Delta V_Y$ | ( ) | . | ( ) |
| $\Delta V_Z$ | ( ) | . | ( ) |
| $\Delta V_T$ | . | . | . |

### Final

| $\Delta V_X$ | ( ) | . | ( ) | ( . ) |
| $\Delta V_Y$ | ( ) | . | ( ) | ( . ) |
| $\Delta V_Z$ | ( ) | . | ( ) | ( . ) |
| $\Delta V_T$ | . | . | ( ) | ( . ) |

## Ti Onboard Solutions

### Preliminary Filter

| 1st Intermediate Filter |
| 2nd Intermediate Filter (If Req'd) |

| Final Filter |

| Prop (If Req'd) |

| Final Ground Limits |

| 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 |

   | TGT ID | -Z | -Y (STRK) | +Y |
   | +1 | +1 | +1 |
   | BODY VECT | +3 | +4 | +5 |
   | P | √+90 | √+0 | +0 |
   | Y | √+0 | √+280.6 | +90 |
   | OM | +0 | +90 | +180 |

   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):

\sqrt{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:

Recall TGT set and recompute

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.
RENDEZVOUS -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]

<table>
<thead>
<tr>
<th>CRT</th>
<th>GNC UNIV PTG</th>
</tr>
</thead>
<tbody>
<tr>
<td>TGT ID</td>
<td>+2</td>
</tr>
<tr>
<td>BODY VECT</td>
<td>+5</td>
</tr>
<tr>
<td>Burn Pad</td>
<td>Ref Posigrade</td>
</tr>
<tr>
<td>P</td>
<td>+102</td>
</tr>
<tr>
<td>Y</td>
<td>+0</td>
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MNVR TO TGT TRACK ATTITUDE [B]

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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
   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
   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
   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

DAPS A9, B9 PITCH AND YAW TO ALL

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

4. During docked operations, or undocking and separation:
   \^MCC for updates to UNDOCKING/SEP TIMELINE
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.
\(\sqrt{\text{MCC for additional procedure updates}}\)

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.
\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, 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, 5-14
When RNG = 250 ft, \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. GO for RPM if re- rendezvous capability available.

If VERSNS 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 RPM 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, 5-18 with following deltas:
      Do not trim VGO Y >>

Cont next page
3. If failure occurs after the RPM start but prior to TORVA +X inputs:
   DAP: FREE
   Maintain DAP FREE until RNG > 1000 ft (CG-CG)
   When RNG > 1000 ft and tgt in overhead field of view:
   DAP: No LO Z
   DAP: A/PRI/LVLH
   If radar not tracking:
      KU OPS Cue Card, steps 1-3 as reqd
   
\MCC for re-rendezvous plan >>

4. If failure occurs between TORVA +X inputs 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

5. If failure occurs after Vbar arrival, backout to RNG > 250 ft:
   Perform VBAR CORRIDOR BACKOUT, 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

6. If failure occurs while docked, or during undocking/separation:
   \MCC for updates to UNDOCKING/SEP TIMELINE >>
7. Perform VBAr BREAKOUT, 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  
     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 |

| 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 |

| 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) |

| 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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POST-CONTACT THRUST (PCT) REFERENCE DATA

PBI FUNCTION WHENEVER IN OPS 2:

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<th>When PCT is armed . . .</th>
<th>When PCT is active . . .</th>
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<td>Arms PCT</td>
<td>Disarms PCT</td>
<td>Disarms and Terminates PCT (^1)</td>
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<td>(PBI lit when PCT armed/active)</td>
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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
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| 12 | MC2 | 00:50:36 | 29.32 | 27.0 | -0.9 | 0 | +1.8 | |
| 13 | MC3 | 00:17:00 | 0 | 10.0 | -0.9 | 0 | +1.8 | |
| 14 | MC4 | 00:27:00 | 0 | 13.0 | 0 | 0 | +1.8 | |
| 19 | MC2 ON TIME | 00:00:00 | 0 | 27.0 | -0.9 | 0 | +1.8 | |

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| 9 | NCC | -00:58:42 | 0 | 58.7 | -48.6 | 0 | +1.2 | BASETIME = Ti TIG |
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| 11 | MC1 | 00:20:00 | 0 | 58.2 | -0.9 | 0 | +1.8 | |
| 12 | MC2 | 00:51:12 | 29.55 | 27.0 | -0.9 | 0 | +1.8 | |
| 13 | MC3 | 00:17:00 | 0 | 10.0 | -0.9 | 0 | +1.8 | |
| 14 | MC4 | 00:27:00 | 0 | 13.0 | 0 | 0 | +1.8 | |
| 19 | MC2 ON TIME | 00:00:00 | 0 | 27.0 | -0.9 | 0 | +1.8 | |

| 250 |        |        |             |                   |          |          |          |          |          |       |
| 9 | NCC | -00:59:06 | 0 | 59.1 | -48.6 | 0 | +1.2 | BASETIME = Ti TIG |
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| 11 | MC1 | 00:20:00 | 0 | 58.9 | -0.9 | 0 | +1.8 | |
| 12 | MC2 | 00:51:54 | 29.80 | 27.0 | -0.9 | 0 | +1.8 | |
| 13 | MC3 | 00:17:00 | 0 | 10.0 | -0.9 | 0 | +1.8 | |
| 14 | MC4 | 00:27:00 | 0 | 13.0 | 0 | 0 | +1.8 | |
| 19 | MC2 ON TIME | 00:00:00 | 0 | 27.0 | -0.9 | 0 | +1.8 | |

| 270 |        |        |             |                   |          |          |          |          |          |       |
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| 11 | MC1 | 00:20:00 | 0 | 59.5 | -0.9 | 0 | +1.8 | |
| 12 | MC2 | 00:52:30 | 30.03 | 27.0 | -0.9 | 0 | +1.8 | |
| 13 | MC3 | 00:17:00 | 0 | 10.0 | -0.9 | 0 | +1.8 | |
| 14 | MC4 | 00:27:00 | 0 | 13.0 | 0 | 0 | +1.8 | |
| 19 | MC2 ON TIME | 00:00:00 | 0 | 27.0 | -0.9 | 0 | +1.8 | |

| 290 |        |        |             |                   |          |          |          |          |          |       |
| 9 | NCC | -00:60:06 | 0 | 60.1 | -48.6 | 0 | +1.2 | BASETIME = Ti TIG |
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| 11 | MC1 | 00:20:00 | 0 | 60.1 | -0.9 | 0 | +1.8 | |
| 12 | MC2 | 00:53:06 | 30.25 | 27.0 | -0.9 | 0 | +1.8 | |
| 13 | MC3 | 00:17:00 | 0 | 10.0 | -0.9 | 0 | +1.8 | |
| 14 | MC4 | 00:27:00 | 0 | 13.0 | 0 | 0 | +1.8 | |
| 19 | MC2 ON TIME | 00:00:00 | 0 | 27.0 | -0.9 | 0 | +1.8 | |

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| 9 | NCC | -00:60:06 | 0 | 60.1 | -48.6 | 0 | +1.2 | BASETIME = Ti TIG |
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| 11 | MC1 | 00:20:00 | 0 | 60.1 | -0.9 | 0 | +1.8 | |
| 12 | MC2 | 00:53:06 | 30.25 | 27.0 | -0.9 | 0 | +1.8 | |
| 13 | MC3 | 00:17:00 | 0 | 10.0 | -0.9 | 0 | +1.8 | |
| 14 | MC4 | 00:27:00 | 0 | 13.0 | 0 | 0 | +1.8 | |
| 19 | MC2 ON TIME | 00:00:00 | 0 | 27.0 | -0.9 | 0 | +1.8 | |
TCS/REFLECTOR VISIBILITY DURING APPROACH FOR FLIGHT STS-133 (ISS-ULF5)

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

Refl #5 on PMA3 points out of plane

Expected TCS Refl and Range at Initial Acquisition
Refls #7, #8 at TCS max range limit of 5000-6000 ft
(An 8000 ft acquisition has been observed)

Arrays, radiators, manipulators, and other structures are not shown for clarity of the TCS reflector information

MRM1 truss may cause some blockage during first 20° of refl #3 coverage.
Refl #3 becomes less visible as Orbiter Y-LVLH position becomes more positive (into the page)
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   MDM  Card/Channel
Starboard LEDs 1 & 2  LA-1  DIO Card Slot 4 Channel 13
Starboard LEDs 3 & 4  LA-1  DIO Card Slot 4 Channel 14

LEDs Numbers:
- Starboard:
  - 1
  - 2
  - 3
  - 4
  - 1.5 in.
  - 4 red LEDs on each plug-type connector

Location wrt Orbiter Structure:
- X=572, Y=0, Z=548.6

Bottom View

Orbiter overhead windows

Side View
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<td>1583</td>
<td>918</td>
<td>558</td>
<td>84</td>
</tr>
<tr>
<td>10.5</td>
<td>1507</td>
<td>874</td>
<td>531</td>
<td>80</td>
</tr>
<tr>
<td>11</td>
<td>1438</td>
<td>834</td>
<td>507</td>
<td>76</td>
</tr>
<tr>
<td>11.5</td>
<td>1375</td>
<td>798</td>
<td>484</td>
<td>73</td>
</tr>
<tr>
<td>12</td>
<td>1318</td>
<td>764</td>
<td>464</td>
<td>70</td>
</tr>
</tbody>
</table>

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

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TCS LIMIT DATA .................................................................................................... 7-28
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
      - \( \sqrt{\text{GAM BLK STR}} \) – ON
      - \( \sqrt{\text{COLOR BAL}} \) – SUN
   2.2 For Cameras A, C, D:
      - ALC pb – press
      - AVG pb – press
      - GAM BLK STR – ON
      - \( \sqrt{\text{COLOR BAL}} \) – 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**

<table>
<thead>
<tr>
<th>CAMERA</th>
<th>ZOOM</th>
<th>OVERLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centerline</td>
<td>40.0° (Corridor)</td>
<td>Corridor</td>
</tr>
<tr>
<td></td>
<td>10.1° (full zoom)</td>
<td>Grid</td>
</tr>
</tbody>
</table>

4. **MONITOR SETUP**
   - MON 1, 2 L-DATA – on
   - C-DATA – grn
   - XHAIR – grn

5. **CAMERA SETUP – CAMERA A, D**
   - A7
   - 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/SEP**
   - 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

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:**

<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 TCS</td>
<td></td>
</tr>
</tbody>
</table>

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

WinDecom

TFL Correct per (ORB OPS FS, COMM/INST)

Telemetry Monitor

Status and Packet data not backlit yellow or red

Telemetry Tab > Stream > “STSXXX-rt gnc”

Status = OK

Packet 40 Present (may need to scroll down)

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,
\( \sqrt{\text{PCMMU cable connection to Panel O5 (port as reqd) and WinDecom PGSC}} \)
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

Cont next page
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>No.</th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Which PGSC is being used?</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Which version of RPOP (per RPOP title bar)? (On request, report the exact location of the RPOP icon)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>COM1 port (on PGSC aft)</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></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></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></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>6a.</td>
</tr>
<tr>
<td></td>
<td>b. MCIU card securely installed in PGSC?</td>
<td>6b.</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></td>
</tr>
<tr>
<td></td>
<td>a. COM1, COM2, COM3, COM4</td>
<td>7a.</td>
</tr>
<tr>
<td></td>
<td>b. DLL</td>
<td>7b.</td>
</tr>
<tr>
<td>8</td>
<td>PCMMU data to RPOP</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></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></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>10a.</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></td>
</tr>
<tr>
<td>12</td>
<td>Reserved</td>
<td></td>
</tr>
</tbody>
</table>

Cont next page
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TCS (answer for all suspect RPOP PGSCs)</strong></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Which PGSC is being used?</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>
</tr>
<tr>
<td>23</td>
<td>COM2 port</td>
</tr>
<tr>
<td>a.</td>
<td>Report associated cable label</td>
</tr>
<tr>
<td>b.</td>
<td>Cable securely connected?</td>
</tr>
<tr>
<td>c.</td>
<td>Grey box installed in proper orientation?</td>
</tr>
<tr>
<td>24</td>
<td>PDIP panel</td>
</tr>
<tr>
<td>a.</td>
<td>Report associated cable label</td>
</tr>
<tr>
<td>b.</td>
<td>Report associated PDIP port</td>
</tr>
<tr>
<td>c.</td>
<td>Cable securely connected?</td>
</tr>
<tr>
<td>25</td>
<td>Check MCIU card status</td>
</tr>
<tr>
<td>a.</td>
<td>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>
</tr>
<tr>
<td>b.</td>
<td>MCIU card securely installed in PGSC?</td>
</tr>
<tr>
<td>c.</td>
<td>Verify correct orientation of card(s), i.e., right side up</td>
</tr>
<tr>
<td>26</td>
<td>TCS OPS window</td>
</tr>
<tr>
<td>a.</td>
<td>Report Mode status (Acq, Stby, blank)</td>
</tr>
<tr>
<td>b.</td>
<td>Report Data status (Good or Bad)</td>
</tr>
<tr>
<td>c.</td>
<td>Report hardware status</td>
</tr>
<tr>
<td>d.</td>
<td>Report messages in message box</td>
</tr>
<tr>
<td>e.</td>
<td>If self-test failed, click “Self-Test” button and report status (Shutter, Z-Latch, CW laser, Pulse laser)</td>
</tr>
<tr>
<td>f.</td>
<td>If TCS CADS processing TCS data (active Range, Rdot, etc.), does the data appear stable and reasonable?</td>
</tr>
<tr>
<td>g.</td>
<td>If TCS CADS processing TCS data (active Range, Rdot, etc.), is the data being received by RPOP?</td>
</tr>
<tr>
<td>27</td>
<td>TCS C&amp;DI (menus)</td>
</tr>
<tr>
<td>a.</td>
<td>Macros &gt; report macros available (not greyed out)</td>
</tr>
<tr>
<td>b.</td>
<td>Commands &gt; report cmds available (not greyed out)</td>
</tr>
<tr>
<td>c.</td>
<td>Override &gt; report any selected items</td>
</tr>
<tr>
<td>d.</td>
<td>Config &gt; Com Port &gt; report current config</td>
</tr>
<tr>
<td>28</td>
<td>Was TCS CADS started before TCS was powered on?</td>
</tr>
<tr>
<td>29-40</td>
<td>Reserved</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Question</th>
<th>Sub-questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>41 HHL unit unresponsive?</td>
<td>a. Report power status -- switch ON, battery connected?</td>
</tr>
<tr>
<td></td>
<td>If no power, have you tried alternate batteries?</td>
</tr>
<tr>
<td></td>
<td>b. Did you adjust the display brightness?</td>
</tr>
<tr>
<td>42 HHL marks unsuccessful</td>
<td>a. Did you try “test” mode? If so, what were the results?</td>
</tr>
<tr>
<td></td>
<td>b. Have you tried taking test marks on alternate targets?</td>
</tr>
<tr>
<td>43 HHL marks successful, but no transfer to PGSC</td>
<td>a. Which PGSC is being used?</td>
</tr>
<tr>
<td></td>
<td>b. Verify cable securely connected on HHL unit</td>
</tr>
<tr>
<td></td>
<td>c. Check COM port config -- refer to question 7</td>
</tr>
<tr>
<td>44-60 Reserved</td>
<td></td>
</tr>
</tbody>
</table>

### WinDecom

<table>
<thead>
<tr>
<th>Question</th>
<th>Sub-questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>61 Which PGSC is being used?</td>
<td></td>
</tr>
<tr>
<td>62 Which version of WinDecom was launched? (WinDecom-Prime,</td>
<td></td>
</tr>
<tr>
<td>WinDecom-RMS, or WinDecom-FCMS)?</td>
<td></td>
</tr>
<tr>
<td>63 COM4 port</td>
<td>a. Report associated cable label</td>
</tr>
<tr>
<td></td>
<td>b. Cable securely connected?</td>
</tr>
<tr>
<td></td>
<td>c. Grey box installed in proper orientation?</td>
</tr>
<tr>
<td>64 Network</td>
<td>a. Network card securely installed in PGSC?</td>
</tr>
<tr>
<td></td>
<td>b. Cable securely connected?</td>
</tr>
<tr>
<td></td>
<td>c. Verify secure network cable connections between WinDecom</td>
</tr>
<tr>
<td></td>
<td>and RPOP PGSCs (and/or wireless router)</td>
</tr>
<tr>
<td></td>
<td>d. If wireless network, report wireless router status.</td>
</tr>
<tr>
<td>65 Check MCIU card status</td>
<td>a. Start &gt; Settings &gt; Control Panel &gt; Administrative Tools &gt;</td>
</tr>
<tr>
<td></td>
<td>Computer Management &gt; Device Manager &gt; Ports &gt; MCIU</td>
</tr>
<tr>
<td></td>
<td>PCMCIA Serial Ports (COM2 and/or COM4)</td>
</tr>
<tr>
<td></td>
<td>b. Verify correct orientation of card(s), i.e., right side up</td>
</tr>
<tr>
<td>66 Is WinDecom processing data</td>
<td>a. Report GNC packet status (any yellow or red backlight?)</td>
</tr>
<tr>
<td></td>
<td>b. Verify packet (PKT) 40 data is processing</td>
</tr>
<tr>
<td>67-80 Reserved</td>
<td></td>
</tr>
<tr>
<td><strong>Telemetry Server (answer for all suspect RPOP PGSCs)</strong></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>81</strong> Which PGSC is being used?</td>
<td>81.</td>
</tr>
<tr>
<td><strong>82</strong> What indicator is shown in the system tray?</td>
<td>82.</td>
</tr>
<tr>
<td>(red “stop” sign, green “go” light, etc)</td>
<td><strong>Double left click this icon to open Telemetry Server window</strong></td>
</tr>
<tr>
<td><strong>83</strong> Which version of Telemetry Server (window title bar)</td>
<td>83.</td>
</tr>
<tr>
<td><strong>84</strong> What message is being displayed? (e.g., green highlight</td>
<td>84.</td>
</tr>
<tr>
<td>“Receiving serial data from…” )</td>
<td><strong>Double left click this icon to open Telemetry Server window</strong></td>
</tr>
<tr>
<td><strong>85</strong> Report packets being processed (main TlmSrvr window)</td>
<td>85.</td>
</tr>
<tr>
<td><strong>86</strong> View &gt; Applications Using the Server -- report results</td>
<td>86.</td>
</tr>
<tr>
<td><strong>87</strong> Source &gt; report current config</td>
<td>87.</td>
</tr>
<tr>
<td>(Serial Windecom; Networked Windecom; Networked ISP)</td>
<td><strong>Double left click this icon to open Telemetry Server window</strong></td>
</tr>
<tr>
<td><strong>88</strong> If Serial Windecom:</td>
<td>88a.</td>
</tr>
<tr>
<td>a. Port -- report current config (COM1 thru COM7)</td>
<td><strong>Double left click this icon to open Telemetry Server window</strong></td>
</tr>
<tr>
<td>b. Baud -- report current config (9600, 19200, 38400)</td>
<td>88b.</td>
</tr>
<tr>
<td><strong>89</strong> Report any other messages</td>
<td>89.</td>
</tr>
<tr>
<td><strong>90</strong> Did you attempt a “File &gt; Reset Server”?</td>
<td>90.</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

√Night Scope – OFF
√Night Scope Lens Cap On

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
   
   \[ \text{[CNTL][F4]} \quad \text{HHL} \]
   
   \( \sqrt{\text{Appropriate aimpoint configuration per table}} \)

<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>As appropriate</td>
<td></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 \text{Rdot} window
   Click [sources] button to select/deselect additional data sources
   NOTE: Nominal configuration is to display “HHL FLT” (RNDZ) or “HHL/dt” (SEP) and “HHL Raw”

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 KEYSTROKE 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 \text{Rdot} or \text{THC-to-Go} windows or associated sub-windows

5. To exit RPOP program – [SHIFT][F10]
* Configure TCS reflectors
  * [CNTL]/[F10]  RPOP Configuration
  * Select [TCS/Refl…] 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
   - L12 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
   
   TCS OPS
   
   - 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: TCS C&DI
   - If Z Latch: Transit
   - 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><strong>NOMINAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1: SV</td>
<td>1: TCS NAV</td>
<td></td>
<td></td>
<td>1: TCS NAV</td>
<td>1: TCS raw</td>
</tr>
<tr>
<td>2: HHL FLT</td>
<td>2: HHL FLT</td>
<td></td>
<td></td>
<td>2: HHL/rdt</td>
<td>2: Rng ruler</td>
</tr>
<tr>
<td><strong>RADAR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1: HHL/rdt</td>
<td>1: TCS NAV</td>
<td></td>
<td></td>
<td>1: TCS raw</td>
<td>2: Rng ruler</td>
</tr>
<tr>
<td>2: SubAng</td>
<td>2: HHL/rdt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HHL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1: SV</td>
<td>1: TCS NAV</td>
<td></td>
<td></td>
<td>1: TCS raw</td>
<td>2: Rng ruler</td>
</tr>
<tr>
<td>2: SubAng</td>
<td>2: Raw radar and SubAng</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TCS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1: SV</td>
<td>1: HHL FLT and raw radar Rdot</td>
<td></td>
<td></td>
<td>1: Rng ruler</td>
<td></td>
</tr>
<tr>
<td>2: HHL FLT</td>
<td>2: SubAng</td>
<td></td>
<td></td>
<td>2: HHL/rdt</td>
<td></td>
</tr>
<tr>
<td><strong>PCMMU</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1: G33 FLTR</td>
<td>1: HHL/rdt</td>
<td></td>
<td></td>
<td>1: Rng ruler</td>
<td></td>
</tr>
<tr>
<td>2: HHL/rdt or TCS-Pulse (Generic)</td>
<td>2: TCS-Pulse (Generic)</td>
<td></td>
<td></td>
<td>2: HHL/rdt</td>
<td></td>
</tr>
<tr>
<td><strong>PGSC (No RPOP, No TCS)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1: SV raw radar</td>
<td>1: HHL raw: short pull for mg, long pull for Rdot</td>
<td></td>
<td></td>
<td>1: Rng ruler</td>
<td></td>
</tr>
<tr>
<td>2: HHL raw: raw range, Rdot vs ΔR/Δt cue card for Rdot</td>
<td>2: SubAng: Rdot vs ΔR/Δt cue card for Rdot</td>
<td></td>
<td></td>
<td>(table on overlay)</td>
<td></td>
</tr>
</tbody>
</table>

Nominal notes:
1. If no TCS lock by 1200 ft, start SubAng ops to backup HHL/rdt inside 1000 ft
2. RPM: Immediately following RPM use raw TCS and raw radar for Rdot until TCS NAV converges
3. Once the Radar rdot data is unusable use HHL DT as backup to TCS

Radar fail notes:
4. State vector data suspect
5. Radar rdot is used in the HHL FLT. HHL FLT should not be used in a radar fail case

HHL fail notes:
6. Radar range 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 range data can become too noisy to use at ranges as great as 1000 ft

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

PCMMU fail notes:
10. RPOP state data, TCS NAV, and HHL FLT are not usable without PCMMU data
11. 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
12. 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
13. Begin gradual transition to HHL/rdt and TCS raw at ~1500 ft
14. 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 9 (above)
RNDZ TOOLS REFERENCE DATA

RPOP FUNCTION KEY SUMMARY

RPOP TRAJECTORY DATA KEYS (Columns F1 → F4)

<table>
<thead>
<tr>
<th>[F1→F4]</th>
<th>PRIME KEY</th>
</tr>
</thead>
<tbody>
<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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>[SHIFT][F1→F4]</th>
<th>SHOW/HIDE KEY</th>
</tr>
</thead>
<tbody>
<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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>[CTRL][F1→F4]</th>
<th>DATA KEY</th>
</tr>
</thead>
<tbody>
<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)

[F5] (Rdot)  RDOT WINDOW
Toggles display of Rdot Window

[SHIFT]/[F5] (Orb Att)  ORBITER ATTITUDE
Update orbiter attitude and attitude rate

[CTRL]/[F5] (Guid)  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] (Sub Ang)  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] (Tgt Att)  TARGET ATTITUDE
Update Target attitude and attitude rate

[CTRL]/[F6] (PCMMMU)  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)  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] (Ovrlay)  OVERLAY
Cycle through displays of overlays

[F8] (Tgt/Orb)  REFERENCE FRAME
Toggle display between Tgt-Centered LVLH plot and Orb-Centered LVLH plot

[SHIFT]/[F8] (Low Z)  LO Z
Toggle jet-select between No Low Z and Low Z for making THC “What If” inputs. Displays Low Z

[CTRL]/[F8] (POR)  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
RPOP GENERAL FUNCTION KEYS (Columns F5 → F12)

(THC Clr) Clear THC “What if” inputs from the Prime Trajectory

[SHIFT]/[F9] TRAJECTORY CLEAR
(TrajClr) 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] RPOP CONFIGURATION
(Config) 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

Cont next page
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

<table>
<thead>
<tr>
<th>Keystroke Combination</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>[CTRL]/[←] or l</td>
<td>Move Vertical axis left</td>
</tr>
<tr>
<td>[CTRL]/[→] or r</td>
<td>Move Vertical axis right</td>
</tr>
<tr>
<td>[CTRL]/[↑] or u</td>
<td>Move Horizontal axis up</td>
</tr>
<tr>
<td>[CTRL]/[↓] or d</td>
<td>Move Horizontal axis down</td>
</tr>
<tr>
<td>[CTRL]/[PGUP]</td>
<td>Zoom IN on Trajectory Display</td>
</tr>
<tr>
<td>[CTRL]/[X]/[PGUP]</td>
<td>Zoom IN on X axis only</td>
</tr>
<tr>
<td>[CTRL]/[Y]/[PGUP]</td>
<td>Zoom IN on Y axis only</td>
</tr>
<tr>
<td>[CTRL]/[Z]/[PGUP]</td>
<td>Zoom IN on Z axis only</td>
</tr>
<tr>
<td>[CTRL]/[PGDN]</td>
<td>Zoom OUT on Trajectory Display</td>
</tr>
<tr>
<td>[CTRL]/[X]/[PGDN]</td>
<td>Zoom OUT on X axis only</td>
</tr>
<tr>
<td>[CTRL]/[Y]/[PGDN]</td>
<td>Zoom OUT on Y axis only</td>
</tr>
<tr>
<td>[CTRL]/[Z]/[PGDN]</td>
<td>Zoom OUT on Z axis only</td>
</tr>
</tbody>
</table>

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>Keystroke Combination</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z IN</td>
<td>[SHIFT]/[→]</td>
</tr>
<tr>
<td>Z OUT</td>
<td>[SHIFT]/[←]</td>
</tr>
<tr>
<td>X UP</td>
<td>[SHIFT]/[↑]</td>
</tr>
<tr>
<td>X DOWN</td>
<td>[SHIFT]/[↓]</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</th>
<th>LOW ALERT</th>
<th>HIGH ALERT</th>
<th>AUTOSAFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(degC) CW Laser</td>
<td>-40.0</td>
<td>45.0</td>
<td>50.0</td>
</tr>
<tr>
<td>APD</td>
<td>-40.0</td>
<td>65.0</td>
<td>70.0</td>
</tr>
<tr>
<td>CPU</td>
<td>-40.0</td>
<td>80.0</td>
<td>85.0</td>
</tr>
<tr>
<td>DC Power</td>
<td>-40.0</td>
<td>80.0</td>
<td>85.0</td>
</tr>
<tr>
<td>Galvos</td>
<td>-40.0</td>
<td>80.0</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>
</tr>
</tbody>
</table>
APDS NOMINAL

DOCKING MECHANISM INITIALIZATION ................................................................. 8-4
POWERUP ........................................................................................................... 8-5
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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
     \sqrt{PMA 2/3 GRP 1,GRP 2 HOOKS (eight)} – op
     \sqrt{SYS PWR MN A,MN B (two)} – ctr
     \sqrt{SYS 1,SYS 2 tb (two)} – OFF
     \sqrt{PYRO PWR MN A,MN C (two)} – OFF
     \sqrt{PMA 2/3 HOOKS SYS A,SYS B (two)} – ctr
     \sqrt{GRP 1,2 tb (two)} – bp
     \sqrt{PSU PWR MN A,MN B (two)} – OFF
     \sqrt{LT TRUSS,VEST (four)} – OFF

A7L  2. \sqrt{CONTROL PANEL POWER A,B,C (three)} – OFF
     \sqrt{HEATERS/DCU POWER (three)} – OFF
     \sqrt{APDS POWER A_{DS},B_{DS},C_{DS} (three)} – OFF
     \sqrt{A_{DS},B_{DS},C_{DS} It (three)} – It off
     \sqrt{STATUS lt (eighteen)} – It off
     \sqrt{PYROS A_{P},B_{P},C_{P} (three)} – OFF
     \sqrt{A_{P},B_{P},C_{P} It (three)} – It off
     \sqrt{PYRO CIRCUIT PROTECT OFF lt} – It off

A6L  3. SYS PWR MN A,MN B (two) – ON (hold 5 sec)
     \sqrt{SYS 1,SYS 2 tb (two)} – ON
     \sqrt{VEST DEP VLV SYS 1,SYS 2 VENT (two)} – ctr (tb-CL)
     \sqrt{VEST DEP VLV SYS 1,SYS 2 VENT It (two)} – It off
     \sqrt{VEST DEP VLV SYS 1,SYS 2 VENT tb (two)} – bp
     \sqrt{PMA 2/3 GRP 1,GRP 2 HOOKS (eight)} – op
     \sqrt{SYS PWR MN A,MN B (two)} – OFF
     \sqrt{LT TRUSS,VEST (four)} – OFF

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

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

### SM 167 DOCKING STATUS

**A7L**

1. **STATUS** lt (eighteen) – It off
2. APDS POWER $A_{DS}, B_{DS}, C_{DS}$ (three) – OFF
   - $A_{DS}, B_{DS}, C_{DS}$ lt (three) – It off
3. CONTROL PANEL POWER $A, B, C$ (three) – OFF
   - CRT
     - CNTL PNL PWR $A, B, C$ (three) – blank
4. HEATERS/DCU POWER (three) – OFF
   - CRT
     - HTR/DCU PWR (three) – blank
5. PSU PWR MN $A, MN B$ (two) – OFF
6. If post-undocking:
   - VEST DEP VLV SYS 1(SYS 2) VENT – CL (tb-CL)
   - ESS 1BC DEP SYS 1 VENT ISOL – op
   - W2CA DEP SYS 2 VENT ISOL – op
   - MNA EXT ARLK HTR VEST Z1/2/3 – op
   - MNB EXT ARLK HTR VEST Z1/2/3 – cl
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

0:00 3. RING OUT pb – push
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/SPLIT):
A7L  * FIXER OFF pb – push *
  * FIXERS OFF lt – lt on *
  * RING OUT pb – push *
CRT  * When PETAL POS BASE (three) = 76 ± 3%: *
A7L  * POWER OFF pb – push *
  * ON pb – push *
  * FIXERS OFF lt – lt off *
  * APDS CIRC PROT OFF pb – push *
  * CIRCUIT PROTECT OFF lt – lt on *
  * RING OUT pb – push *
  * After 1 sec: *
CRT  * RING DRV CMD – OFF *
  *
A7L  * If RING FORWARD POSITION lt failed on (ring stops after *
CRT  * 10 sec):
A7L  * 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 – lt on: *
  * RING OUT pb – push *

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:
* A7L 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:
* A7L 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
* 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 on
CLUTCH – LOCK/blank

A7L If RING FINAL POSITION lt failed on (ring stops after
10 sec): *
RING IN pb – push *
3:40 CRT When PETAL POS BASE = 5 ± 3% and not decr:
Wait 10 sec, then:
A7L POWER OFF pb – push *
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
AIRLOCK FAN ACT AND ODS VOLUME PREP

MO13Q  1. ARLK FAN A – OFF

MIDDK  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. ARLK 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. ARLK 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. √Hatch ΔP < 0.2 psid

4. Open Hatch per decal

5. Equal vlv (two) – OFF, reinstall caps

MO13Q

6. AIRLK 2 – ON/OFF

7. ARLK FAN A(B) – OFF

TNL EXT MIDDK

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

AW18A

9. As required, LTG FLOOD 1(3,4) – ON

EXT A/L

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

11. √Airflow at top of external airlock halo

12. Go to P/TV02 DOCK, DEACTIVATION, step 2 (PHOTO/TV, SCENES)
AIRLOCK PREP FOR INGRESS – AIRLOCK FAN ACTIVE

Inner Hatch
1. Equal vlv caps (two) – remove
2. Equal vlv (two) – NORM
3. \( \sqrt{\text{Hatch}} \) \( \Delta P < 0.2 \text{ psid} \)
4. Open Hatch per decal
5. Equal vlv (two) – OFF, reinstall caps

MO13Q
6. AIRLK 2 – ON/OFF
7. AIRLK FAN A – OFF

TNL EXT MIDDK
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

MO13Q
9. AIRLK FAN A – ON

AW18A
10. As required, LTG FLOOD 1(3,4) – ON

EXT A/L
11. Unstrap Centerline Camera diffuser flex duct from camera bracket
    Stow duct along Stbd top of EXT A/L wall (in straps)
12. \( \sqrt{\text{Airflow at top of external airlock halo}} \)
13. Go to P/TV02 DOCK, DEACTIVATION, step 2 (PHOTO/TV, SCENES)
MIDDECK DUCT CONFIG

NOTE
Minimize bends in Middeck duct to provide maximum airflow

INITIAL CONFIG
MIDDK 1. Disconnect Bypass duct from Aft Middeck Floor Fitting. Remove cap from Airlock Fan outlet and install on Aft Middeck Floor Fitting. Attach Bypass duct to Airlock Fan outlet

2. Unstow Middeck duct from Middeck Floor Stbd 1 (Bag C). Connect Middeck duct to Airlock Fan inlet

3. Configure Middeck duct across the Inner hatch, up the Aft Starboard wall in the ditch, and forward across the Middeck ceiling towards the Middeck forward lockers

4. Verify the Middeck duct inlet screen is placed forward of the trampoline, aft of the Escape Pole, and between the two sets of 5 MLE bags on the Middeck ceiling. Secure Middeck duct using cable ties as reqd

5. Remove mylar sleeve/tape from outer screen of Fwd Middeck Floor Fitting

MO13Q 6. AIRLK FAN A – ON

MIDDK Ext A/L 7. Airflow at Fwd Middeck Floor Fitting and top of external airlock halo

8. Record Middeck duct installation using D2Xs digital camera:
   Lens – 12-24 mm, zoom to 12 mm
   Set camera to nominal in-cabin setup
   If required, perform SETUP, D2Xs Program
   In Cabin (CUE CARD, D2Xs SETUP), then:
   Record photo(s) showing location of Middeck duct and relation to surroundings
APDS OFF-NOMINAL

POWER FAILED OFF (STATUS LTS OFF) ................................................................. 8-16
DAMPING FAILED ON .......................................................................................... 8-17
CAPTURE LT FAILED ON ....................................................................................... 8-17
FIXERS FAILED ON ............................................................................................... 8-18
  OFF LT FAILED ON .......................................................................................... 8-20
  OFF .................................................................................................................. 8-20
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  OPEN .............................................................................................................. 8-40
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:
   \( ^\text{\textbackslash MCC} \) >>
   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**
   \( ^\text{\textbackslash CIRCUIT PROTECT OFF} \) lt – lt on
   OPEN LATCHES pb – push
   \( ^\text{\textbackslash LATCHES CLOSED} \) 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
   \( ^\text{\textbackslash CIRCUIT PROTECT OFF} \) 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>A6L</td>
</tr>
<tr>
<td>1. PSU PWR MN A,MN B (two) – OFF</td>
</tr>
<tr>
<td>CRT</td>
</tr>
<tr>
<td>If DAMPING – ON (TLM failure only):</td>
</tr>
<tr>
<td>A6L</td>
</tr>
<tr>
<td>PSU PWR MN A,MN B (two) – ON</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Continue approach or DOCKING SEQUENCE (Cue Card), as reqd &gt;&gt;</td>
</tr>
</tbody>
</table>

| 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 >> |

| CRT                  |
| 2. PSU PWR MN A – ON |
| A6L                   |
| PSU PWR MN A – OFF |
| MN B – ON           |

| CRT                  |
| If DAMPING – ON:     |
| A6L                   |
| PSU PWR MN A, MN B (two) – OFF |
| 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</td>
</tr>
<tr>
<td>If DAMPING – OFF:</td>
</tr>
<tr>
<td>Continue Approach</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>If DAMPING – ON:</td>
</tr>
<tr>
<td>A6L</td>
</tr>
<tr>
<td>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

SM 167 DOCKING STATUS

A7L 1. POWER OFF pb – push
CRT If RING FIXERS – ON:
A7L POWER ON pb – push
Continue Approach or DOCKING SEQUENCE (Cue Card),
as reqd >>

2. POWER ON pb – push
APDS POWER A_Ds – OFF
CRT If RING FIXERS – ON:
A7L APDS POWER A_Ds – ON
B_Ds – OFF
CRT If RING FIXERS – OFF:
Pre-Contact:
Continue Approach
Post-Capture, continue in DOCKING SEQUENCE (Cue Card),
as reqd, with the following change:
After DOCKING SEQUENCE (Cue Card), step 16:
A7L APDS POWER A_Ds (B_Ds) – ON >>

3. APDS POWER B_Ds – ON
A6L PSU PWR MN A,MN B (two) – OFF
If post-contact:
\sqrt{MCC} for subsequent steps
Continue Approach
Post-capture wait 7 seconds, then:
A7L APDS POWER A_Ds,B_Ds,C_Ds (three) – OFF
A6L PSU PWR MN A,MN B (two) – ON
CRT \sqrt{DAMPING} – ON

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
   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 A_{DS},B_{DS},C_{DS} (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
   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 A_{DS},B_{DS},C_{DS} (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:

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

**A7L** 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
   \[\text{CIRCUIT PROTECT OFF lt – lt on}\]
   RING OUT pb – push

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

**A7L**
   POWER OFF pb – push
   Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F) to drive slip clutch to SLIP

---

**FIXERS OFF LT FAILED OFF**

**SM 167 DOCKING STATUS**

**A7L** 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 req’d >>

**CRT** 2. If not CLUTCH – LOCK/blank

**A6L** PSU PWR MN A,MN B (two) – OFF

**A7L** RING IN pb – push
   POWER ON pb – push

0:00 **A6L** PSU PWR MN A,MN B (two) – ON

0:05 **CRT** \[\text{CLUTCH – LOCK/blank}\]

**A6L** 3. 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

0:00 **A6L** PSU PWR MN A,MN B (two) – ON (ring will begin to drive in this step)

**CRT** PETAL POS BASE (three) – decr

0:05 **A7L** POWER ON pb – push

**CRT** RING DRV CMD – OFF

**A6L** 4. PSU PWR MN A,MN B (two) – OFF

**A7L** APDS CIRC PROT OFF pb – push
   CIRCUIT PROTECT OFF lt – lt on

0:00 **A6L** PSU PWR MN A,MN B (two) – ON (ring will begin to drive in this step)

**CRT** PETAL POS BASE (three) – incr

0:05 **A7L** POWER ON pb – push

**CRT** RING DRV CMD – OFF

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>V CIRCUIT PROTECT OFF lt – lt on</td>
</tr>
<tr>
<td>FIXER OFF pb – push</td>
</tr>
<tr>
<td>V FIXERS OFF lt – lt on</td>
</tr>
<tr>
<td>2. RING OUT pb – push</td>
</tr>
</tbody>
</table>

CRT If PETAL POS BASE (three) incr:
A7L 3. POWER ON pb – push
✓ MCC

CRT If PETAL POS BASE (three) not incr:
A7L If not CLUTCH – LOCK/blank:

3. If PETAL POS BASE (three) not incr:
   If RING DRV CMD – ON:
     POWER OFF pb – push
     ON pb – push
     Go to CLUTCH NOT ‘LOCK’ >>

CRT If RING DRV CMD – OFF:
Go to RING DRV CMD OFF

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>
</tbody>
</table>

2. APDS POWER A DS – OFF
RING IN pb – push

CRT If RING DRV CMD – OFF:
A7L APDS POWER A DS – ON
C DS – OFF
RING IN pb – push

CRT If RING DRV CMD – OFF:
Go to step 3

A7L POWER ON pb – push
Continue in DOCKING SEQUENCE (Cue Card) through step 16, then:
APDS POWER A DS (C DS) – ON
OPEN LATCHES pb – push
After 5 sec:
V LATCHES OPEN lt – lt on
APDS POWER A DS (C DS) – OFF
Go to DOCKING SEQUENCE (Cue Card), step 18 >>

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 >>

4. Go to FAILED CAPTURE (VBAR APPROACH, Cue Card) to undock
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

A7L  POWER ON pb – push

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

A7L  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]

CRT  \ 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

A6L  *   When PETAL POS BASE (three) not changing for 30 sec:

CRT  *   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  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 A_{DS} – OFF
   If HOOKS 1(2) OPEN lt – lt off:
   Go to nominal UNDOCKING OPERATIONS per nominal mission timeline with APDS POWER A_{DS} – 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

<table>
<thead>
<tr>
<th>SM 167 DOCKING STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRT 1. If no hook motion when commanded:</td>
</tr>
<tr>
<td>A7L APDS POWER A₀₅ – OFF</td>
</tr>
<tr>
<td>CLOSE HOOKS pb – push</td>
</tr>
<tr>
<td>CRT If no hook motion after 10 sec:</td>
</tr>
<tr>
<td>A7L APDS POWER A₀₅ – ON</td>
</tr>
<tr>
<td>B₀₅ – OFF</td>
</tr>
<tr>
<td>CLOSE HOOKS pb – push</td>
</tr>
<tr>
<td>CRT If Hook Pos increasing after 10 sec:</td>
</tr>
<tr>
<td>Continue in DOCKING SEQUENCE (Cue Card) with the following change:</td>
</tr>
<tr>
<td>After step 16:</td>
</tr>
<tr>
<td>A7L APDS POWER A₀₅ (B₀₅) – ON &gt;&gt;</td>
</tr>
</tbody>
</table>

2. APDS POWER A₀₅ (B₀₅) – ON
   POWER OFF pb – push
   ON pb – push

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, 8-38, to secure interface with 12 hooks >>

4. If neither hook gang closed:
   \MCC for IFM capability
   Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F) and PMA 2/3 HOOKS CLOSE, 8-38, as reqd, to secure interface with 12 hooks >>

5. If no IFM capability or time does not permit IFM:
   APDS CIRC PROT OFF pb – push
   CIRCUIT PROTECT OFF lt – lt on
   OPEN HOOKS pb – push
   CRT HK₁,HK₂ POS (two) – decr
   A7L HOOKS 1,HOOKS 2 OPEN lt (two) – lt on
   0:00 RING OUT pb – push
   CRT PETAL POS BASE (three) – incr
   3:40 A7L 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 $A_{DS}$ – OFF
     - If READY TO HOOK lt – lt on:
       - APDS POWER $A_{DS}$ – ON
         - B$_{DS}$ – OFF
     - If READY TO HOOK lt – lt off:
       - If HOOKS 1(2) OPEN lt – lt off:
         - APDS CIRC PROT OFF pb – push
         - CIRCUIT PROTECT OFF lt – lt on
         - OPEN HOOKS pb – push
         - L 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:
             - APDS POWER $A_{DS}(B_{DS})$ – ON

2. APDS POWER $B_{DS}$ – ON
   - Continue in DOCKING SEQUENCE (Cue Card), as reqd, with the following
     changes:
     - Replace step 4 with:
       - CRT When PETAL POS BASE (three) not changing for 30 sec:
         - A7L FIXER OFF pb – push
         - √FIXER OFF lt – lt on
       - A6L PSU PWR MN A, MN B – OFF
       - A7L APDS CIRC PROT OFF pb – push
         - CIRCUIT PROTECT OFF lt – lt on
         - RING IN pb – push
         - OPEN HOOKS pb – push
       - A6L PSU PWR MN A, MN B – ON
         - Wait 5 seconds, then:
       - A7L POWER ON pb – push
   - In step 8 replace RING IN pb – push with:
     - A7L APDS CIRC PROT OFF pb – push
       - CIRCUIT PROTECT OFF lt – lt on
     - 0:00 RING IN pb – push, then immediately:
       - OPEN HOOKS pb – push
     - CRT HK1(2) POS decreasing to 5%
   - At the beginning of step 10 add:
     - A7L CLOSE HOOKS pb – push
HOOKS 1(2) CLOSED LT FAILED ON

A7L

1. APDS POWER $A_{DS}$ – OFF

2. If HOOKS 1(2) CLOSED lt – lt off:
   
   3. If Pre-Contact:
      APDS POWER $A_{DS}$ – ON
      Continue Approach

   4. Post-Capture, continue in DOCKING SEQUENCE (Cue Card). If affected hooks do not close in step 10:
      APDS POWER $A_{DS}$ – OFF
      CLOSE HOOKS pb – push

   5. Continue in DOCKING SEQUENCE (Cue Card) with the following change:
      After step 13:
      APDS POWER $A_{DS}$ – ON >>

6. If HOOKS 1(2) CLOSED lt – lt on:
   APDS POWER $A_{DS}$ – 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**  
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:

---

**CAUTION**

Associated capture latch cannot be driven open, resulting in inability to separate interfaces once the structural interfaces are within 3 inches of each other

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/REMate

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, 5-23

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  9. RING IN pb – push
      CRT  \ DRV CMD – ON [PETAL POS BASE (three) - decr]
      \ CLUTCH – LOCK/blank

3:15  \ READY TO HOOK lt – lt on
0:00  \ HOOKS 1,HOOKS 2 OPEN lt (two) – lt off
≤1:30 \ INTERF SEALED lt – lt on
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  \ DRV CMD – OFF

A7L  13. POWER OFF pb – push
      \ STATUS lt (eighteen) – lt off

14. Perform DOCKING MECHANISM POWERDOWN, 8-6, if reqd, then:

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, 8-33.

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 It – It off
   √CLOSED It – It on

4. APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF It – It on
   FIXER OFF pb – push
   √FIXERS OFF It – It on
   RING OUT pb – push
   √FINAL POSITION It – It off

5. When CAPTURE It – It on:
   POWER OFF pb – push
   ON pb – push
   √CAPTURE It – It off

Cont next page
0:00  6. RING IN pb – push
      POWER ON pb – push
      \sqrt{RING FINAL POSITION} lt – lt off
  CRT  \sqrt{DRV CMD} – OFF
A7L  \sqrt{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
      \sqrt{CIRCUIT PROTECT OFF} lt – lt on
      OPEN HOOKS pb – push
A7L  8. When good HOOKS 1(2) OPEN lt on
      and jammed HK2(1) POS not decr:
      POWER OFF pb – push
      ON pb – push

DISCHARGE ACTIVE HOOK PYROS
A6L  9. PYRO PWR MN A,MN C (two) – ON
A7L  10. PYROS A_P,B_P,C_P (three) – ON
      \sqrt{A_P,B_P,C_P} lt (three) – lt on
      PYRO CIRC PROT OFF pb – push
      \sqrt{CIRCUIT PROTECT OFF} lt – lt on
A6L  11. PYRO PWR MN A,MN C (two) – OFF

EXTEND RING TO INITIAL POSITION FOR INTERFACE SEPARATION
A7L  12. APDS CIRC PROT OFF pb – push
      \sqrt{CIRCUIT PROTECT OFF} lt – lt on
      RING OUT pb – push
      \sqrt{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  14. PSU PWR MN A,MN B (two) – OFF
A7L  15. RING IN pb – push
      \sqrt{APDS POWER} A_{DS},B_{DS},C_{DS} (three) – OFF
      \sqrt{ON}
A6L  16. PSU PWR MN A,MN B (two) – ON
  CRT  When PETAL POS BASE (three) = ~6% and not decr:
A7L  17. POWER ON pb – push

Cont next page
14. A6L  PYRO PWR MN A,MN C (two) – ON

15. A7L  PYROS A_p,B_p,C_p (three) – ON
       \[\sqrt{A_p,B_p,C_p}\] lt (three) – lt on
       PYRO CIRC PROT OFF pb – push
       \[\sqrt{CIRCUIT\ PROTECT\ OFF}\] lt – lt on

16. PAS HOOKS FIRING pb – push

17. A6L  PYRO PWR MN A,MN C (two) – OFF

18. A7L  REATTEMPT EXTENDING RING TO INITIAL POSITION FOR INTERFACE
        SEPARATION

19. 0:00 A7L  APDS CIRCUIT PROTECT OFF lt – lt on
       RING OUT pb – push
       \[\sqrt{INTERF\ SEALED}\] lt – lt off

20. CRT  If interface separates [PETAL POS BASE (three) incr after 20 sec]:
        Go to step 19

21. A7L  RECONFIGURE AND PREPARE FOR 96 BOLT EVA

22. 3:20 A7L  POWER ON pb – push
       RING IN pb – push

23. 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) >>

24. FINAL PREPARATION FOR VEHICLE SEPARATION

25. ~3:20 CRT  RING INITIAL POSITION lt – lt on
       \[\sqrt{DRV\ CMD}\] OFF
       \[\sqrt{PETAL\ POS\ BASE\ (three)}\] = 76 ± 3%

26. 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

<table>
<thead>
<tr>
<th>SM 167 DOCKING STATUS</th>
</tr>
</thead>
</table>

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
   ✓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 lt 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 It – It on
0:00
8. OPEN HOOKS pb – push
   √HOOKS 1,HOOKS 2 CLOSED lt (two) – It off
   CRT
   √HK1,HK2 POS (two) < 92% and decr
2:20 A7L 9. √HOOKS 1,HOOKS 2 OPEN lt (two) – It on

ATTEMPT TO EXTEND RING TO INITIAL POSITION FOR INTERFACE
SEPARATION
0:00 A7L 10. RING OUT pb – push
   √INTERF SEALED lt – It 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_DS,B_DS,C_DS (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_p,B_p,C_p (three) – ON
   √A_p,B_p,C_p lt (three) – It on
   PYRO CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – It on

13. PAS HOOKS FIRING pb – push

14. PYRO CIRC PROT ON pb – push
   √CIRCUIT PROTECT OFF lt – It off
   PYROS A_p,B_p,C_p (three) – OFF
   √A_p,B_p,C_p lt (three) – It 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 – It on
0:00
   RING OUT pb – push
   √INTERF SEALED lt – It 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_D, B_D, C_D (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_P, B_P, C_P (three) – ON
\sqrt{A_P, B_P, C_P} lt (three) – lt on
PYRO CIRC PROT OFF pb – push
\sqrt{CIRCUIT PROTECT OFF} lt – lt on

18. ACT HOOKS FIRING pb – push

19. PYRO CIRC PROT ON pb – push
\sqrt{CIRCUIT PROTECT OFF} lt – lt off
PYROS A_P, B_P, C_P (three) – OFF
\sqrt{A_P, B_P, C_P} lt (three) – lt off
A6L PYRO PWR MN A,MN C (two) – OFF

REATTEMPT EXTENDING RING TO INITIAL POSITION FOR INTERFACE
SEPARATION

A7L 20. \sqrt{APDS CIRCUIT PROTECT OFF} lt – lt on
0:00 RING OUT pb – push
\sqrt{INTERF SEALED} lt – lt 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. \sqrt{RING INITIAL POSITION} lt – lt on
CRT \sqrt{DRV CMD} – OFF
\sqrt{PETAL POS BASE (three)} = 76 \pm 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

A7L 1. If LATCHES OPEN It – lt on:

0:00 CLOSE LATCHES pb – push
\LATCHES OPEN It – lt off

0:05 \CLOSED It – lt on

2. \APDS CIRCUIT PROTECT OFF It – lt on

3. FIXER OFF pb – push

0:00 RING OUT pb – push

CRT \PETAL POS BASE (three) – incr

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

CRT * When PETAL POS BASE (three) = 98 ± 2%:

A7L *
* 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 5. RING IN pb – push

CRT \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

1:15 *
* \INITIAL POSITION lt – lt on (for ~16 sec), then lt off *

4:50 CRT *
* 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 CIRCUIT PROTECT 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 *
  * When PETAL POS BASE (three) = 76 ± 3%: *
    * POWER OFF pb – push *
    * POWER ON pb – push *
    * √FIXERS OFF lt – lt off *
    * APDS CIRC PROT OFF pb – push *
    * √CIRCUIT PROTECT OFF lt – lt on *
    * RING OUT pb – push *
    * After 1 sec:
      * √RING DRV CMD – OFF *

CRT

A7L

* 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: *

A7L

* √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: *

A7L

* √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. ODS CONN X3,X4 (two) – ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>A6L</td>
<td>2. cb PMA 2/3 GRP 1,2 HOOKS (eight) – op</td>
</tr>
<tr>
<td></td>
<td>√PMA 2/3 HOOKS SYS A,SYS B (two) – ctr</td>
</tr>
<tr>
<td></td>
<td>√GRP 1 tb – bp</td>
</tr>
<tr>
<td></td>
<td>√GRP 2 tb – bp</td>
</tr>
</tbody>
</table>

TO CLOSE HOOKS 1, PERFORM STEPS 3 THRU 6

| CRT  | 3. cb PMA 2/3 GRP 1 HOOKS SYS A OP,CL (two) – cl |
|      | cb PMA 2/3 GRP 1 HOOKS SYS B OP,CL (two) – cl |
|      | √PMA 2/3 HOOKS GRP 1 tb – OP |
|      | √HK1 IND OP – 1,2 |
|      | √IND CL – blank |
|      | √HK CLS 1/3/5, 7/9/11 (two) – blank |

* If either IND CL present, hooks may operate single motor. If both IND CL present, hooks may not drive: *

| CRT  | 4. PMA 2/3 HOOKS SYS A,SYS B (two) – CL |
|      | √GRP 1 tb – bp |
|      | √HK1 CMD CL – 1,2 |
|      | √IND OP – blank |
| 0:00 | A6L 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 |
| 2:20 | A6L 6. 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 |

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
   * motor. 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): *
A6L
* 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, *
* 8-33 *

5. 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 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, *
* 8-33 *

9. PMA 2/3 HOOKS SYSA, SYS B (two) – ctr

   cb PMA 2/3 GRP 2 HOOKS SYS A OP, CL (two) – op
   B OP, CL (two) – op
## APDS FAILURE/IMPACT MATRIX

<table>
<thead>
<tr>
<th>APDS Status</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></td>
<td>Failed OFF (m)</td>
<td>No RING OUT, OPEN LATCHES, OPEN HOOKS, or UNDOCKING pb capability</td>
<td></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 (s)</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>
<tr>
<td>APDS Status I</td>
<td>APDS FAILURE</td>
<td>IMPACT</td>
<td>OFF NOMINAL PROCEDURE (IF APPLICABLE)</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------</td>
<td>--------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>UNDOCK COMPLET</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>Starred 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></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>READY TO HOOK LT FAILED ON</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>Manual CLOSE HOOKS pb command required to drive hooks closed per starred block on DOCKING SEQUENCE (Cue Card)</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><strong>PROTECT OFF</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></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>
<tr>
<td>APDS TLM</td>
<td>APDS FAILURE OFF NOMINAL PROCEDURE (IF APPLICABLE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>--------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damping</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<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>
<td></td>
</tr>
<tr>
<td>Failed OFF (s)</td>
<td>No impact for single failure. If all dampers failed, large rates/misalignments may cause mechanism to hit hard stops, exceeding its load capability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failed ON (s)</td>
<td>Mechanism may not have compliance on contact; load capability may be exceeded</td>
<td>Fixers Failed ON</td>
<td></td>
</tr>
<tr>
<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>
<td></td>
</tr>
<tr>
<td>Clutch – Slip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<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>
<td></td>
</tr>
<tr>
<td>Failed OFF (s)</td>
<td>Must verify clutch in SLIP prior to contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clutch – Lock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<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>
<td></td>
</tr>
<tr>
<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>
<td></td>
</tr>
<tr>
<td>Cap Man Rel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failed OP (s)</td>
<td>If latch is released, may be unable to draw interfaces together</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cntl Pnl Pwr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failed ON (s)</td>
<td>One logic bus remains powered. Still at least two failures from any inadvertent ops</td>
<td>Next failure may require APDS Direct Drive IFM to complete docking or separate, or require manual capture latch release</td>
<td></td>
</tr>
<tr>
<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></td>
<td></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>

s = Potential single failure  
m = Multiple failures required
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RCS BURN (+X, -X, Multi-axis)

1. GNC, OPS 202 PRO
   GNC ORBIT MNVR EXEC
   RCS SEL, ITEM 4 – (*)

2. If onboard computed burn:
   \[ \text{TIG and TGT PEG 7 } \Delta V \text{s per Final solution} \]
   Guidance option is LAMBERT
   If ground computed burn:
   \[ \text{TGT data per Burn Pad (reload WT as reqd)} \]
   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)
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
KU OPS

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 – (*)
  - FLTR TO PROP – ITEM 8 EXEC (*)
  - AUT RNG – ITEM 17 EXEC (*)
  - RDOT – ITEM 20 EXEC (*)
  - Angles – ITEM 23 EXEC (*) >>

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
    - sel – GPC
    - CNTL – CMD
  - A2
    - DIGI-DIS sel – EL/AZ

(reduced copy)
### TOP

**HOOK VELCRO**

**APPROACH**

<table>
<thead>
<tr>
<th>CG to CG RNG (ft)</th>
<th>RPM &amp; CONT TORVA RDOT (ft/s)</th>
<th>MC2 ET RNG (h:mm:ss)</th>
<th>DAP (ft/s)</th>
<th>EVENT</th>
<th>NO- RPM RDOT (ft/s)</th>
<th>HHL RNG (ft)</th>
<th>Raw TCS RNG* (ft) (Ref. 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>3.0</td>
<td>0.27:00</td>
<td>A8/B8</td>
<td>AUTO/ VERN (PRI)</td>
<td>If RDOT falls below value for next gate, THC: -2 (in) as reqd to maintain RDOT</td>
<td>-3.0</td>
<td>1990 HHL Report</td>
</tr>
<tr>
<td>1700</td>
<td>-2.4</td>
<td>0.29:00</td>
<td>Start centerline camera recorder</td>
<td>-2.6</td>
<td>1690 1698</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td>-2.1</td>
<td>0.31:00</td>
<td></td>
<td></td>
<td>-2.3</td>
<td>1490 1498</td>
<td></td>
</tr>
<tr>
<td>1300</td>
<td>-1.3</td>
<td>0.36:00</td>
<td>LO Z</td>
<td>MCC UPDATE: Go for RPM, Go to proceed inside 600 ft</td>
<td>-1.5</td>
<td>950 365</td>
<td></td>
</tr>
<tr>
<td>900</td>
<td>-1.1</td>
<td>0.37:00</td>
<td>A9/B9</td>
<td>ATU KU BD RDOT OUTPUT – LOW</td>
<td>If RDOT falls below value for next gate, THC: 0 (in) as reqd to maintain RDOT</td>
<td>-1.3</td>
<td>890 865</td>
</tr>
<tr>
<td>800</td>
<td>-0.9</td>
<td>0.38:00</td>
<td></td>
<td></td>
<td>790</td>
<td>786</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>-0.6</td>
<td>0.41:00</td>
<td>Null ISS rates in C/L cam</td>
<td>690</td>
<td>686</td>
<td></td>
<td></td>
</tr>
<tr>
<td>650</td>
<td>-0.4</td>
<td>0.42:30</td>
<td>Report to ISS: Range 650 ft</td>
<td>640</td>
<td>636</td>
<td></td>
<td></td>
</tr>
<tr>
<td>620</td>
<td>-0.4 &lt; Rdot &lt; -0.3</td>
<td></td>
<td>If Go for RPM, null Xdot to 0 ± 0.1 ft/sec prior to mnvr start</td>
<td>610</td>
<td>606</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>-0.3 &lt; Rdot &lt; -0.2</td>
<td></td>
<td>If reqd: stationkeep at 600-620 ft until RPM window opens</td>
<td>590</td>
<td>586</td>
<td></td>
<td></td>
</tr>
<tr>
<td>580</td>
<td>-0.2 &lt; Rdot &lt; -0.1</td>
<td></td>
<td></td>
<td></td>
<td>570</td>
<td>568</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>-0.7</td>
<td>0.56:00</td>
<td>A9/B9</td>
<td>TORVA</td>
<td>-0.8</td>
<td>590 586</td>
<td></td>
</tr>
<tr>
<td>550</td>
<td>-0.6</td>
<td></td>
<td></td>
<td>UNIV PTG – ITEM 15 + 1 7 9 EXEC</td>
<td>-0.7</td>
<td>540 536</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>-0.4</td>
<td></td>
<td></td>
<td>THG – X (up) as reqd to null tgt motion in C/L cam and initiate flyaround</td>
<td>-0.5</td>
<td>490 486</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>0.0 to -0.1</td>
<td></td>
<td>RPPOP POR – OSG DP to Tgt DP</td>
<td>0.0 to -0.1</td>
<td>590 343 HHL Report</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When Pitch Error &lt; 2°</td>
<td>1:10:00</td>
<td></td>
<td>Maintain ISS within C/L cam FOV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>415-315 (350-250 DP-DP)</td>
<td>-0.2</td>
<td>1:10:30</td>
<td>Perform CONFIGURE FOR DOCKING</td>
<td>-0.2</td>
<td>357-257 HHL Report</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Raw TCS Range assumes ISS in docking attitude

### RPM SETUP

- PRI ROT RATE – ITEM 10 + 0.75 EXEC
- VERN ROT RATE – ITEM 23 + 0.75 EXEC
- PRI Y OPTION – ITEM 16 EXEC (ALL)

If no-go to proceed inside 600 ft, perform CONTINGENCY 600 FT TORVA.

### CONTINGENCY 600 FT TORVA

- 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 Rdot -0.3 ft/s (alternate range 650 ft Rdot -0.1 ft/s)
  - Maintain RNG > 600 ft (CG-CG) until VBAR arrival
  - On VBAR, stationkeep RNG 630-530 ft (DP-DP), maintain ISS in C/L cam FOV

On MCC GO, perform CONFIGURE FOR DOCKING and VBAR APPROACH (Cue Card)

### RPM START WINDOW (MET)

OPEN: ___ / ___ : ___ : ___

CLOSE: ___ / ___ : ___ : ___

### CONFIGURE FOR DOCKING

- Perform AIRLOCK FAN ACT AND ODS VOLUME PREP (APDS), 8-10
- Perform DOCKING MECHANISM POWERUP (APDS), 8-5
- Perform DOCKING PREP (APDS), 8-7

### RBAR PITCH MNVR

- P = 90 (0) (Rbar attitude)
- P = 100 (10) VERN (PRI)
- P = 170 (80) FREE
- P = 250 (145) Start Photos
- P = 300 (215) End Photos
- P = 10 (280) PRI AUTO
- P = 60 (330) KU PWR – ON
- P = 90 (mnvr complete) VERN (PRI)
- Start Photos
- End Photos

**APPROACH**

<table>
<thead>
<tr>
<th>RPM SETUP</th>
<th>CONTINGENCY 600 FT TORVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRI ROT RATE – ITEM 10 + 0.75 EXEC</td>
<td>If no-go to proceed inside 600 ft, perform CONTINGENCY 600 FT TORVA.</td>
</tr>
<tr>
<td>VERN ROT RATE – ITEM 23 + 0.75 EXEC</td>
<td></td>
</tr>
<tr>
<td>PRI Y OPTION – ITEM 16 EXEC (ALL)</td>
<td></td>
</tr>
</tbody>
</table>

**RBAR PITCH MNVR**

A PRI ROT RATE – ITEM 10 + 0.75 EXEC
A VERN ROT RATE – ITEM 23 + 0.75 EXEC
A PRI Y OPTION – ITEM 16 EXEC (ALL)

- P = 90 (0) (Rbar attitude)
- P = 100 (10) VERN (PRI)
- P = 170 (80) FREE
- P = 250 (145) Start Photos
- P = 300 (215) End Photos
- P = 10 (280) PRI AUTO
- P = 60 (330) KU PWR – ON
- P = 90 (mnvr complete) VERN (PRI)

**CONFIGURE FOR DOCKING**

- Perform AIRLOCK FAN ACT AND ODS VOLUME PREP (APDS), 8-10
- Perform DOCKING MECHANISM POWERUP (APDS), 8-5
- Perform DOCKING PREP (APDS), 8-7
## VBAR APPROACH

<table>
<thead>
<tr>
<th>Interface RNG (ft)</th>
<th>RDOT (ft/s)</th>
<th>MCC 2 ET h:mm:ss (doc-PET)</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>LO Z</td>
<td>MCC UPDATE: Go for docking Maintain ISS docking target within 8 deg Corridor</td>
<td>267</td>
<td>255</td>
</tr>
<tr>
<td>(170 ± 10) 170</td>
<td>(0.00) -0.20</td>
<td>(-34.00)</td>
<td>DAP: B</td>
<td>If reqd, THC as reqd to null RDot and perform VBAR stationkeeping</td>
<td>177</td>
<td>175</td>
</tr>
<tr>
<td>110</td>
<td>-0.15</td>
<td>1:26:30</td>
<td>No LO Z</td>
<td>Note: DAP A allowed for ±X and ±Z THC</td>
<td>117</td>
<td>115</td>
</tr>
<tr>
<td>75</td>
<td>-0.10</td>
<td>1:30:30</td>
<td>A10,B10</td>
<td>ADCM 5 EXEC (*)</td>
<td>82</td>
<td>80</td>
</tr>
<tr>
<td>30 ± 5</td>
<td>0.0</td>
<td>1:38:00</td>
<td>A10,B10</td>
<td>THC: as reqd to establish RDOT = 0.07 ± 0.02 fps</td>
<td>32-42</td>
<td>30-40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-11.00)</td>
<td>DAP: B</td>
<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>-0.06:00</td>
<td>5º Corridor</td>
<td>37</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-11.00)</td>
<td>DAP: B</td>
<td>If Flyout Reqd: TIC: ±Z (out) as reqd to null RDOT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-0.05)</td>
<td></td>
<td>Perform AUTO ANGULAR FLYOUT (Cue Card) 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, CAUTION (Cue Card, DOCKING SEQUENCE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>\A7L Panel Config</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>3</td>
<td>1:44:00</td>
<td>1:47:20 (-01.40)</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 F2(F4) SPDBK/THROT pb – AUTO</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>-0.10</td>
<td>1:48:30</td>
<td>-0.00:30</td>
<td>Maintain 3 inch lateral alignment cylinder</td>
<td>N/A</td>
<td>8</td>
</tr>
<tr>
<td>CONTACT or ~2 in</td>
<td>-0.10</td>
<td>1:49:00</td>
<td>PCT</td>
<td>CAPTURE</td>
<td>N/A</td>
<td>5</td>
</tr>
<tr>
<td>or ~2 in</td>
<td></td>
<td>(00:00)</td>
<td>(SPARE pbl)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Raw TCS Range assumes ISS in docking attitude

### CAPTURE

<table>
<thead>
<tr>
<th>MS</th>
<th>START EVENT TIMER = 00:00:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7L</td>
<td>^CAPTURE It – It on</td>
</tr>
<tr>
<td></td>
<td>Notify ISS and MCC-H: &quot;Capture Confirmed&quot;</td>
</tr>
<tr>
<td></td>
<td>DISARM PCT:</td>
</tr>
<tr>
<td></td>
<td>SPDBK/THROT pb – push (It off)</td>
</tr>
</tbody>
</table>

\^ISS in FREE DRIFT (ISS indicator lights flashing)

\* IF NO INDICATION OF ISS FREE
\* DRIFT AT CAPTURE + 65 SEC.
\* Go to FIALED CAPTURE

A6U SSP2

When capture confirmed and ISS in FREE
FLT CNTRL PWR – OFF
DRAGNEYE PWR – OFF (4b-4p)
Perform TCS DEACTIVATION (RNDZ TOOLS), 7-20
Go to DOCKING SEQUENCE (Cue Card)

### FAILED CAPTURE

1. APDS CIRC PROT OFF pb – push
\^CIRCUIT PROTECT OFF It – It on
\^LATCHES CLOSED It – It off
\^OPEN It – It on

2. DAP: NO LO Z

\* IF VERN FAIL:
\* DAP: PRI

If perils clear:
DAP: A(B)/LV/HL

3. THC: ±Z (out) to establish 0.1 fps opening rate
\^DAP: B/LV/LH
If ISS in FREE URF1ST:
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)**

Target Displaced DOWN (Cross Displaced UP)

3. \[ \text{PITCH} = 179 - P = \_\_\_\_\_ (A) \]
5. \[ \text{PITCH} = \text{PITCH} - P = \_\_\_\_\_ (D) \]

Target Displaced UP (Cross Displaced DOWN)

3. \[ \text{PITCH} = 179 + P = \_\_\_\_\_ (A) \]
5. \[ \text{PITCH} = \text{PITCH} + P = \_\_\_\_\_ (D) \]

**ROLL (R)**

ITEM 16

Rotated CW

3. \[ \text{YAW} = 360 - R = \_\_\_\_\_ (B) \]
5. \[ \text{YAW} = \text{YAW} - R = \_\_\_\_\_ (E) \]

Rotated CCW

3. \[ \text{YAW} = 0 + R = \_\_\_\_\_ (B) \]
5. \[ \text{YAW} = \text{YAW} + R = \_\_\_\_\_ (E) \]

**YAW (Y)**

ITEM 17

Target Displaced RIGHT (Cross Displaced LEFT)

3. \[ \text{OM} = 0 + Y = \_\_\_\_\_ (C) \]
5. \[ \text{OM} = \text{OM} + Y = \_\_\_\_\_ (F) \]

Target Displaced LEFT (Cross Displaced RIGHT)

3. \[ \text{OM} = 360 - Y = \_\_\_\_\_ (C) \]
5. \[ \text{OM} = \text{OM} - Y = \_\_\_\_\_ (F) \]
AUTO ANGULAR FLYOUT

CAUTION
AUTO ANGULAR FLYOUT must be completed by RNG = 10 ft

1. RECORD ANGULAR MISALIGNMENT
\[ \text{DAP: A10, B10} \]
Read error from ISS centerline target
\[ \text{PITCH } (P) \]
\[ \text{YAW } (Y) \]
\[ \text{ROLL } (R) \]
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
\[ \text{GNC UNIV PTG} \]
\[ \sqrt{TGT ID } +2 \]
\[ \sqrt{BODY VECT } +5 \]
\[ \text{PITCH } +(A) \]
\[ \text{YAW } +(B) \]
\[ \text{OM } +(C) \]
TRK – ITEM 19 EXEC (CUR-*)

When mnvr cplt,

4. RECORD REMAINING ANGULAR MISALIGNMENT
Record error from ISS centerline target:
\[ \text{PITCH } (P) \]
\[ \text{YAW } (Y) \]
\[ \text{ROLL } (R) \]
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
   \[ \text{GNC UNIV PTG} \]
   \[ \sqrt{TGT ID } +2 \]
   \[ \sqrt{BODY VECT } +5 \]
   \[ \text{PITCH } +(D) \]
   \[ \text{YAW } +(E) \]
   \[ \text{OM } +(F) \]
   TRK – ITEM 19 EXEC (CUR-*)
DOCKING SEQUENCE

CAUTION
If the 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 tlm Failed On</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPTURE lt Failed Off</td>
<td>FIXERS tlm 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)

NOTE
A PETAL POS BASE measurement is considered “not changing” even if oscillating between two sequential values (bit toggling)

Event Time

<table>
<thead>
<tr>
<th>Contact/Capture/Damping</th>
<th>SM 167 DOCKING STATUS</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 PETAL POS BASE (three) not changing for 60 sec:
   A7L   POWER ON pb – push
   CRT   √DAMPING – OFF

4. When PETAL POS BASE (three) not changing for 30 sec:
   A7L   FIXER OFF pb – push
   √FIXERS OFF lt – lt on
   RING IN pb – push
   Wait 5 seconds, then:
   POWER ON pb – push

CRT 5. √RING DRV CMD – OFF
   √CLUTCH – LOCK/blank

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
   RING OUT pb – push
   Wait 5 seconds, then:
   POWER OFF pb – push

7. POWER ON pb – push
   √FIXERS OFF lt – lt off

CRT 6. √RING DRV CMD – OFF

(reduced copy)
### Retract Ring

**A7L,CRT** 8. On MCC GO (RING ALIGNED lt on and [PETAL POS BASE (three) not changing] for 30 sec):

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td><strong>A7L</strong> RING IN pb – push</td>
</tr>
<tr>
<td></td>
<td><strong>CRT</strong> \DRV CMD – ON [PETAL POS BASE (three) – decr]</td>
</tr>
<tr>
<td></td>
<td>\FIXERS – ON</td>
</tr>
<tr>
<td></td>
<td>\CLUTCH – LOCK/blank</td>
</tr>
<tr>
<td>CRT,A7L</td>
<td>* If PETAL POS BASE (three) &gt; 20 % and RING ALIGNED lt off:</td>
</tr>
<tr>
<td>A7L</td>
<td>* POWER ON pb – push</td>
</tr>
<tr>
<td>A7L</td>
<td>* Wait for ring alignment (up to 30 min)</td>
</tr>
<tr>
<td>A7L,CRT</td>
<td>* When RING ALIGNED lt on and [PETAL POS BASE (three) not changing]</td>
</tr>
<tr>
<td>A7L</td>
<td>* for 30 sec:</td>
</tr>
<tr>
<td>3:15</td>
<td><strong>A7L</strong> 9. \READY TO HOOK lt – lt on</td>
</tr>
<tr>
<td>CRT</td>
<td>\PETAL POS BASE (three) ≤ 7%</td>
</tr>
</tbody>
</table>

### Close Hooks

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td><strong>A7L</strong> \HOOKS 1,HOOKS 2 OPEN lt (two) – lt off</td>
</tr>
<tr>
<td>CRT</td>
<td>\HK1,HK2 DRV CMD (two) – ON</td>
</tr>
<tr>
<td></td>
<td>\POS (two) ≥ 5% &amp; incr</td>
</tr>
<tr>
<td></td>
<td>* If HK1(2) DRV CMD – OFF or HK1(2) POS not incr:</td>
</tr>
<tr>
<td>A7L</td>
<td>* CLOSE HOOKS pb – push</td>
</tr>
<tr>
<td>A7L</td>
<td>* If HOOKS 1(2) CLOSED lt failed ON:</td>
</tr>
<tr>
<td></td>
<td>* Perform HOOKS 1(2) CLOSED LT FAILED ON, 8-26</td>
</tr>
<tr>
<td>0:20</td>
<td><strong>CRT</strong> 11. \RING DRV CMD – OFF</td>
</tr>
<tr>
<td></td>
<td>* If RING DRV CMD – ON 20 sec after hooks begin:</td>
</tr>
<tr>
<td></td>
<td>* driving in step 10:</td>
</tr>
<tr>
<td></td>
<td>* POWER ON pb – push</td>
</tr>
<tr>
<td>A7L</td>
<td>≤ 1:30 <strong>A7L</strong> 12. \INTERF SEALED lt – lt on (expect intermittent it initially)</td>
</tr>
<tr>
<td>2:20</td>
<td>13. <strong>A7L</strong> \HOOKS 1,HOOKS 2 CLOSED lt (two) – lt on</td>
</tr>
<tr>
<td>CRT</td>
<td>\HK1,HK2 POS (two) = 92 - 93%</td>
</tr>
<tr>
<td></td>
<td>\IND (two) – blank/CL</td>
</tr>
<tr>
<td></td>
<td>\ODS INDIV HK CL (twelve) – CL</td>
</tr>
</tbody>
</table>

### Load Relieve Capture Latches (Extend Ring)

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7L</td>
<td>14. APDS CIRC PROT OFF pb – push</td>
</tr>
<tr>
<td></td>
<td>\CIRCUIT PROTECT OFF lt – lt on</td>
</tr>
<tr>
<td>15.</td>
<td>RING OUT pb – push</td>
</tr>
<tr>
<td>CRT</td>
<td>Wait 10 seconds, then:</td>
</tr>
<tr>
<td>16.</td>
<td>POWER ON pb – push</td>
</tr>
<tr>
<td>CRT</td>
<td>\RING DRV CMD – OFF</td>
</tr>
</tbody>
</table>

### Open Capture Latches

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td><strong>A7L</strong> 17. OPEN LATCHES pb – push</td>
</tr>
<tr>
<td></td>
<td>\LATCHES CLOSED lt – lt off</td>
</tr>
<tr>
<td>0:05</td>
<td>**OPEN lt – lt on</td>
</tr>
</tbody>
</table>

### Retract Ring to FNL POS

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td><strong>A7L</strong> 18. RING IN pb – push</td>
</tr>
<tr>
<td>CRT</td>
<td>\DRV CMD – ON [PETAL POS BASE (three) – decr]</td>
</tr>
<tr>
<td></td>
<td>\FIXERS – ON</td>
</tr>
<tr>
<td>0:10</td>
<td><strong>A7L</strong> \FINAL POSITION lt – lt on</td>
</tr>
<tr>
<td>CRT</td>
<td>\PETAL POS BASE (three) = 5 ± 3%</td>
</tr>
<tr>
<td>0:20</td>
<td>**RING DRV CMD – OFF</td>
</tr>
</tbody>
</table>

### Power Off

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7L</td>
<td>19. POWER OFF pb – push</td>
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<td>Go to TERMINATE RNDZ OPS 22A 4-22 &gt;&gt;</td>
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(reduced copy)
### STOPWATCH RDOT CONVERSION

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<tr>
<th>TIME BETWEEN 1 FT MARKS (SEC)</th>
<th>RANGE RATE (FT/SEC)</th>
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**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

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**NOTE:**
If RPOP is available, use RPOP subtended angle function.

### TIME DELTA RANGE DELTA

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**RNDZ-6b/133/O/A**
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, THCs 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>
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<tbody>
<tr>
<td>GPC1</td>
<td>FF1</td>
<td>1. If -Z ST NAV, INH ST to NAV</td>
<td>1. C3 DAP lights latched (go out with MDM pwr fail)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. If -Z ST not recovered:</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Use -Y ST, if reqd</td>
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</tr>
<tr>
<td>FA1</td>
<td></td>
<td>DAP: ALT/AUTO</td>
<td>VERNs ↓</td>
</tr>
<tr>
<td>GPC2</td>
<td>FA2</td>
<td>DAP: ALT/AUTO</td>
<td>VERNs ↓</td>
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<tr>
<td>Man OMS Shutdown</td>
<td>FF3</td>
<td>1. DAP: ALT/AUTO</td>
<td>1. VERNs ↓</td>
</tr>
<tr>
<td>GPC3</td>
<td></td>
<td>2. If RR NAV, INH RR to NAV</td>
<td>2. RR → NAV/RPOP ↓</td>
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<tr>
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<td>3. If -Y ST NAV, INH ST to NAV</td>
<td>(Panel A2 OK)</td>
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<tr>
<td>Loss of Aft DAP</td>
<td></td>
<td>4. If RR not recovered:</td>
<td>3. A6 DAP lights latched (go out with MDM pwr fail)</td>
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<td>Work RR FAIL procedures</td>
<td>4. -Y ST ↓</td>
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<td>5. Also for loss of GPC3:</td>
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<td>R OMS GMBL PRI/SEC ↓</td>
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<tr>
<td>GPC4</td>
<td>PL</td>
<td>If Ku breaks lock: Ku sel – AUTO TRK</td>
<td>1. GPC Ku ptg ↓, slew in AUTO TRK if Ku breaks lock</td>
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<td>2. No Ku self-test</td>
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* Expect this NBAT if GPC fail

MALFUNCTION

RNDZ-7a/133/O/A

CC 9-15

RNDZ/133/FIN
TOP
BACK OF ‘GPC/MDM FAILURE RESPONSE DURING RNDZ’

**RNDZ REF DATA**

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<th>Category</th>
<th>Description</th>
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<td>F MANF 2 JETS</td>
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<tr>
<td>FF3</td>
<td>F MANF 4 JETS</td>
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<tr>
<td>FF4</td>
<td>F MANF 2 JETS</td>
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<tr>
<td>FA1</td>
<td>L R MANF 1 JETS</td>
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<tr>
<td>FA2</td>
<td>L R MANF 3 JETS</td>
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<tr>
<td>FA3</td>
<td>L R MANF 2 JETS</td>
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<td>F RCS OX, FU QTY</td>
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<td>F MANF 1,2 RM</td>
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<td>DSC OL1</td>
<td>VERSN &amp; L MANF 1,2 RM</td>
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<tr>
<td>DSC OL2</td>
<td>L MANF 3,4 RM</td>
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<td>DSC OR1</td>
<td>VERSN &amp; R MANF 1,2 RM</td>
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<tr>
<td>DSC OR2</td>
<td>R MANF 3,4 RM</td>
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<tr>
<td>DSC OA2</td>
<td>VERSN RM</td>
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**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

**MAIN A**

- FPC1: MCIU
- FLC1: F MANF 1 JETS
- AC1B: PNL O3 RCS/OMS QTY
- FWD EVENT TIMER
- APC4:
  - APC1: VERSN
  - L OMS GMBL PRI
  - R OMS GMBL SEC
- ALC1: VERSN
- O14: -Z STRK
- AFT EVENT TIMER
- O14/A8: RMS PRI PWR
- R14: CCTV CAM-C,D
- CCTV MON-1
- 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: F MANF 2 JETS
- FLC2: F MANF 2 JETS
- AC2C: PNL A2 DIGITALS
- APC5:
  - APC2: VERSN
  - L OMS GMBL SEC
- ALC2: VERSN
- O15: -Y STRK
- FWD EVENT TIMER
- O15/A8: RMS B/U PWR
- R14: KU COMM & RR
- CCTV CAM-A, RMS
- CCTV CON’T UNIT SEC
- VPU (C/L CAM CMDHS)
- MPC2: KU COMM & RR
- APDS RING DAMP 3
- APDS HK, RING MTR 2
- RMS B/U PWR
- PLB LTS (Fwd-S, Mid-P, Bulkhead)
- AUX PL B: TCS

**MAIN C**

- FPC3: KU COMM & RR
- FLC3: VERSN
- AC3A: COAS PWR
- APC6:
  - APC3: R OMS GMBL PRI
- O16: PNL O3 OMS/RCS QTY
- R14: KU SIG PROC (RR OK)
- CCTV CAM-B
- MPC3: PLB LTS (Aft-P, Mid-S)

**ESS 2CA**

- TCS

**CABIN PL** (Flt Specific)

- CCTV C/L CAM

RNDZ-7b/133/O/A

CC 9-16
RNDZ/133/FIN
Note: Fabricate As Transparency

C/L CAMERA

CORRIDOR AND ALIGNMENT

CTVC 40.0 DEG HFOV - CORRIDOR
CTVC FULL ZOOM - ALIGNMENT
Note: Fabricate As Transparency

CAMERA A/D

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RANGE RULER

0 feet

feet

Use Bottom/Back Of ISS Ring

Use Top/Front Of ISS Ring

CTVC FULL NO ZOOM

RNDZ-9a/133/O/A
Note: Fabricate As Transparency

C/L Camera

Zoom Calibration (Ring Ready For Dock)

CTVC AT HFOV = 40.0 DEG

RNDZ-10a/133/O/A
FLIGHT

H-FOV

40 deg

20 deg

10 deg

SUB ANG RULER
Note: Fabricate As Transparency
Note: Fabricate As Transparency

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<th>A31P PGSC CAMERA A/D</th>
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RCS FAILURE RESPONSE DURING PROX OPS

**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.

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## RCS/DPS/EPS Failure Impacts

### GPC MDM
- **1**
- **2**
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- **4**
- **5**
- **6**
- **VERNS**

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### Case 1 JET
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- **1 Fx D**
- **VERN**
- **VERN**

### Case 2 JETS
- **-X**
- **Y**
- **Y**
- **2 Fx D**
- **2 Fx D**

### Case
- **1 JET**
- **2 JETS**

### Case
- **1 JET**
- **2 JETS**

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.