Rendezvous

STS-118

Mission Operations Directorate
Flight Design and Dynamics Division

Final
May 14, 2007
PCN-1 (July 16, 2007) Sheet 1 of 1

List of Implemented Change Requests (482s):

RNDZ-1258A  
RNDZ-1259A  
RNDZ-1265  
RNDZ-1266  
RNDZ-1268B  
RNDZ-1269  
RNDZ-1270

Incorporate the following:

1. Replace v thru viii
2. Replace 2-5 and 2-6
3. Replace 5-15 thru 5-18, 5-37 thru 5-40
4. Replace 6-9 and 6-10
5. Replace CC 9-7 and CC 9-8  
   After 9-26, add CC 9-27 and CC 9-28

Prepared by: [Signature]  
Book Manager

Approved by: [Signature]  
Lead, Rendezvous Guidance and Procedures Group

Accepted by: [Signature]  
Chief, Orbit Dynamics Branch

Encl: 20 pages  
File this PCN immediately behind the front cover as a permanent record
MISSION OPERATIONS DIRECTORATE

RENNDEVOUS
STS-118

FINAL
May 14, 2007

PREPARED BY:

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David J. Harshman
Book Manager

APPROVED BY:

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Steve R. Walker
Lead, Rendezvous Guidance and Procedure Group

ACCEPTED BY:

[Signature] 5/14/07
R. T. Gavin
Chief, Orbit Dynamics Branch

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Incorporates the following:

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**AREAS OF TECHNICAL RESPONSIBILITY**

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NOTE
This checklist is the controlling crew document for the ISS-13A.1 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>( \vec{V}, \vec{VBAR} )</td>
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<tr>
<td>( \pm X, Y, ZLV )</td>
<td>( \pm X, Y, \text{ or } Z ) Local Vertical (( \pm X, Y, \text{ or } Z ) toward Earth)</td>
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<tr>
<td>( X, Y, ZPOP )</td>
<td>( X, Y, \text{ or } Z ) orbiter body axis Perpendicular to Orbit Plane (aligned with the angular momentum vector)</td>
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<tr>
<td>( \pm X, Y, ZVV )</td>
<td>( \pm X, Y, \text{ or } Z ) orbiter body axis along the LVLH Velocity Vector</td>
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<td>SHUTTLE CENTERLINE TARGET</td>
<td>6-11</td>
</tr>
<tr>
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<td>6-12</td>
</tr>
<tr>
<td>RANGING CHARTS</td>
<td>6-13</td>
</tr>
<tr>
<td>COAS SUBTENDED ANGLES (DEG) VS RANGE (FT)</td>
<td>6-14</td>
</tr>
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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 Vs 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><strong>DPS:</strong> &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><strong>GNC:</strong> Loss of redundant +Z Trans</td>
<td>PROX OPS within 250 ft not permitted</td>
</tr>
<tr>
<td>or PRCS TRANS, any axis ↓</td>
<td></td>
</tr>
<tr>
<td>or PRCS ROT, any axis ↓</td>
<td></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>
ORBIT RENDEZVOUS PROFILE

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

ISS AT CENTER OF ROTATING LVLH REFERENCE FRAME

S TRK
NIGHT

RADAR NAV
NCC
ORBIT POST Ti PROFILE

ISS AT CENTER OF ROTATING LVLH REFERENCE FRAME

PET EVENT
0:00 Ti BURN
0:05 RR NAV (OR S TRK NAV, IF REQD)
0:20 MC1 BURN
0:28 SUNSET
~0:31 OOP NULL BURN
~0:50 MC2 BURN
~1:03 SUNRISE
~1:07 MC3 BURN
~1:17 MC4 BURN, START MANUAL PHASE

Rbar
15 kft

Vbar
-10 -20 -30 -40 -50 kft
### 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>2 0:29</td>
<td>1700</td>
<td>-2.4</td>
<td></td>
</tr>
<tr>
<td>3 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 Option 600</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 Option 580</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 Option 550</td>
<td>-0.7</td>
<td>RELOAD DAP A9, LOAD UNIV PTG P=180 DEG, REESTABLISH RDOT PER TORVA ICs</td>
</tr>
<tr>
<td></td>
<td>550</td>
<td>-0.6</td>
<td>INITIATE TORVA: DAP A, ITEM 19 (+X PULSES AS REQ'D TO NULL TARGET MOTION IN CAMERA)</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>-0.4</td>
<td></td>
</tr>
</tbody>
</table>
VBAR APPROACH

<table>
<thead>
<tr>
<th>Event</th>
<th>MC2 ET (h:mm)</th>
<th>Range (ft)</th>
<th>Rdot (fps)</th>
<th>Event Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1:25</td>
<td>320</td>
<td>-0.20</td>
<td>VBAR ARRIVAL (X PULSES AS REQ'D TO NULL TARGET MOTION IN CAMERA)</td>
</tr>
<tr>
<td></td>
<td>1:42</td>
<td>110</td>
<td>-0.15</td>
<td>TRANSITION TO NORMZ, LOAD DAP A10/B10, CONFIGURE FOR SINGLE -X JET (DESELECT F1F/F2F)</td>
</tr>
<tr>
<td></td>
<td>1:46</td>
<td>75</td>
<td>-0.10</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>1:54</td>
<td>30</td>
<td>-0.07</td>
<td>STATIONKEEP FOR 5 MINUTES IF ANGULAR ALIGNMENT MANEUVER REQUIRED</td>
</tr>
<tr>
<td>10</td>
<td>2:05</td>
<td>0</td>
<td>-0.10</td>
<td>DOCKING</td>
</tr>
</tbody>
</table>

EARTH
ISS-Centered LVLH Frame
UNDOCKING, TORS/TORF, AND FINAL SEPARATION

<table>
<thead>
<tr>
<th>UNDOCK ET (h:mm)</th>
<th>RANGE (ft)</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0:03</td>
<td>0</td>
<td>ORBITER AND ISS IN FREE DRIFT TO BEGIN UNHOOKING (ISS LVLH PYR 0,0,0 ATTITUDE)</td>
</tr>
<tr>
<td>1 0:00</td>
<td>0</td>
<td>UNDOCKING AT MIDNIGHT-2 MIN; DAP B/ALT MODE TO LVLH; MAINTAIN CORRIDOR</td>
</tr>
<tr>
<td>0:01</td>
<td>2</td>
<td>SELECT VERNS; 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 (F1F, F2F)</td>
</tr>
<tr>
<td>2 0:07</td>
<td>75</td>
<td>TRANSITION TO LOWZ</td>
</tr>
<tr>
<td>3 0:29 [1:15]*</td>
<td>&gt;400 (CG-CG)</td>
<td>SEP1: 1.5 FPS +X, RADIAL BURN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[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>4 0:57 [1:43]*</td>
<td>&gt;2000 (CG-CG)</td>
<td>SEP2: 1.0 FPS -X, NORMZ POSIGRADE BURN</td>
</tr>
</tbody>
</table>

* ALTERNATE TIMES ARE FOR FLYAROUND CASE
This Page Intentionally Blank
### UNDOCKING/SEPARATION PAD 4A

<table>
<thead>
<tr>
<th>Nominal Undocking Time:</th>
<th>/</th>
<th>:</th>
<th>:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbiter Weight:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

-00:45
\[ \text{PET} \]
DPS config for Undocking Ops - STRING 1233

-00:40
\[ \text{UNDOCKING PREP (APDS), 8-7} \]
Configure for Separation

-00:35
\[ \text{ENABLE RENDEZVOUS NAV (5B)} \]

-00:30
On RPOP PGSCs:
    Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-8, then:
    Perform RPOP OPS, steps 1 thru 5 (RNDZ TOOLS), 7-9, 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

-00:25
Perform HHL CHECKOUT (RNDZ TOOLS), 7-6

-00:20
Perform DOCKING MECHANISM POWERUP (APDS), 8-5
UNDOCKING PREP (APDS), 8-7

-00:15
Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZ TOOLS), 7-2

-00:10
MCC UPDATE
ORB SV
TGT SV
Covar Matrix

-00:05
MCC UPDATE
Undocking Time 4A

-00:00
\[ \text{ENABLE RENDEZVOUS NAV (5B)} \]
UNDOCKING OPERATIONS

1. PREP FOR UNDOCKING
   When MCC-H issues 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

2. RECONFIGURE DAP
   **GNC 25 DAP CONFIG**
   When ATT and RATES in limits:
   
   | ATT ERR (Each Axis) | ≤ 3.0 (VERN) |
   | ROLL, YAW RATE     | ≤ 0.05 (VERN) |
   | PITCH RATE         | ≤ 0.07 (ALT)  |
   
   -0:30 >
   DAP: FREE
   O14:F, Pri RJD DRIVER (eight) - ON
   O15:F, O16:F
   **GNC 20 DAP CONFIG**
   CRT: Config DAP A to A9.B9
   X Jets ROT ENA – ITEM 7 EXEC (no *)
   DAP: B/FREE/ALT
   DAP TRANS: NO LO Z
   DAP TRANS: PULSE/PULSE/PULSE
   SENSE: -Z

3. COMMAND UNDOCKING
   **SM 167 DOCKING STATUS**
   A7L
   * If HOOKS 1(2) OPEN it failed on:
   * APDS POWER A_off - OFF (√A_off and failed its off) *
   APDS CIRCUIT PROT OFF pb - push
   √CIRCUIT PROTECT OFF lt - It on
   √HOOKS 1,HOOKS 2 CLOSED lt (two) - It off [HK1,HK2 POS (two) < 92% + decr]
   -0:20 >
   UNDOCKING pb - push
   √HOOKS 1,HOOKS 2 CLOSED lt (two) - It off [HK1,HK2 POS (two) < 92% + decr]

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:
   √PERFORM TCS MANUAL ACQUISITION, step 3 (RNDZ TOOLS), 7-19
   At last pulse TIG+2:00 and when RNG > 30 ft (DP-DP):
   THC: +Z(out) pulses at 10 sec intervals as reqd to establish and maintain RDOT > 0.2 fps
   When RNG = 50 ft (DP-DP):  √RCS 23 RCS
   CRT:
   √RCS FWD – ITEM 1 EXEC (*)
   JET DES P1F – ITEM 31 EXEC (no *)
   P2F – ITEM 35 EXEC (no *)

5. POWER OFF
   A7L
   √POWER OFF pb - push
   √STATUS lt (eighteen) - It off
   GO TO SEP/FLYAROUND [BA]
SEP/FLYAROUND 8A

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
   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 BURN 8B
   If flyaround, Go to FLYAROUND 9A

SEP BURNS 8B

1. RADIAL BURN
   DAP TRANS: NORM/PULSE/PULSE
   THC: +X (up) 6 sec (1.5 fps)
   DAP: A/AUTO/VERN(PRI)
   DAP TRANS: PULSE/PULSE/PULSE
   FLT CNTRL PWR – OFF
   Inform MCC when SEP complete
   Record Radial Burn TIG __ __ __
   [GNC 2 TIME]
   Set GNC TIMER counting to final burn (Radial Burn TIG + 28 min)

2. CONFIG FOR FINAL BURN
   At final burn TIG - 1 minute:
   A6U √SENSE: -Z
   FLT CNTRL PWR – ON
   DAP TRANS: NORM/PULSE/PULSE
   DAP: NO LO Z

3. FINAL BURN
   At final burn TIG:
   Aft THC: ·X (down) 4 sec (1.0 fps)
   DAP TRANS: PULSE/PULSE/PULSE
   FLT CNTRL PWR – OFF
   Inform MCC when SEP complete
   Go to TERMINATE SEP OPS 8C

TERMINATE SEP OPS 8C

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
   Exit RPOP - [Shift]/[F10]
   Perform TCS DEACTIVATION (RNDZ TOOLS), 7-20
   Perform HHL STOW (RNDZ TOOLS), 7-6
   Go to FLIGHT PLAN
FLYAROUND

\[ \sqrt{ \text{Flyaround terminate criteria per } \text{4A} } \]
- If Breakout required during flyaround
- Go to SHUTTLE NOSE IN-PLANE BREAKOUT
- (CONTINGENCY OPS), 5-16 >>

1. DAP: A/AUTO/VERN(PRI)
   THC: Maintain ISS cg inside ±15 degree vertical and ±20 degrees horizontal on C/L camera
2. Prior to -Rbar crossing (Aft ADI P = 270):
   [GNC UNIV PTG]
   P \rightarrow +0 (-VBAR)
   TRK - ITEM 19 EXEC (CUR - *)
   When RNG > 600 ft (CG-CG):
   THC: Maintain flyaround range of 650 ± 50 ft (CG-CG)
3. Prior to -Vbar crossing (Aft ADI P = 0):
   [GNC UNIV PTG]
   P \rightarrow +180 (+VBAR)
   TRK - ITEM 19 EXEC (CUR - *)
4. Prior to +Rbar crossing (Aft ADI P = 90):
   [GNC UNIV PTG]
   P \rightarrow +180 (+VBAR)
   TRK - ITEM 19 EXEC (CUR - *)
5. Prior to +Vbar crossing (Aft ADI P = 180):
   [GNC UNIV PTG]
   P \rightarrow +90 (-RBAR)
   TRK - ITEM 19 EXEC (CUR - *)
6. Repeat steps 2 thru 5 as reqd to continue flyaround
7. At flyaround completion -10 minutes:
   If radar not tracking target:
   INITIAL RADAR ACQ [10A]
8. When flyaround complete (in +Vbar attitude),
   Go to SEP BURN [8B]

FLYAROUND RANGE REFERENCE

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

<table>
<thead>
<tr>
<th>HHL Aim Point</th>
<th>Raw HHL Range (ft)</th>
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<tbody>
<tr>
<td>US Lab - Fwd</td>
<td>585</td>
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<tr>
<td>Centerline Target</td>
<td>578</td>
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<tr>
<td>ISS Airlock</td>
<td>626</td>
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<tr>
<td>P6 Truss - End</td>
<td>592</td>
</tr>
<tr>
<td>Progress - Aft</td>
<td>553</td>
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</table>

TCS Reflector Visibility During Flyaround

Ref#3 becomes less visible as Orbiter YLVLH position becomes more positive (into the page)
Ref#5 is on PMA 3 and out of plane (into the page)
Flyaround between 600 - 700 ft
ISS is not to scale
INITIAL RADAR ACQ  [10A]

[GNC_33__REL_NAV]
CRT
\n\sqrt{\text{INH RNG}, \text{ ITEM } 18} \quad (+)
\sqrt{\text{RDOT}, \text{ ITEM } 21} \quad (+)
\sqrt{\text{Angles}, \text{ ITEM } 24} \quad (+)
\sqrt{\text{KU ANT ENA}, \text{ ITEM } 2 \text{ EXEC}} \quad (+)
\text{GNC I/O RESET }
\sqrt{\text{SV SEL}, \text{ ITEM } 4 - \text{ (FLTR)}}
\text{RADAR - ITEM } 13 \text{ EXEC} \quad (+)

[SM_ANTENNA]
CRT
\text{RDR RNG MIN - ITEM } 17 \text{ EXEC} \quad (+)
A2 \text{ DIGI-DIS sel} \quad - \text{ R/RDOT}
A1U \text{ KU PWR} \quad - \text{ STBY}
\text{MODE} \quad - \text{ RR PASSIVE}
\text{RADAR OUTPUT} \quad - \text{ LO}
\sqrt{\text{sel}} \quad - \text{ GPC}
\text{CNTL} \quad - \text{ PNL (wait 3 seconds)}
PWR \quad - \text{ ON}

IF NO RADAR LOCK-ON WITHIN 2 MIN

KU sel \quad - \text{ AUTO TRK}
SLEW \text{ EL, AZ to } 0.0 \text{ deg}
KU SEARCH \quad - \text{ SEARCH (tb–gray)}

When lock on occurs:

[GNC_33__REL_NAV]
CRT
\text{AUT RNG - ITEM } 17 \text{ EXEC} \quad (+)
\text{RDOT - ITEM } 20 \text{ EXEC} \quad (+)
\text{Angles - ITEM } 23 \text{ EXEC} \quad (+)
If \text{ RATIO} > 1.0,
\quad \text{Force aff mark until RATIO} < 1.0
When RESIDs small and stable,

[SM_ANTENNA]
\text{RDR RNG AUTO - ITEM} 16 \text{ EXEC} \quad (+)
MANEUVER PADS
## MNVR PADS

### PRELIMINARY ORBIT MANEUVER PAD FOR NC

<table>
<thead>
<tr>
<th>OMS BOTH</th>
<th>L</th>
<th>R</th>
<th>RCS SEL</th>
<th>TV ROLL</th>
<th>TRIM LOAD</th>
<th>WT</th>
<th>TIG</th>
<th>TGT PEG</th>
<th>ΔVX</th>
<th>ΔVY</th>
<th>ΔVZ</th>
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<tr>
<th>OMS GMBL CK:</th>
<th>NOTES</th>
<th>DOWN MODE OPTIONS:</th>
<th>ORBIT BURN MONITOR</th>
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<tbody>
<tr>
<td>PRE</td>
<td></td>
<td>2 OMS → 1 OMS</td>
<td>GPC FILL-INS __ (__)</td>
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<tr>
<td>POST-BURN</td>
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<td>1 OMS → RCS</td>
<td>CRIT BURN</td>
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<tr>
<th>RCS I’CNCT:</th>
<th>OMS HE REG TEST:</th>
<th>-X RCS BURNS:</th>
<th>BURN ATT</th>
<th>LVLH ATT</th>
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<td>L OP CL</td>
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<td>P</td>
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<th>MAX TIG SLIP</th>
<th>DO NOT UPDATE TIG</th>
<th>UPDATE TIG AFTER</th>
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<td>__ MIN.</td>
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**NOTES**

3-2

RNDZ/118/FIN
**FINAL ORBIT MANEUVER PAD FOR NC**

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

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

| TGT PEG | 7 |
| ΔVX | 19 |
| ΔVY | 20 |
| ΔVZ | 21 |

### BURN ATT

- **ΔVTOT**
- **TGO**

- **VGO X**
- **VGO Y**
- **VGO Z**

- **HA**
- **HP**

### ORBIT BURN MONITOR

- **GPC FILL-INS**
- **CRIT BURN**
- **NON-CRIT BURN**

### MAX TIG SLIP

- **MIN.**

### DO NOT UPDATE TIG

- **UPDATE TIG AFTER MIN.**
### Preliminary Orbit Maneuver Pad for NH

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

**Delta V Tot**
- TGO

**Delta V Total**
- VGO X
- VGO Y
- VGO Z

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

**WT**
- 9

**TIG**
- 10

**TGT PEG**
- 7

**AVX**
- 19

**AVY**
- 20

**AVZ**
- 21

**OMS GMBL CK**
- L PRI
- L SEC
- R PRI
- R SEC
- NONE

**RCS I’CNCT:**
- L OMS \(\rightarrow\) RCS
- R OMS \(\rightarrow\) RCS
- NONE

**Down Mode Options:**
- 2 OMS \(\rightarrow\) 1 OMS
- 1 OMS \(\rightarrow\) RCS
- NONE

**Orbit Burn Monitor**
- GPC Fill-Ins \(\_\_\_ (\_\_)\)

**CRIT Burn**
- NON-CRIT Burn

**Notes**
- DO NOT UPDATE TIG
- UPDATE TIG AFTER \(\_\_\_\_\_ MIN)
FINAL ORBIT MANEUVER PAD FOR Ti

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 Δ VX 19
Δ VY 20
Δ VZ 21

TIDELAY

TGT PEG 7 Δ VX 19
Δ VY 20
Δ VZ 21

NEW Ti (BASETIME )

BURN ATT
R 24
P 25
Y 26

Δ VTOT
TGO

VGO X
VGO Y
VGO Z

HA
HP

NOTES

VGO X

TGT PEG 7

OMS GMBL CK:
P RE: POST-BURN

RCS I’CNCT:
L PRI
L SEC
R PRI
R SEC
NONE

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

ORBIT BURN MONITOR

GPC FILL-INS __ ( __ )

CRIT BURN
NON-CRIT BURN

TIG SLIP: If Ti not started by nominal TIG + ___ min (G34 as reqd), reload original TIG and go to Ti DELAY, 5-27

Max Ti DELAY TIG slip ___ min.

DO NOT UPDATE TIG
UPDATE TIG AFTER ___ MIN.

NOTES

A
B

GPC

L OP CL

R OP CL

P 15
A

Y 16
B

OM 17

R

P

Y

TIG SLIP: If Ti not started by nominal TIG + ___ min (G34 as reqd), reload original TIG and go to Ti DELAY, 5-27

Max Ti DELAY TIG slip ___ min.

DO NOT UPDATE TIG
UPDATE TIG AFTER ___ MIN.

NOTES
## Orbit Maneuver Pad for __________

### BURN ATT

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### ΔVTOT

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### TGO

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### ΔVZ

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### ΔVY

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### ΔVX

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### TRIM LOAD

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<td>RY</td>
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### WT

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### TV ROLL

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### RCS SEL

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### OMS BOTH

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### L

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### R

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### RCS SEL

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### TRIM LOAD

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### WT

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### TV ROLL

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### GPC FILL-INS

\[ GPC \quad L \quad CL \]

### OM S GMBL CK:

<table>
<thead>
<tr>
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<th>POST-BURN</th>
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<tbody>
<tr>
<td>L PRI</td>
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### RCS I’CNCT:

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### DOWN MODE OPTIONS:

<table>
<thead>
<tr>
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<tbody>
<tr>
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<td>1 OMS → RCS</td>
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### ORBIT BURN MONITOR

<table>
<thead>
<tr>
<th>GPC FILL-INS</th>
<th>CRIT BURN</th>
<th>NON-CRIT BURN</th>
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### ORBIT FINISH

<table>
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### LVLH ATT

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### MAX TIG SLIP

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### DO NOT UPDATE TIG

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### UPDATE TIG AFTER

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### NOTES

- OMS HE REG TEST:
  - GPC: L OP CL
  - A B
- -X RCS BURNS:
  - BURN ATT
  - LVLH ATT

- MAX TIG SLIP

- DO NOT UPDATE TIG

- UPDATE TIG AFTER

---

3-9

RNDZ/118/FIN
### Orbit Maneuver Pad for ____________

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<thead>
<tr>
<th>OMS BOTH</th>
<th>L 2</th>
<th>R 3</th>
<th>RCS SEL 4</th>
<th>TV ROLL 5</th>
<th>TRIM LOAD P 6</th>
<th>LY 7</th>
<th>RY 8</th>
<th>WT 9</th>
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<tr>
<th>BURNT ATT</th>
<th>BURN ATT</th>
<th>Post-BURN</th>
<th>RCS I’CNCT:</th>
<th>DOWN MODE OPTIONS:</th>
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</thead>
<tbody>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td>2 OMS → 1 OMS</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td>1 OMS → RCS</td>
</tr>
<tr>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td>oNEx</td>
</tr>
<tr>
<td>ΔVTOT</td>
<td>TGO</td>
<td></td>
<td></td>
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<tr>
<th>OMS GMBL CK:</th>
<th>NOTES</th>
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<tr>
<td>L PRI</td>
<td>PRE</td>
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<tr>
<td>L SEC</td>
<td>POST-BURN</td>
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<tr>
<td>R PRI</td>
<td>RCS I’CNCT:</td>
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<tr>
<td>R SEC</td>
<td>L OMS → RCS</td>
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<td>OMS HE REG TEST:</td>
<td>R OMS → RCS</td>
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<tr>
<td>OMS HE REG TEST:</td>
<td>NONE</td>
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<td>-X RCS BURNS:</td>
<td>NONE</td>
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<tr>
<td>ORBIT BURN MONITOR</td>
<td>ORBIT BURN MONITOR</td>
</tr>
<tr>
<td>GPC FILL-INS</td>
<td>CRIT BURN</td>
</tr>
<tr>
<td>CRIT BURN</td>
<td>NON-CRIT BURN</td>
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</table>

<table>
<thead>
<tr>
<th>MAX TIG SLIP</th>
<th>MIN.</th>
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<table>
<thead>
<tr>
<th>ORBIT BURN MONITOR</th>
<th>DO NOT UPDATE TIG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UPDATE TIG AFTER MIN.</td>
</tr>
</tbody>
</table>

### Notes

- MAX TIG SLIP __ MIN.
- DO NOT UPDATE TIG
- UPDATE TIG AFTER __ MIN.
O14,16:E  √cb MNA,C DDU AFT (two) - cl
A6U  ADI ATT - LVH
   ERR - MED
   RATE - LO
   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  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**
  - MS Perform 6.105 SSOR ACTIVATION, steps 1 and 2 (SODF: JOINT OPS, COMM/DATA)

- **02:50**
  - 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)
    - Postburn DAP: A/LVLH/VERN(ALT)

- **02:45**

- **02:40**

- **02:35**

- **02:30**

**MCC UPDATE**

Final NH Burn Pad, 3-6 (if reqd)

**ORB SV**

TGT SV

Drag K-factor

**RNDZ OPS INITIALIZATION [5A]**

\(\sqrt{\text{DPS Config for Rndz Ops - String 1233}}\)

**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 1 ITEM 26 EXEC (+)
2 ITEM 27 EXEC (+)
3 ITEM 28 EXEC (+)
\(\sqrt{\text{INH GPS to G&C, ITEM 33 - (+)}}\)
NAV ITEM 36 - (+)
RENDEZVOUS TIMELINE

---

**PET**

- **02:25**
  - If reqd.
  - NH TIG

- **02:20**
  - Postburn DAP: A/LVLH/VERN(ALT)

---

**Enable Rendezvous Nav [7A]**

1. **GNC 33 REL NAV**
   - CRT RNDZ NAV ENA - ITEM 1 EXEC (*)
   - √ SV SEL, ITEM 4 - PROP
   - √ INH RNG, ITEM 18 - (+)
   - RDOT, ITEM 21 - (+)
   - Angles, ITEM 24 - (+)
   - √ 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

---

**PLT**

- **02:15**
  - Enable Rendezvous Nav [7A]

- **02:10**
  - PGSCs setup per PGSC Usage Chart (if available) or UTILITY OUTLET PLUG-IN
  - PLAN ORBIT CONFIGURATION (REF DATA FS, UTIL PWR)

- **02:05**
  - PLC, On RPOP PGSCs:
    - MS Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-8, then
    - Perform RPOP OPS (RNDZ TOOLS), 7-9, then
    - Perform TCS ACTIVATION, step 1 (RNDZ TOOLS), 7-18

- **02:00**
  - MS Perform HHL CHECKOUT (RNDZ TOOLS), 7-6

---

**MCC Update**

Final NC Burn Pad, 3-3
RENDEZVOUS TIMELINE

CDR LOAD TARGET TRACK [9A]

NOTE
If NH performed, delay mnvr to NC burn attitude
until NC TIG - 5 min to minimize attitude mnvr

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

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

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

DO NOT INITIATE TARGET TRACK [9B] until post NC

LOAD TARGET TRACK [9A]

\[\text{DAP: } A/LVLH/VERN(ALT)\]
\[\text{GNC UNIV PTG}\]

CNCL - ITEM 21 EXEC
TGT ID +1

\[\begin{align*}
\text{BODY VECT} & : +3 \; (+Z) & +4 \\
\text{P} & : +90 & +0 \\
\text{Y} & : +0 & +280.57 \\
\text{OM} & : +0 & +90 \\
\end{align*}\]

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

INITIATE TARGET TRACK [9B]

\[\text{GNC UNIV PTG}\]

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

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

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

**GNC 21 IMU ALIGN**

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

**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

---

**END S TRK NAV**

**GNC 33 REL NAV**

**CRT**

- **INH Angles** - ITEM 24 EXEC (**)

**GNC 21 IMU ALIGN**

**IMU DES - ITEM 7(8,9) EXEC (no **)**
TARGET NCC BURN [11A]

FINAL SOLUTION
OPS 202 PRO
GNC ORBIT MNVR EXEC
√Eng Sel CORRECT

CRT √SV SEL correct
GNC 34 ORBIT TGT
TGT NO - ITEM 1 +9 EXEC
√TGT Set data:
T1 TIG = NCC BURN SOLUTION TIG
EL +0
ΔT +57.7
ΔX -48.6
ΔY +0.0
ΔZ +1.2
COMPUTE T1 - ITEM 28 EXEC
Record solution in PAD

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

NCC BURN SOLUTION
PRELIMINARY

INTERMEDIATE

FINAL

GROUND FINAL - GROUND LIMITS

ΔVX

( ) *

( ) *

( ) *

(0.5) *

ΔVY

( ) *

( ) *

( ) *

(1.5) *

ΔVZ

( ) *

( ) *

( ) *

(1.7) *

ΔVT

( ) *

( ) *

( ) *

( ) *
-Z AXIS TARGET TRACK 12A

CRT

| GNC UNIV PTG |
|---|---|
| TGT ID | +1 |
| BODY VECT | +3 (-Z) |
| OM | +0 |

C3

DAP: B/AUTO/ALT

CRT

TRK - ITEM 19 EXEC (CUR - +)

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

PET

-01:00

A7(B7)

NCC TIG

-00:55

PLT TARGET Ti BURN 13A (Preliminary)

MCC UPDATE

RNDZ PRPLT PAD

IF Y STRK TRACK

CDR 

-00:50

2 AXIS TARGET TRACK 12A

When:

GNC 33 REL NAV

NAV RNG < 150 KFT:

MS KU OPS, step 1 (Cue Card)

-00:45

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

MS KU OPS, step 2 (Cue Card)

-00:40

PLT Perform RR NAVIGATION 13B

-00:35

When NAV converged (SV UPDATES small and stable):

PLT TARGET Ti BURN 13A (Intermediate)

-00:30

RR NAVIGATION 13B

GNC 33 REL NAV

CRT RR - ITEM 13 EXEC (*)

√Elev, Az approx 0

Record Initial RESID RANGE = ______

RDOT = ______

IF RESID RANGE > 5.0 or
RDOT > 3.0

SV SEL - ITEM 4 EXEC (PROP)
Proceed with taking data and contact MCC
as soon as practical

FLTR TO PROP - ITEM 8 EXEC

AUTO RNG - ITEM 17 EXEC (*)

RDOT - ITEM 20 EXEC (*)

Angles - ITEM 23 EXEC (*)

Record 1st SV UPDATE POS = ______

IF SV SEL = PROP

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

SV SEL - ITEM 4 EXEC (FLTR)

TARGET Ti BURN 13A

CRT √SV SEL correct

GNC 34 ORBIT TGT

TGT NO - ITEM 1 +1 0 EXEC

√TGT Set data:

T1 TIG = BASE TIME

EL +0

ΔT +76.9

ΔX - 0.9

ΔY +0

ΔZ +1.8

COMPUTE T1 - ITEM 28 EXEC

Record solution in PAD

A7(B7)

When RR RNG < 135 KFT:

PLT Perform RR NAVIGATION 13B

PET

-00:00

-00:55

-00:50

-00:45

-00:40

-00:35

-00:30
## Rendezvous Timeline

### Final - Ground Limits

<table>
<thead>
<tr>
<th>ΔVx</th>
<th>ΔVy</th>
<th>ΔVz</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.7)</td>
<td>(1.1)</td>
<td>(1.6)</td>
</tr>
</tbody>
</table>
MCC for burn type. If no comm:
If \( \Delta VT > 6 \), at TIG-17:
- Perform RNDZ OMS BURN (CONTINGENCY OPERATIONS), 5-4
If \( 4 \leq \Delta VT \leq 6 \), at TIG-17:
- Perform \( +X \) RCS burn, RCS BURN (Cue Card)
If \( \Delta VT < 4 \), at TIG-5:
- Perform multi-axis RCS burn, RCS BURN (Cue Card)

\( TIG-17 \)  If Ti is multi-axis burn, delay final targeting un til TIG-5
\( PLT \)  TARGET Ti BURN [15A] (Final)
\( MCC UPDATE \)  Ti Final Ground Soln, Ti DELAY Soln, 3-7
\( MCC UPDATE \)  GO for Ti

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

\( TIG-5 \)  If Ti is multi-axis burn:
\( CDR \)  Perform RCS BURN (Cue Card)
\( CDR \)  Perform RNDZ OMS BURN (CONTINGENCY OPERATIONS), 5-4

\( CDR \)  Perform Ti DELAY BURN (CONTINGENCY OPS), 5-27

\( PET \)

\(-00:30\)
\(-00:25\)
\(-00:20\)
\(-00:15\)
\(-00:10\)
\(-00:05\)
\(00:00\)

\( TIG-17 \)  If Ti is multi-axis burn, delay final targeting until TIG-5
\( CDR \)  Perform RCS BURN (Cue Card)
\( CDR \)  Perform RNDZ OMS BURN (CONTINGENCY OPERATIONS), 5-4

\( TIG-5 \)  If Ti is multi-axis burn:
\( CDR \)  Perform RCS BURN (Cue Card)
RENDEZVOUS TIMELINE

POST Ti NAV [16A]

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

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

\textbf{GNC 22 S TRK/COSAS CNTL}
- CRT \checkmark - Z TGT TRK - ITEM 6 EXEC (+)

\textbf{IF RR FAIL}
- If - Z Star Tracker:
  - \checkmark - Z TGT TRK ATT, then:
    - Perform STAR TRACKER NAV [10A]
- If COAS NAV:
  - \checkmark - Z TGT TRK ATT, then:
    - Perform COAS NAVIGATION (CONTINGENCY OPS), 5-10
- If - Y Star Tracker:
  - \textbf{GNC UNIV PTG}
    - TGT ID \checkmark +1
    - BODY VECT \checkmark +4
    - P \checkmark +0
    - Y \checkmark +280.57
    - OM \checkmark +90
  - DAP: B/AUTO/ALT
    - TRK - ITEM 19 EXEC
    - When MNVR cmplt:
      - DAP: A/AUTO/VERN(ALT)
      - Perform STAR TRACKER NAV [10A]
When MNVR to att cmp: CDR POST Ti NAV [16A]

When NAV converged, (SV UPDATES small and stable):
PLT TARGET MC 1 BURN [17A] (Intermediate)

Perform RCS BURN (Cue Card)

When Y = 0:
PLT MANUAL OUT-OF-PLANE NULL [19A]

<table>
<thead>
<tr>
<th>TIG</th>
<th>PRELIMINARY</th>
<th>INTERMEDIATE</th>
<th>FINAL</th>
<th>MEAN ± (3σ VARIATION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔVX</td>
<td>( ) *</td>
<td>( ) *</td>
<td></td>
<td>-0.0 ± (0.4)</td>
</tr>
<tr>
<td>ΔVY</td>
<td>( ) *</td>
<td>( ) *</td>
<td></td>
<td>-0.1 ± (0.6)</td>
</tr>
<tr>
<td>ΔVZ</td>
<td>( ) *</td>
<td>( ) *</td>
<td></td>
<td>+0.0 ± (1.2)</td>
</tr>
<tr>
<td>ΔVT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TGT NO - ITEM 1 +1 EXEC
TGT Set data:
T1 TIG = MC1 BURN SOLUTION TIG
EL +1.0
ΔT 96.9
ΔX ±0.9
ΔY ±1.0
ΔZ ±1.8

MC 1 BURN SOLUTION

TARGET MC 1 BURN [17A]

TARGET MC 2 [17B] (Preliminary)

CRT `SV SEL correct

GNC 34 ORBIT TGT

TGT NO - ITEM 1 +1 EXEC

TGT Set data:
T1 TIG = MC2 BURN SOLUTION TIG
EL +29.07
ΔT 27.0
ΔX ±0.9
ΔY ±1.0
ΔZ ±1.8

PLT TARGET MC 2 BURN [17B] (Preliminary)

Perform RCS BURN (Cue Card)

When Y = 0:
PLT MANUAL OUT-OF-PLANE NULL [19A]
Target MC 2 Burn (Intermediate)

- SV SEL correct
- TGT NO - ITEM 1 +1 2 EXEC
- COMPUTE T1 - ITEM 28 EXEC
- Record solution in PAD

Target MC 2 Burn (Final)

- SV SEL correct
- TGT NO - ITEM 1 +1 2 EXEC
- T1 TIG = BASE TIME
- ΔT = +27.0
- ΔX = -0.9
- ΔY = 0.0
- ΔZ = +1.8
- COMPUTE T1 - ITEM 28 EXEC
- Set EVENT TIMER counting to MC 2 TIG
- Record solution in PAD

End S Trk Nav (18C)

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

Z Axis Target Track (18D)

- GNC UNIV PTG
- TGT ID
- BODY VECT +3 (-Z)
- OM +3
- C3 DAP: B/AUTO/ALT
- TRK - ITEM 19 EXEC (CUR - *)
- When MNVR cmplt, DAP: A/AUTO/VERN(ALT)

Nighttime Strk Ops (18E)

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

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>
<thead>
<tr>
<th>ΔVX</th>
<th>ΔVY</th>
<th>ΔVZ</th>
<th>ΔVT</th>
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FINAL

<table>
<thead>
<tr>
<th>ΔVX</th>
<th>ΔVY</th>
<th>ΔVZ</th>
<th>ΔVT</th>
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TIG

<table>
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</tr>
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<tbody>
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TIG Slip (Computed-Nominal)

<table>
<thead>
<tr>
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<th>INTER</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
RENDEZVOUS TIMELINE

PET

00:30

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

A7(B7)

00:35

IF S TRK NAV

At sunset-2 minutes:

PLT TARGET MC 2 BURN [18A] (Intermediate)

When NAV converged (SV UPDATES small and stable):

TARGET MC 2 BURN [18A] (Intermediate)

00:40

MC2 ET

00:10

On RPOP PGSC:

MS Perform TCS ACTIVATION, steps 2-4 (RNDZ TOOLS), 7-2

(Set AUTO ACQ to 10,000 ft)

00:45

00:05

TIG-5 MIN

PLT TARGET MC 2 BURN [18B] (Final)

Perform RCS BURN (Cue Card)

00:50

00:00

MC 2 TIG

PLT TARGET MC 3 BURN [19B] (Preliminary)

IF INITIAL RR ACQ POST-MC2

CDR Perform LATE RR NAV [20E]

00:55

00:05

IF -Y S TRK TRACK

PLT END STAR TRACKER NAV [18C]

-Z AXIS TARGET TRACK [18D]

01:00

00:10

IF S TRK NAV,

PLT END STAR TRACKER NAV [18C]

TARGET MC 3 [19B]

CRT SV SEL correct

GNC_34__REL_NAV

TGT NO - ITEM 1 +1 3 EXEC

TGT Set data:

ΔT +10.0

ΔX -0.9

ΔY +0

ΔZ +1.8

COMPUTE T1 - ITEM 28 EXEC

Record solution in PAD

00:05

MANUAL OUT-OF-PLANE NULL [19A]

GNC_33__REL_NAV

CRT When Y = 0:

F7 FLT CNTRL PWR - ON

DAP: A/AUTO/PRI

DAP TRANS: as reqd

THC: Null YDOT

IF -Z AXIS TRACK,

+YDOT = FWD THC left

AFT THC right

IF -Y S TRK TRACK,

+YDOT = FWD THC down

AFT THC out

F7 FLT CNTRL PWR - OFF

DAP: A/AUTO/ALT

When rates nulled:

DAP: VERN(ALT)

00:10

A7(B7)

00:05

TIG-5 MIN

PLT TARGET MC 2 BURN [18B] (Final)

Perform RCS BURN (Cue Card)

00:45

00:00

MC 2 TIG

PLT TARGET MC 3 BURN [19B] (Preliminary)

IF INITIAL RR ACQ POST-MC2

CDR Perform LATE RR NAV [20E]

00:55

00:05

IF -Y S TRK TRACK

PLT END STAR TRACKER NAV [18C]

-Z AXIS TARGET TRACK [18D]

01:00

00:10

IF S TRK NAV,

PLT END STAR TRACKER NAV [18C]

TARGET MC 3 [19B]

CRT SV SEL correct

GNC_34__REL_NAV

TGT NO - ITEM 1 +1 3 EXEC

TGT Set data:

ΔT +10.0

ΔX -0.9

ΔY +0

ΔZ +1.8

COMPUTE T1 - ITEM 28 EXEC

Record solution in PAD

00:05

MANUAL OUT-OF-PLANE NULL [19A]

GNC_33__REL_NAV

CRT When Y = 0:

F7 FLT CNTRL PWR - ON

DAP: A/AUTO/PRI

DAP TRANS: as reqd

THC: Null YDOT

IF -Z AXIS TRACK,

+YDOT = FWD THC left

AFT THC right

IF -Y S TRK TRACK,

+YDOT = FWD THC down

AFT THC out

F7 FLT CNTRL PWR - OFF

DAP: A/AUTO/ALT

When rates nulled:

DAP: VERN(ALT)

00:10

A7(B7)

00:05

TIG-5 MIN

PLT TARGET MC 2 BURN [18B] (Final)

Perform RCS BURN (Cue Card)

00:45

00:00

MC 2 TIG

PLT TARGET MC 3 BURN [19B] (Preliminary)

IF INITIAL RR ACQ POST-MC2

CDR Perform LATE RR NAV [20E]

00:55

00:05

IF -Y S TRK TRACK

PLT END STAR TRACKER NAV [18C]

-Z AXIS TARGET TRACK [18D]

01:00

00:10

IF S TRK NAV,

PLT END STAR TRACKER NAV [18C]

TARGET MC 3 [19B]

CRT SV SEL correct

GNC_34__REL_NAV

TGT NO - ITEM 1 +1 3 EXEC

TGT Set data:

ΔT +10.0

ΔX -0.9

ΔY +0

ΔZ +1.8

COMPUTE T1 - ITEM 28 EXEC

Record solution in PAD

00:05

MANUAL OUT-OF-PLANE NULL [19A]

GNC_33__REL_NAV

CRT When Y = 0:

F7 FLT CNTRL PWR - ON

DAP: A/AUTO/PRI

DAP TRANS: as reqd

THC: Null YDOT

IF -Z AXIS TRACK,

+YDOT = FWD THC left

AFT THC right

IF -Y S TRK TRACK,

+YDOT = FWD THC down

AFT THC out

F7 FLT CNTRL PWR - OFF

DAP: A/AUTO/ALT

When rates nulled:

DAP: VERN(ALT)
**RENDEZVOUS TIMELINE**

- **MC 4 BURN SOLUTION**
  - **TIG**
  - **PRELIMINARY**
    - ΔX
    - ΔY
    - ΔZ
    - ΔV
  - **FINAL**
    - ΔX
    - ΔY
    - ΔZ
    - ΔV
  - **MEAN ± 3σ VARIATION**
    - +1.2 ± (1.7)
    - -0.0 ± (0.5)
    - +0.3 ± (2.4)

- **TARGET MC 4 BURN**
  - **CRT**
    - √ SV SEL correct
    - GNC 34 ORBIT TGT
    - TGT NO - ITEM 1 +1 EXEC
    - T1 TIG = BASE TIME + 0/00:27:00
    - EL +0
    - ΔX +13.0
    - ΔY +0
    - ΔZ +0.6
  - **COMPUTE T1**
    - ITEM 28 EXEC
    - Record solution in PAD

- **CONFIG FOR RBAR**
  - GNC UNIV PTG
  - √ ERR TOT - ITEM 23 EXEC (+)
  - When ERR <2 deg each axis
    - GNC 20 DAP CONFIG
    - Config DAP A,B to A8,B8
  - GNC UNIV PTG
  - TGT ID +2
  - BODY VECT +270
  - P +270
  - Y +0
  - OM +0
  - Do not initiate Target Track until ESTABLISH RBAR

- **ESTABLISH RBAR**
  - A6U FLT CTNLR 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

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

- **RADAR FAIL PROCEDURE**
  - Note: When TGT visible, report TGT Tally-Ho to MCC
  - **MS**
    - If TGT outside COAS reticle, config CCTV as reqd to measure vertical position
  - **1.** At MC2 TIG+14:00 (MC3 TIG-3:00):
    - PLT TARGET MC3 (19B) (final)
    - CDR Perform RCS BURN (Cue Card)
  - **AT MC2+18 IF NO VISUAL ACQUISITION OR TARGET > 30 Deg FROM COAS HORIZONTAL**
    - CDR Go to RNDZ BREAKOUT (CONTINGENCY OPS) 5-18 >>
  - **2.** At MC2 TIG + 19:00:
    - A6U FLT CTNLR PWR - ON
    - √ SENSE - Z
    - DAP: A/TLVLH/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/TLVLH/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
  - **3.** At MC2 TIG + 24:00 or 2000 ft, whichever comes first:
    - GNC UNIV PTG
    - CRT TRK - ITEM 19 EXEC (CUR - *)
    - A6U DAP: A/AUTO/VERN (PRI)
    - 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**
  - 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

- **Do not initiate Target Track until ESTABLISH RBAR**
IF NO RR INTO NAV
CDR Go to RADAR FAIL PROCEDURES [20D]

← TIG-3 MIN
PLT TARGET MC3 BURN [19B] (Final)
Perform RCS BURN (Cue Card)

← MC 3 TIG
PLT TARGET MC 4 BURN [20A] (Preliminary)
CDR CONFIG FOR RBAR [20B]
MS Perform HHL OPS (RNDZ TOOLS), 7-7

← TIG-3 MIN
PLT TARGET MC 4 [20A] (Final)
Perform RCS BURN (Cue Card)

← MC 4 TIG
CDR ESTABLISH RBAR [20C]

Perform APPROACH (Cue Card)

Manual Trajectory Control
TERMINATE RNDZ OPS [22A]

1. ORBITER CONFIG FOR MATED ATTITUDE CONTROL
   IF VERNs available:
   O14:F, Pri RJD LOGIC, DRIVER (sixteen) – OFF
   O15:F, RJDA 1A L2/R2 MANF DRIVER – ON
   O16:F
   O14:E, All DDU cbs (six) – op
   O15:E, O16:E
   CDR A6U
   √ FLT CNTRL PWR - OFF
   PLT
   [GNC 23 RCS]
   CRT RCS F – ITEM 1 EXEC (+)
   JET DES F1L – ITEM 9 EXEC (+)
   F3L – ITEM 11 EXEC (+)
   F2R – ITEM 13 EXEC (+)
   F4R – ITEM 15 EXEC (+)
   F1U – ITEM 17 EXEC (+)
   F3U – ITEM 19 EXEC (+)
   F2U – ITEM 21 EXEC (+)
   [GNC 20 DAP CONFIG]
   Config DAP A,B to A12,B12
   X JET ROT ENA - ITEM 7 EXEC (+)
   EDIT A9 - ITEM 3 + 9 EXEC
   PRI RATE DB - ITEM 52 + 0.2 EXEC
   LOAD - ITEM 5 EXEC
   EDIT B9 - ITEM 4 + 9 EXEC
   PRI RATE DB - ITEM 52 + 0.2 EXEC
   LOAD - ITEM 5 EXEC

   DAP: LO Z
   If Loss of Verns:
   [SM 167 DOCKING STATUS]
   CRT √ 12 hooks closed
   DAP: B/ALT
   DAP: LVLH
   If VERN:
   DAP: LVLH
   * If ISS attitude control required,
   * Perform 3.111 HANDOVER ATTITUDE CONTROL ORBITER TO
   * CMG TA, (SODF: JOINT OPS, MATED OPERATIONS)

2. ORBITER CONFIG FOR MATED OPS
   MS A6L
   Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6
   LTS TRUSS FWD, AFT (two) - OFF
   VEST PORT, STBD (two) - OFF
   Exit RPOP - [Shift][F10]
   Perform HHL STOW (RNDZ TOOLS), 7-6
   -Z COAS – OFF

   ~ GNC 22 S TRK/COAS CNTL
   CRT -Z(-Y) STAR TRK - ITEM 4(3) EXEC (+)
   -Y THOLD - ITEM 13 + 0 EXEC
   -Z THOLD - ITEM 14 + 0 EXEC
   [GNC 55 GPS STATUS]
   DES RCVR 1 - ITEM 26 EXEC (no +)
   2 ITEM 27 EXEC (no +)
   3 ITEM 28 EXEC (no +)
   [GNC 33 REL NAV]
   RNDZ NAV ENA - ITEM 1 EXEC (no +)

   RETURN TO FLIGHT PLAN

RENNZOUVOS TIMELINE
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RNDZ OMS BURN
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)

   Wedge
   1: GNC 20 DAP CONFIG

   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 ΔVs per Final ORBIT TGT solution
   √Guidance option is LAMBERT

   If ground-computed burn:
   √TGT data per Burn Pad (reload WT as reqd)
   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC
   √Burn data

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

   CRT1
   MNVR – ITEM 27 EXEC (*)

   If RR ops:
   A1U
   KU sel – AUTO TRK
   1: GNC 33 REL NAV

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

   When mnvr to att complete:
   √DAP: A/AUTO/ALT

3. PERFORM RNDZ OMS BURN

   CAUTION
   LAMBERT burn must be completed by
   T1 TIG + 1:30 to avoid guidance errors

   * If start of LAMBERT burn delayed: *
   * Retarget burn, then go to step 2 *

   TIG-3
   F6,F8
   FLT CNTLR PWR (two) – ON
   Perform OMS2/ORBIT OMS BURNS (Cue Card)

Cont next page
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

5. **MNVR TO POST BURN ATTITUDE**

- Desired UNIV PTG load active

C3 DAP: B/AUTO/ALT

If RR ops, when ATT ERR < 30 deg:
A1U KU sel – GPC
\(\sqrt{\text{KU TRACK tb – gray}}\)

CRT1 AUTO Angles – ITEM 23 EXEC (*)

When in attitude and rates nulled:

C3 DAP: A/AUTO/VERN(ALT)
SENSOR FAIL
1. **NAV SAFING**

   **1: GNC 33 REL NAV**

   CRT1 INH Angles – ITEM 24 EXEC (*)

   On MCC GO (if no comm, continue):

2. **CHECK FOR S TRK FAKE LOCK**

   **2: GNC 22 S TRK/COAS CNTL**

   If -Z S TRK, perform COAS visual check:

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

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

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

3. **CHECK IMU MISALIGNMENT**

   **2: GNC 21 IMU ALIGN**

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

4. **RESUME PASS**

   Continue with pass per STAR TRACKER NAV, step 3 10A, then:

   After S TRK pass, on MCC GO:

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

   **2: GNC 22 S TRK/COAS CNTL**

   CRT2 -Z(-Y) SELF-TEST – ITEM 2(1) EXEC (*)
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 (*)
COAS NAVIGATION

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
√SENSE: -Z
√DAP: B7/AUTO/VERN(ALT)

[COAS NAV CONFIG]

CRT
GNC 22 STRK/COAS CNTL

REQD ID – ITEM 21 +1 EXEC
√POS -Z: ITEM 27 (*)

GNC 33 REL NAV
INH Angles – ITEM 24 EXEC (*)
√SV SEL, ITEM 4 – FLTR
If TGT NOT in COAS FOV:
| √MCC
If TGT in COAS FOV:
FLTR TO PROP – ITEM 8 EXEC
COAS – ITEM 14 EXEC (*)

Upon MCC uplink of COVARIANCE MATRIX,
COVAR REINIT – ITEM 16 EXEC

2. COAS MARKS

A6U
FLT CNTLR PWR – ON
DAP: B/FREE/PRI
RHC: As reqd to move TGT near COAS center and maintain BODY YAW ERR < 10 deg
DAP: B/FREE/VERN
RHC: As reqd to maintain TGT at COAS center and maintain BODY YAW ERR < 10 deg

When TGT centered in COAS, ATT REF pb – push

[COAS MARKS]

CRT
If X and Y RESID magnitudes ≥ 1.0:
| √MCC
If X and Y RESID magnitudes < 1.0:
FOR – ITEM 25 EXEC
√SV UPDATE – non-zero (within 8 sec), then – 0.0 (after 8 sec more)

Repeat step 2 per schedule:
One mark every 10 to 20 sec until sunset Post-Ti

At sunset,

3. END COAS NAV

A6U
DAP: A7/AUTO/VERN(ALT)
FLT CNTLR PWR – OFF

[END COAS NAV]

CRT
GNC 22 STRK/COAS CNTL
COAS: DES – ITEM 25 EXEC (*)

Resume rendezvous timeline
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 F1F – ITEM 31 EXEC (no *)
   F2F – ITEM 35 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 F1F – ITEM 31 EXEC (no *)
   - F2F – ITEM 35 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 ≤ 700 ft cg to cg*
- Tgt stable on orbiter -Z axis

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

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

   **NOTE**
   DAP A allowed for ±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 F1F – ITEM 31 EXEC (no *)
   F2F – ITEM 35 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 +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 (±X) Burn TIG ____/____:____:____

   Report Tig to MCC

A6U FLT_CNTL/PWR – OFF

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

   GNC, OPS 202 PRO

   √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 \((\pm X)\) burn + 30 min

   If Posigrade Sep:
   \[
   \begin{align*}
   \Delta V_x &= \text{ITEM 19} + 4.3 \text{ EXEC} \\
   \Delta V_y &= \text{ITEM 20} + 3.6 \text{ EXEC} \\
   \Delta V_z &= \text{ITEM 21} + 0 \text{ EXEC}
   \end{align*}
   \]

   If Retrograde Sep:
   \[
   \begin{align*}
   \Delta V_x &= \text{ITEM 19} - 4.3 \text{ EXEC} \\
   \Delta V_y &= \text{ITEM 20} + 3.6 \text{ EXEC} \\
   \Delta V_z &= \text{ITEM 21} + 0 \text{ EXEC}
   \end{align*}
   \]

   TV ROLL – ITEM 5 + ___ EXEC
   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC

   Config DAP A,B to A7,B7

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

   **At TIG -0:30:**
   DAP TRANS: as reqd
   DAP: A/INRTL/PRI

   F7 FLT CNTLR PWR – ON

   **At TIG, THC:** Trim VGOs ≤ 0.2 fps

   F7 FLT CNTLR PWR – OFF

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

   GNC, OPS 201 PRO

   **On MCC call:**
   Go to **TERMINATE SEP OPS 8C, 2-8**
NOTE
This procedure may be performed anytime between Ti and TORVA init (+X burns to start TORVA are complete)

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

2. 3 FPS RETROGRADE
   CRT
   OPS 202 PRO
   [GNC ORBIT MNVR EXEC]
   √RCS SEL – ITEM 4 (*)
   Set TIG to current time
   TGT PEG 7 ΔVX – ITEM 19 –3 EXEC
   ΔVY – ITEM 20 +0 EXEC
   ΔVZ – ITEM 21 +0 EXEC
   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC
   Do not maneuver to burn attitude
   DAP TRANS: as reqd
   Deflect THC to null VGOs
   FLT CNTLR PWR – OFF

CRT
   OPS 201 PRO
   DAP: A/AUTO/VERN(ALT)
EXPEDITED SEPS
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 F1F – ITEM 31 EXEC (no *)
- F2F – ITEM 35 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 9A, 2-9
  Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6

2. PERFORM RADIAL BURN ON ±VBAR
When RNG > 150 ft (DP–DP):
- DAP: A/LVLH/VERN(PRI), LO Z
- DAP TRANS: NORM/PULSE/PULSE
- THC: +X (up) for 12 sec (3.0 fps)
- DAP TRANS: PULSE/PULSE/PULSE

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

At radial burn TIG + 6 min or when RNG > 1000 ft confirmed:
- GNC 20 DAP CONFIG
 Config DAP A,B to A7,B7
 DAP: no LO Z

Cont next page
3. PERFORM FINAL BURN

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

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

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

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

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

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

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

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

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

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

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

GNC, OPS 201 PRO

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

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

1. INSTALL RNDZ TOOLS
If rendezvous tools already installed, go to step 2
   - Perform C/L CAM INSTALL (PHOTO/TV, CENTERLINE (C/L) CAMR)
   - Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZ TOOLS), 7-2
   - If reqd, install -Z COAS
   - If RPOP setup reqd:
     - GNC 33 REL NAV
     - RNDZ NAV ENA – ITEM 1 EXEC (*)
     - ORB TO TGT – ITEM 10 EXEC
   - Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-8, then:
   - Perform RPOP OPS (RNDZ TOOLS), 7-9, steps 1 to 5, 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 HHL CHECKOUT (RNDZ TOOLS), 7-6

2. CONFIGURE FOR UNDOCKING
   - ISS: FREE
   - A6U: FREE
   - DAP: FREE
   - SENSE: -Z
   - AFT ADI ATT – LVLH
   - ERR – MED
   - RT – LO
   - GNC 23 RCS

   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
   - Reselect manually deselected primary jets (no *) except F1F and F2F
   - 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**

   **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 3

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

   When RNG > 50 ft (DP to DP):
   - **GNC 23 RCS**
   - √RCS FWD – ITEM 1 EXEC (*)
   - JET DES F1F – ITEM 31 EXEC (no *)
   - F2F – ITEM 35 EXEC (no *)

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

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

   Cont next page
5. PERFORM +X BURN AT RNG > 150 FT
When RNG > 150 ft (DP-DP):
   DAP: A/LVLH/VERN(PRI), LO Z
   DAP TRANS: NORM/PULSE/PULSE
   THC: +X (up) for 8 sec (2.0 fps)
   DAP TRANS: PULSE/PULSE/PULSE
Record +X Burn TIG ___ / ___ : ___ : ___
Stop maintaining 8 deg corridor
Inform MCC when burn complete

6. ROTATE TO PLACE AND MAINTAIN ISS IN OVHD WINDOW
   DAP: A/INRTL/PRI
Perform manual pitch rotation as reqd:
   DAP ROT: DISC/PULSE/DISC
   RHC: ± PITCH as reqd to place and maintain ISS in OVHD Window
When RNG > 1000 ft (CG–CG):
   DAP: no LO Z

7. PERFORM OUT-OF-PLANE BURN
   GNC 20 DAP CONFIG
   Config DAP A,B to A7/B7
   GNC, OPS 202 PRO
   [GNC ORBIT MNVR EXEC]
   √RCS SEL – ITEM 4 EXEC (*)
   Set TIG to +X Burn TIG + 22 min
   TGT PEG 7 ΔVX – ITEM 19 +0 EXEC
   ΔVY – ITEM 20 +2.5 EXEC
   ΔVZ – ITEM 21 +0 EXEC
   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC
   If VGO Z is negative:
     TGT PEG 7 ΔVY – ITEM 20 -2.5 EXEC
     LOAD – ITEM 22 EXEC
     TIMER – ITEM 23 EXEC
     √VGO Z ≥ 0
   Do not maneuver to burn attitude
   At TIG:
     √RNG > 1500 ft (CG–CG)
     A6U
     FLT CNTLR PWR – OFF
     DAP ROT: DISC/DISC/DISC
     F6
     FLT CNTLR PWR – ON
     THC: trim VGOs ≤ 0.2 fps
     FLT CNTLR PWR – OFF
Record Out-of-Plane Burn TIG ___ / ___ : ___ : ___

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 ΔVY from Out-of-Plane burn (step 4) was positive:
TV ROLL – ITEM 5 +2 7 0 EXEC
If ΔVY from Out-of-Plane burn (step 4) was negative:
TV ROLL – ITEM 5 +9 0 EXEC
TGT PEG 7 ΔVX – ITEM 19 +7.0 EXEC
ΔVY – ITEM 20 +0 EXEC
ΔVZ – ITEM 21 +0 EXEC

If retrograde sep desired:

If ΔVY from Out-of-Plane burn (step 4) was positive:
TV ROLL – ITEM 5 +9 0 EXEC
If ΔVY from Out-of-Plane burn (step 4) was negative:
TV ROLL – ITEM 5 +2 7 0 EXEC
TGT PEG 7 ΔVX – ITEM 19 -7.0 EXEC
ΔVY – ITEM 20 +0 EXEC
ΔVZ – 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 ≤ 0.2 fps
F6 FLT CNTLR PWR – OFF
DAP: A/INRTL/VERN(ALT)
GNC, OPS 201 PRO

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

1. **OPS 202 PRO**

   **GNC ORBIT MNVR EXEC**
   Load Ti Delay Pad, 3-7

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

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

   If RCS:
   Perform RCS BURN (Cue Card)

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

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

   **GNC 34 ORBIT TGT**
   TGT NO – ITEM 1 +1 EXEC
   Set BASETIME to new Ti TIG __/__/__:___
   Load – ITEM 26 EXEC
   Reset ET, SM timers to new Ti TIG

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

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

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

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

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

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

#### TIG

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### PRELIMINARY INTERMEDIATE

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### FINAL GROUND FINAL-GROUND LIMITS

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### Ti ONBOARD SOLUTIONS

#### PREL FLTR 1ST INTER FLTR 2ND INTER FLTR (IF REQD)

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### FINAL FLTR PROP (IF REQD) FINAL-GROUND LIMITS

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### FINAL Ti PAD (MNVR PADS)
RNDZ NAV RECOVERY

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

   **NOTE**
   Asterisks will not change until RNDZ NAV enabled

   CRT
   Inhibit RNG – ITEM 18 EXEC
   RDOT – ITEM 21 EXEC
   Angles – ITEM 24 EXEC
   RNDZ NAV ENA – ITEM 1 EXEC (*)
   GNC UNIV PTG
   TRK – ITEM 19 (CUR-*)
   Go to step 3

2. If Recovery from OPS TRANSITION (G8/G3 to G2):
   GNC 34 ORBIT TGT
   TGT NO – ITEM 1 +1 EXEC
   Set BASE TIME to Ti TIG (Ti Burn Pad, 3-6)
   LOAD – ITEM 26 EXEC
   GNC 33 REL NAV
   Upon MCC uplink of TGT SV,
   RNDZ NAV ENA – ITEM 1 EXEC (*)

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

   Select appropriate target track attitude
   GNC UNIV PTG

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<tr>
<td>OM</td>
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   TRK – ITEM 19 (CUR-*)

C3

3. DAP: ALT
   DAP: A/AUTO
   DAP ROT: DISC/DISC/DISC
   When in attitude, DAP: VERN

   If NAV sensor data available:
   If STRK NAV:
   Go to STAR TRACKER NAV 10A, 4-10 >>
   If RR NAV:
   GNC 33 REL NAV

   CRT
   KU ANT ENA – ITEM 2 (*)
   GNC I/O RESET
   Go to RR NAVIGATION 13B, 4-13
TGT ITER

When in Lambert Targeting and TGT ITER occurs:

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

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

If PRED MATCH 999999 (all 9s):

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

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

Ground-Targeted Burns
1. If NH or NC PADs not available, do not perform burn
2. If a day of rendezvous NC or NH maneuver was not performed nominally, then discontinue rendezvous operations
3. If the day of rendezvous NC maneuver is performed using preliminary pads, a large NCC burn can be expected

Lambert-Targeted Burns
1. If “GO for Ti” not received from MCC by Ti TIG - 5 min, perform Ti DELAY BURN (CONTINGENCY OPS), 5-27. If comm is not recovered after two delay revs, perform modified RNDZ BREAKOUT per Ti DELAY BURN (CONTINGENCY OPS), 5-27
2. If radar nav was stopped in an attempt to get Ku comm during the delay, do not perform second or third NCC burn unless radar nav is re-enabled and sufficient radar marks are taken to provide a converged solution
3. If no comm for any midcourse correction (MC) burn, perform burn and continue to prox ops

Prox Ops
1. If “GO for RPM” not received from MCC, do not perform Rbar Pitch Maneuver. Proceed directly to the TORVA and continue to the Vbar. On the Vbar, stationkeep for a maximum of 1 rev and attempt to re-establish comm. If no comm after 1 rev of stationkeeping, perform VBAR BREAKOUT (CONTINGENCY OPS), 5-14
2. If “GO to proceed inside 600, to 400 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 to proceed inside 400, to 170 ft” not received from MCC, do not approach inside 400 ft (CG-CG). Stationkeep on the Vbar outside of 400 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
4. If “GO to proceed inside 170 ft” or “go for docking” not received from MCC do not attempt docking. Back out (if required) and stationkeep outside of 170 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
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 ΔV.
+X translation couples into Y translation toward the failed jets (selection of DAP P,Y – ALL minimizes coupling)

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

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

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

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

| DAPS A9, B9 PITCH AND YAW TO ALL [A] |
| GNC 20 DAP CONFIG |
| DAP EDIT – ITEM 3 +9 EXEC |
| PRI P OPTION – ITEM 55 EXEC – (ALL) |
| PRI Y OPTION – ITEM 56 EXEC – (ALL) |
| LOAD – ITEM 5 EXEC |
| DAP EDIT – ITEM 4 +9 EXEC |
| PRI P OPTION – ITEM 55 EXEC – (ALL) |
| PRI Y OPTION – ITEM 56 EXEC – (ALL) |
| LOAD – ITEM 5 EXEC |
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{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 ±Y translation.
NO-GO for RPM, approach within 250 ft, or docking

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

Do not approach inside 250 ft (interface to interface)

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

NOTE

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

If VERNS failed, perform APPROACH and VBAR APPROACH Cue Cards with following deltas:

Do not perform braking (LO Z or NORM Z) between 600 ft and the Vbar (PITCH ERR < 2 deg)
When in Vbar attitude (PITCH ERR < 2 deg):
  DAP: NO LO Z, maintain NORM Z until docking
  For braking, use DAB 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)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2. COAS NAV should not be performed if VERN fail

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

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

5. Twelve hooks reqd for mated attitude control in ALT
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### ISS RNDZ OPS DAP CONFIGURATIONS

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

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

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

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TCS REFLECTOR VISIBILITY DURING APPROACH

- P4 Solar Array (Out of Plane)
- Refl #1
- Refl #2
- Refl #3

Expected TCS/Ref# Acquisition Range
Refl #2 at TCS max range limit (5000-6000 ft)
Refl #3 is on PMA 3 and Out of Plane (Out of Page)

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

Trajectory NOT TO SCALE

x_{LVLH} z_{LVLH}
HHL AIMING LOCATIONS

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

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

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

Unit/LEDs | MDM | Card/Channel
--- | --- | ---
Unit 1 LEDs 1 & 2 | LA-1 | DIO Card Slot 4 Channel 13
Unit 1 LEDs 3 & 4 | LA-1 | DIO Card Slot 4 Channel 14
Unit 2 LEDs 1 & 2 | LA-2 | DIO Card Slot 4 Channel 13
Unit 2 LEDs 3 & 4 | LA-2 | DIO Card Slot 4 Channel 14

Bottom View

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

Side View

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

PMA2

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<td>6.5</td>
<td>859</td>
<td>695</td>
<td>133</td>
</tr>
<tr>
<td>7</td>
<td>797</td>
<td>645</td>
<td>123</td>
</tr>
<tr>
<td>7.5</td>
<td>744</td>
<td>602</td>
<td>115</td>
</tr>
<tr>
<td>8</td>
<td>698</td>
<td>564</td>
<td>108</td>
</tr>
<tr>
<td>8.5</td>
<td>656</td>
<td>531</td>
<td>102</td>
</tr>
<tr>
<td>9</td>
<td>620</td>
<td>502</td>
<td>96</td>
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<tr>
<td>9.5</td>
<td>587</td>
<td>475</td>
<td>91</td>
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<td>10</td>
<td>558</td>
<td>451</td>
<td>86</td>
</tr>
<tr>
<td>10.5</td>
<td>531</td>
<td>430</td>
<td>82</td>
</tr>
<tr>
<td>11</td>
<td>507</td>
<td>410</td>
<td>78</td>
</tr>
<tr>
<td>11.5</td>
<td>484</td>
<td>392</td>
<td>75</td>
</tr>
<tr>
<td>12</td>
<td>464</td>
<td>376</td>
<td>72</td>
</tr>
</tbody>
</table>
RENDEZVOUS TOOLS

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CCTV CONFIG FOR DOCKING/UNDOCKING

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

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

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

3. SET CAMERA ZOOM SETTINGS
<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 next page)
Use Top/Front Of ISS Ring
Use Bottom/Back Of ISS Ring

Camr A,D Range Ruler Vew
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)

4. Perform RPOP INITIALIZATION, steps 1 thru 6, 7-8

   On MCC GO:

5. Perform TCS ACTIVATION, steps 1 and 2, 7-18

6. Perform HAND-HELD LIDAR CHECKOUT, 7-6

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; then perform each step from appropriate procedure, one at a time, until functionality restored. Troubleshooting steps assume RPOP is configured to receive PCMMU data via the RS-422 data cable.

**TCS CADS NOT RECEIVING TCS DATA**
1. √Windows system tray for PC card icon to verify good connection to MCIU/Quatech card.
2. √TX/RX end of TCS data cable connected to MCIU/Quatech card COM2.
3. √Correct port config in TCS CADS s/w.
4. Quit and restart TCS CADS.
5. Change out TCS data cable and MCIU/Quatech card.
6. Reboot PGSC and restart TCS CADS.
7. On MCC GO, perform TCS DEACTIVATION, 7-20, followed by TCS ACTIVATION, 7-18.
8. √MCC.

**RPOP NOT RECEIVING PCMMU DATA**
1. √Windows system tray for PC card icon to verify good connection to MCIU/Quatech card.
2. √Correct end of RS-422 Y data cable connected to MCIU/Quatech card COM4.
3. √Correct port config in RPOP s/w.
4. Quit and restart RPOP.
5. Change out RS-422 Y data cable and MCIU/Quatech card.
6. Reboot PGSC and restart RPOP.
7. √MCC.

**RPOP NOT RECEIVING HHL DATA**
1. √HHL cable securely connected to HHL unit and COM1.
2. √RPOP port config set to COM1 for HHL.
3. Quit and restart RPOP.
4. Reboot RPOP PGSC and restart RPOP.
5. Connect HHL cable to backup RPOP PGSC COM1 to check data flow. Swap to backup HHL data cable or backup HHL as reqd.
6. √MCC.

**RPOP NOT RECEIVING TCS DATA (TCS CADS IS RECEIVING DATA ON SAME PGSC)**
1. √RPOP configured to receive TCS data via DLL.
2. Quit and restart RPOP.
3. Reboot RPOP PGSC and restart RPOP and TCS CADS.
4. √MCC.
HAND-HELD LIDAR CHECKOUT

1. Unstow HHL, Battery Pack(s), and RS-232 cable
   - Connect RS-232 cable from HHL to PGSC
   - Plug Battery Pack into HHL
   - Verify RPOP program enabled per RPOP INITIALIZATION, 7-8

2. Perform HAND-HELD LIDAR OPS, 7-7

3. Take multiple (~10) Range and Velocity measurements using top center of aft PLB bulkhead or S0 Truss Segment as TGT
   - 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 = ~23 ft
     - Velocity check:
       - Depress trigger for 5 sec
       - Velocity = 0.0 fps
      - Report range and velocity discrepancies to MCC
      - Self-Test: Press and hold Test Mode button, 8.8.8.8. Select range

HAND-HELD LIDAR STOW

- Power sw – OFF
- Remove RS-232 cable
- Unplug Battery Pack
- Stow HHL, Battery Pack(s), and RS-232 cable
HAND-HELD LIDAR OPS

Power sw – ON

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

Display Intensity knob – Adjust intensity to minimum acceptable level

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

Center red dot on TGT

Depress trigger for each measurement
Hold trigger for velocity measurements

Velocity accuracy increases with trigger hold duration:

<table>
<thead>
<tr>
<th>Duration</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0.15</td>
</tr>
<tr>
<td>1.0</td>
<td>0.06</td>
</tr>
<tr>
<td>2.0</td>
<td>0.03</td>
</tr>
<tr>
<td>5.0</td>
<td>0.01</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
RPOP INITIALIZATION

NOTE
Do not connect RS232 cable (with data flowing over it) to PGSC prior to PGSC powerup

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

2. From Startup Menu, select appropriate Expansion Chassis config

3. Select Shuttle Apps Icon
   Select RPOP folder
   Select appropriate RPOP icon
   [RPOP logo display]
   [RPOP Initialization]

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

   NOTE
   Time synchronized on [OK]

5. √ PCM selected – status displayed above F6 ([CTRL]/[F6] to enable/disable)
   √ RPOP is receiving PCMMU data

   If no target state vector on board, expect flashing error msg
   If target state vector on board but rel nav not enabled, expect bad relative state

6. Update target LVLH attitude as reqd – [SHIFT]/[F6]
   [Enter Target Vehicle Attitude Info]
   Select appropriate Attitude (PYR Seq.)

   Pitch > ______   Yaw > ______   Roll > ______

   Select appropriate attitude rate
   Enter rates (as reqd)
   Click [OK] to continue
RPOP OPS

1. √RPOP SETUP complete:
   √RPOP window title bar – verify mission specific scenario
   In upper right corner of Trajectory Display:
   √Time – counting as reqd
   √RPOP configuration – as reqd (Pitch, Alt)

2. Begin processing trajectory data:
   Configure/input trajectory data as needed per RPOP FUNCTION KEY
   SUMMARY (Trajectory Data Keys)

3. Update MET (as reqd):
   [CNTL]/[F10]
   RPOP Configuration

   Select [Update MET. . .] button
   Update MET

   Update MET and click [OK] when finished

4. Reconfig Serial Ports (as reqd):
   [CNTL]/[F10]
   RPOP Configuration

   Select [Comm Ports. . .] button
   RPOP Communications Setup

   Reconfig desired com ports/DLL and click [OK] when finished

   NOTE
   TCS source for RPOP must be set to DLL

5. Reconfig TCS No./Reflector No. Settings (as reqd):
   [CNTL]/[F10]
   RPOP Configuration

   Select [TCS/Refl. . .] button
   Select TCS/Reflector Set

   Reconfig desired TCS No. and/or Reflector No. and click [OK] when finished

6. Config Average Rdot guidance (as reqd):
   Select Guid – [CTRL]/[F5]
   Select Guidance Type

   Select [Average Rdot] button – [A]
   Enter time until docking (countdown time)
   Min > ________
   Sec > ________

   Select [Start]. Timer starts when [Start] pressed
   Click [OK] when finished

   Cont next page
7. Configure TCS NAV (as reqd):
   Select [Data] key for the TCS (CTRL row in columns F1 through F4)
   If there is no [Data] key for TCS, reconfigure data source for TCS
   
   Select Nav option – [N]
   Click [OK] when finished

8. Configure HHL NAV (as reqd):
   Select [Data] key for the HHL (CTRL row in columns F1 through F4)
   If there is no [Data] key for HHL, reconfigure data source for HHL
   
   Select [HHL Nav...] config button – [ALT]/[H]
   HHL Nav Configuration
   Enable HHL Nav (if unchecked) – [H]
   Click [OK] to close HHL Nav dialog
   Click [OK] or [Update Settings] to close HHL dialog

9. Configure OOP, Glideslope, or +Vbar Acquisition Guidance (as reqd):
   Select Guid – [CTRL]/[F5]
   [Select Guidance Type]
   Select [OOP Control] – [O]
   Select [Glideslope Control] – [G]
   Select [+Vbar Acquisition] – [V]
   Click [OK] when finished.

   NOTE
   Glideslope Control with Init:Auto must first be selected to make +Vbar Acquisition available

10. Change configuration and/or input data as reqd per RPOP FUNCTION KEY

    SUMMARY
    Move axes or zoom in/out as desired per RPOP KEYSTROKE SUMMARY
    Use [SPACEBAR] to toggle on-screen Function Key Menu ON/OFF
    Use [F10] for HELP
    Use [F11] to cycle thru declutter levels
    Use [F12] to snap a range ruler mark; [SHIFT]/[F12] to delete it

11. To exit RPOP program – [SHIFT]/[F10]
RPOP FUNCTION KEY SUMMARY

TRAJECTORY DATA KEYS (Columns F1 → F4)

[F1→F4] PRIME KEY
(SV, RR, HHL, CCTV or TCS)
- Make this Trajectory Prime Trajectory
- Only one trajectory can be Prime at a time
- Prime Trajectory has orbiter graphics, predictors, and color-coordinated digital data

[SHIFT]/[F1→F4] SHOW/HIDE KEY
(Show/Hide)
- Show or hide this Trajectory (toggle)
- Prime Trajectory cannot be hidden
- Background processing of trajectory continues even when hidden
  (Exception: HHL trajectory data will not prompt for user input when hidden)

[CTRL]/[F1→F4] DATA KEY
(Data)
- Configure/input data for trajectory
  - Allows user to configure specific Trajectory Data Source Options
  - Allows user to input manual data
  - Allows user to reconfigure function key to another Trajectory Data Source
  - Duplicate Trajectory Data Source configurations are permitted
    (e.g., HHL could be configured for both F3 and F4, if desired)

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.
### GENERAL FUNCTION KEYS (Columns F5 → F12)

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>[F5]</td>
<td>RDOT WINDOW</td>
</tr>
<tr>
<td>(Rdot)</td>
<td>Toggles display of Rdot Window</td>
</tr>
<tr>
<td>[SHIFT]/[F5]</td>
<td>ORBITER ATTITUDE</td>
</tr>
<tr>
<td>(Orb Att)</td>
<td>Update orbiter attitude and attitude rate</td>
</tr>
<tr>
<td>[CTRL]/[F5]</td>
<td>GUIDANCE</td>
</tr>
<tr>
<td>(Guid)</td>
<td>Select guidance cues on demand</td>
</tr>
<tr>
<td></td>
<td>Available options are:</td>
</tr>
<tr>
<td></td>
<td>CW Targeting – given a burn time, transfer time, and desired LVLH position, CW Targeting will provide required THC inputs</td>
</tr>
<tr>
<td></td>
<td>OOP Control – provides THC recommendations for controlling out-of-plane motion</td>
</tr>
<tr>
<td></td>
<td>Glideslope Control – provides THC recommendations for flying the final approach along a glideslope</td>
</tr>
<tr>
<td></td>
<td>+Vbar Acquisition – provides THC recommendations for acquiring the +Vbar in preparation for final approach</td>
</tr>
<tr>
<td></td>
<td>LVLH Velocity Null – provides THC recommendations for nulling LVLH velocities in each direction</td>
</tr>
<tr>
<td></td>
<td>Average Rdot – information for timed approach</td>
</tr>
<tr>
<td>[F6]</td>
<td>SUBTENDED ANGLE</td>
</tr>
<tr>
<td>(Sub Ang)</td>
<td>Enter subtended angle in Rdot Window to get range and range rate. Only active when SubAng source active on Rdot Window</td>
</tr>
<tr>
<td>[SHIFT]/[F6]</td>
<td>TARGET ATTITUDE</td>
</tr>
<tr>
<td>(Tgt Att)</td>
<td>Update Target attitude and attitude rate</td>
</tr>
<tr>
<td>[CTRL]/[F6]</td>
<td>PCMMU MODE</td>
</tr>
<tr>
<td>(PCMMU)</td>
<td>No PCM mode (displays No PCM)</td>
</tr>
<tr>
<td></td>
<td>Requires orbiter attitude data to be entered manually with each sensor mark</td>
</tr>
<tr>
<td></td>
<td>PCM MODE (displays PCM)</td>
</tr>
<tr>
<td></td>
<td>Orbiter attitude is automatically computed using PCMMU data</td>
</tr>
<tr>
<td>[F7]</td>
<td>VIEW</td>
</tr>
<tr>
<td>(View)</td>
<td>If Tgt-Centered LVLH, cycle through views: XZ, XY, YZ</td>
</tr>
<tr>
<td></td>
<td>If Orb-Centered LVLH, cycle through views: XZ, XY, YZ, CAM</td>
</tr>
<tr>
<td></td>
<td>View identification displayed upper left-hand corner of Trajectory Display</td>
</tr>
<tr>
<td>[SHIFT]/[F7]</td>
<td>OVERLAY</td>
</tr>
<tr>
<td>(Ovrlay)</td>
<td>Cycle through displays of overlays</td>
</tr>
<tr>
<td>[CTRL]/[F7]</td>
<td>OVERLAY ORIGIN (Available only if Overlay is enabled)</td>
</tr>
<tr>
<td>(OvrOrgn)</td>
<td>Toggle anchor point of corridor overlay between Target vehicle attach point and orbiter attach point</td>
</tr>
<tr>
<td>[F8]</td>
<td>REFERENCE FRAME</td>
</tr>
<tr>
<td>(Tgt/Orb)</td>
<td>Toggle display between Tgt-Centered LVLH plot and Orb-Centered LVLH plot</td>
</tr>
<tr>
<td>[SHIFT]/[F8]</td>
<td>LO Z</td>
</tr>
<tr>
<td>(Low Z)</td>
<td>Toggle jet-select between No Low Z and Low Z for making THC “What If” inputs. Displays Low Z</td>
</tr>
<tr>
<td>[CTRL]/[F8]</td>
<td>POINT OF REFERENCE</td>
</tr>
<tr>
<td>(POR)</td>
<td>Cycle through preselected orbiter Point-Of-Reference to Target Point-Of-Reference sets (e.g., CG to CG, Dock Port to Dock Port)</td>
</tr>
</tbody>
</table>
THC CLEAR
Clear THC “What if” inputs from the Prime Trajectory

TRAJECTORY CLEAR
Clear Prime Trajectory history of all but 2 most recent data inputs

BACK 1
Delete last data input from the Prime Trajectory

HELP
Access on-line help information

EXIT
Save output files and exit RPOP program

RPOP CONFIGURATION
Configure following RPOP options:

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

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

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

Update MET...
Change the mission elapsed time

Altitude...
Change altitude of target vehicle

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

TCS/Refl...
Select TCS ID number (1-2) and reflector ID number (1-6)

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
GENERAL FUNCTION KEYS (Columns F5 → F12) (Cont)

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

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

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

- `[CTRL]/[←]` or l: Move Vertical axis left
- `[CTRL]/[→]` or r: Move Vertical axis right
- `[CTRL]/[↑]` or u: Move Horizontal axis up
- `[CTRL]/[↓]` or d: Move Horizontal axis down
- `[CTRL]/[PGUP]`: Zoom IN on Trajectory Display
- `[CTRL]/[X]/[PGUP]`: Zoom IN on X axis only
- `[CTRL]/[Y]/[PGUP]`: Zoom IN on Y axis only
- `[CTRL]/[Z]/[PGUP]`: Zoom IN on Z axis only
- `[CTRL]/[PGDN]`: Zoom OUT on Trajectory Display
- `[CTRL]/[X]/[PGDN]`: Zoom OUT on X axis only
- `[CTRL]/[Y]/[PGDN]`: Zoom OUT on Y axis only
- `[CTRL]/[Z]/[PGDN]`: Zoom OUT on Z axis only

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

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

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

<table>
<thead>
<tr>
<th></th>
<th>DAP A8</th>
<th>DAP B8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z IN</td>
<td>[SHIFT]/[→]</td>
<td>[→]</td>
</tr>
<tr>
<td>Z OUT</td>
<td>[SHIFT]/[←]</td>
<td>[←]</td>
</tr>
<tr>
<td>X UP</td>
<td>[SHIFT]/[↑]</td>
<td>[↑]</td>
</tr>
<tr>
<td>X DOWN</td>
<td>[SHIFT]/[↓]</td>
<td>[↓]</td>
</tr>
</tbody>
</table>
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
- HHL Nav... – HHL Nav activation (on/off) and configuration (display residuals and ratios, force measurements, reinitialize, length of trigger pull (short/long or long only))
- Config... – Reconfigure the Trajectory Data Source for this function key

**Angle Source options include:**
- Fwd CCTV, Aft CCTV, Dock Cam, COAS, Radar, TCS, Other, None

**NOTE**

Manual inputs reqd for all angle sources except Radar, TCS and None. 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
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
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
   > TCS

2. TCS PWRUP/INITIALIZATION
   
   L12
   TCS PWR – ON (tb-gray)

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

   PGCS
   TCS Self Test

<table>
<thead>
<tr>
<th>Status</th>
<th>Override</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shutter:</td>
<td>Passed</td>
</tr>
<tr>
<td>Z Latch:</td>
<td>Passed</td>
</tr>
<tr>
<td>CW Laser:</td>
<td>Passed</td>
</tr>
<tr>
<td>Pulse Laser:</td>
<td>Passed</td>
</tr>
</tbody>
</table>

   ✓ MSG: INITIALIZATION COMPLETE

   * If error msg received during initialization, *
   * \MCC

   TCS OPS

   ✓ Mode: Stby
   ✓ Z Latch: Unlocked
   ✓ Pulse: Avail
   ✓ CW: Active

   * 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
   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**
   
   Input current estimate of range to Target and zero for Azimuth and Elevation:
   
   RANGE > ________________
   AZIMUTH > ________________
   ELEVATION > ________________

   √ 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
   
   √ 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 RPOP TCS NAV**
   Perform RPOP OPS, step 7, 7-10

3. **ENABLE AUTO ACQUISITION**
   
   √ Data – Good (and active tracking data)
   
   **TCS C&DI**
   
   > Config > Automatic
   If Seed Update – (no √)
   
   > Seed Update
   √ Maximum Range (ft): 5000
   > OK
   
   > Config > Automatic
   If Acquisition – (no √)
   
   > Acquisition
   √ Maximum Range (ft): 5000
   > OK
   
   > Config > Automatic
   √ Initialization – (√)
   √ Seed Update – (√)
   √ Acquisition – (√)
TCS DEACTIVATION

1. **SHUTDOWN TCS**

   **PGSC**
   - **TCS C&DI**
   - > Macros > SHUTDOWN

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

   **TCS OPS**
   √Shutter: Closed (takes ~22 sec)

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

   If Final TCS deactivation for mission:

2. **SECURE Z AXIS**

   **PGSC**
   - **TCS C&DI**
   - > Commands > Lock Z Axis Latch

   **TCS OPS**
   √Z Latch: Locked

   * If Z Latch fails to lock: *
   * If Z Latch: Transit *
   * > 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
TCS LIMITS

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

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

TRAD FAIL RANGE AND RANGE RATE DETERMINATION

1. Maintain a prime and a backup range and rdot estimate
2. Prime and backup range and rdot estimates shall have independent sensor sources
3. Maintain prime and backup RPOP PGSCs
4. Refer to tables below for the recommended prime and backup source/configuration for NOMINAL OPS, RADAR FAIL, TCS FAIL, HHL FAIL, PCMMU/WINDECOM FAIL, and PGSC FAIL (No RPOP, No TCS) scenarios

NOMINAL OPS

<table>
<thead>
<tr>
<th>Phase</th>
<th>Prime Source:</th>
<th>Configuration</th>
<th>Backup Source:</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Manual Takeover thru TCS lock-on (R &gt; 3000 ft assumed for TCS nominal lock-on*)</td>
<td>State data: SV</td>
<td>Rdot window: HHL/Dt</td>
<td>NOTE: Configure HHL angle source to Dock Cam and lock angles to 0</td>
<td></td>
</tr>
<tr>
<td>2. TCS lock-on thru 15 ft</td>
<td>State data: TCS NAV</td>
<td>Rdot window: HHL/Dt</td>
<td>NOTE: Configure HHL angle source to Dock Cam and lock angles to 0</td>
<td></td>
</tr>
<tr>
<td>3. 15 ft thru dock</td>
<td>Raw data: TCS Raw</td>
<td>Rdot Window: Range Ruler (F12)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*If no joy on TCS lock-on by 1200 ft, start subtended angle operations so that subtended angle estimates can back up the HHL/Dt inside of 1000 ft
### RADAR FAIL

<table>
<thead>
<tr>
<th>Phase</th>
<th>Prime Source: Configuration</th>
<th>Backup Source: Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Manual Takeover thru TCS lock-on*</td>
<td>Rdot window: HHL/Dt NOTE: Configure HHL angle source to Dock Cam and lock angles to 0</td>
<td>Rdot window: Subtended angles</td>
</tr>
<tr>
<td>NOTE: RPOP State data: (HHL/SV) can be suspect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. TCS lock-on thru 15 ft</td>
<td>State data: TCS NAV</td>
<td>State data: RCS NAV</td>
</tr>
<tr>
<td></td>
<td>Rdot window: HHL Dt NOTE: Configure HHL angle source to Dock Cam and lock angles to 0</td>
<td>Rdot window: Subtended angles</td>
</tr>
<tr>
<td>3. 15 ft thru dock</td>
<td>Raw data: TCS Raw</td>
<td>Rdot Window: Range Ruler (F12)</td>
</tr>
</tbody>
</table>

*Start Subtended angle ops after the radar fail correction if no joy on TCS lock-on

### TCS FAIL

<table>
<thead>
<tr>
<th>Phase</th>
<th>Prime Source: Configuration</th>
<th>Backup Source: Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Manual Takeover thru ~1200 ft</td>
<td>State data: SV</td>
<td>State data: SV</td>
</tr>
<tr>
<td>NOTE: Transition from phase 1 to phase 2 should be gradual. Start transition at ~1500 ft and complete it prior to 1000 ft braking gate</td>
<td>Rdot window: HHL/Dt NOTE: Configure HHL angle source to Dock Cam and lock angles to 0</td>
<td>Rdot window: Subtended angles</td>
</tr>
<tr>
<td>2. ~1200 ft thru 15 ft</td>
<td>Rdot window: HHL Dt NOTE: Configure HHL angle source to Dock Cam and lock angles to 0</td>
<td>Spec 33: Raw Radar*</td>
</tr>
<tr>
<td>NOTE: Spec 33: FLTR, and State data: HHL can be suspect</td>
<td>Spec 33: Raw Radar*</td>
<td>Spec 33: Raw Radar*</td>
</tr>
<tr>
<td>3. 15 ft thru dock</td>
<td>Rdot Window: Range Ruler (F12)</td>
<td>Rdot window: HHL/Dt**</td>
</tr>
</tbody>
</table>

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

**HHL will not work if the aimpoint surface is closer than 12 feet (5 ft DP-DP)

### HHL FAIL

<table>
<thead>
<tr>
<th>Phase</th>
<th>Prime Source: Configuration</th>
<th>Backup Source: Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Manual Takeover thru TCS lock-on</td>
<td>State data: SV</td>
<td>State data: SV</td>
</tr>
<tr>
<td></td>
<td>Rdot window: Subtended Angle</td>
<td>Rdot window: Subtended Angle</td>
</tr>
<tr>
<td>2. TCS lock-on thru 15 ft</td>
<td>State data: TCS NAV</td>
<td>Spec 33: Raw RR*</td>
</tr>
<tr>
<td></td>
<td>Rdot window: Subtended Angle</td>
<td>Spec 33: Raw RR*</td>
</tr>
<tr>
<td>3. 15 ft thru dock</td>
<td>Raw data: TCS Raw</td>
<td>Rdot Window: Range Ruler (F12)</td>
</tr>
</tbody>
</table>

*Radar data will be unusable at close ranges. The range at which the data becomes unusable is dependent on the target size, geometry, and physical characteristics, but cannot be accurately predicted. For ISS the RR can become too noisy to use at ranges as great as 1000 ft
### PCMMU/WINDECOM FAIL

<table>
<thead>
<tr>
<th>Phase</th>
<th>Prime Source: Configuration</th>
<th>Backup Source: Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOTE: Transition from phase 1 to 2 should be gradual. Start transition at ~1500 ft and complete it prior to 1000 ft braking gate</td>
<td>NOTE: RPOP state data is bad</td>
<td>NOTE: RPOP prompts user for Orb attitude after 1st HHL mark. Enter P/Y/R = (90/0/0)* and check “Do not prompt for attitude”</td>
</tr>
<tr>
<td>TCS CADS: Raw TCS (pulse active)</td>
<td>NOTE: Range data good, rdot can be quite noisy</td>
<td>NOTE: RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
</tr>
<tr>
<td>2. ~1200 ft thru TCS CW lock-on (~800 ft)</td>
<td>Rdot window: HHL/Dt</td>
<td>TCS CADS: Raw TCS (pulse active)</td>
</tr>
<tr>
<td>NOTE: RPOP State data is bad</td>
<td>NOTE: RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
<td>NOTE: Range data good, rdot can be quite noisy</td>
</tr>
<tr>
<td>Rdot window: Generic</td>
<td>Rdot window: Raw TCS (pulse active)</td>
<td>Rdot window: Raw TCS (pulse active)</td>
</tr>
<tr>
<td>3. TCS CW lock-on (~800 ft) thru Vbar arrival</td>
<td>TCS CADS: Raw TCS (cw active)</td>
<td>Rdot window: HHL/Dt</td>
</tr>
<tr>
<td>NOTE: RPOP State data is bad</td>
<td>TCS CADS: Raw TCS (cw active)</td>
<td>Rdot window: HHL/Dt</td>
</tr>
<tr>
<td>4. Vbar arrival thru 15 ft</td>
<td>TCS CADS: Raw TCS (cw active) and/or State Data: TCS AUTO</td>
<td>Rdot window: Range Ruler(F12)</td>
</tr>
<tr>
<td>NOTE: Check Orb Att = (90/0/0), and set TCS frequency to 30 sec[CNTRL F10]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. 15 ft thru dock</td>
<td>TCS CADS: TCS Raw (cw active)</td>
<td>Rdot window: Range Ruler(F12)</td>
</tr>
<tr>
<td>For Range: Subtended Angle table(6-13): COAS or Centerline Cam subtended angle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For Rdot: HHL (back of unit): Raw HHL (long trigger pulls)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Orbiter attitude displayed on RPOP will not be correct until maneuver to Vbar attitude is complete. Until Vbar arrival, do not use the RPOP trajectory data other than the data in the Rdot Window</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### PGSC FAIL (NO RPOP, NO TCS)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Prime Source: Configuration</th>
<th>Backup Source: Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Rdot – Rdot vs. ΔRng/Δt Cue Card: Record Raw HHL range and times on cue card</td>
<td>For range – HHL (back of unit): Raw HHL</td>
<td></td>
</tr>
<tr>
<td>2. ~1200 ft thru 15 ft</td>
<td>For Range: HHL (back of unit): Raw HHL (short pulls)</td>
<td>For range – Subtended Angle table(6-13): COAS or Centerline Cam subtended angle</td>
</tr>
<tr>
<td>For Rdot: HHL (back of unit): Raw HHL (long pulls)</td>
<td>For Rdot – Rdot vs. ΔRng/Δt Cue Card: Record subtended angle range and times on cue card</td>
<td></td>
</tr>
<tr>
<td>3. 15 ft thru dock</td>
<td>For Range: Range Ruler Overlay: Camera A/D HHL (back of unit): Raw HHL* (long trigger pulls)</td>
<td>For Rdot – Rdot vs. ΔRng/Δt Cue Card: Record subtended angle range and times on cue card</td>
</tr>
<tr>
<td>Rdot table on Range Ruler Overlay: Dt between 1 ft DRange</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*HHL will not work if the aimpoint surface is closer than 12 feet (5 ft DP-DP)
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APDS NOMINAL

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DOCKING MECHANISM INITIALIZATION

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

A7L  2.  √CONTROL PANEL POWER A,B,C (three) – OFF
      √HEATERS/DCU POWER (three) – OFF
      √APDS POWER A_DS,B_DS,C_DS (three) – OFF
      √A_DS,B_DS,C_DS lt (three) – Lt off
      √STATUS lt (eighteen) – Lt off
      √PYROS A_p,B_p,C_p (three) – OFF
      √A_p,B_p,C_p lt (three) – Lt off
      √PYRO CIRCUIT PROTECT OFF lt – Lt off

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

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

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 – OP (tb-OP)

A7L 2. HEATERS/DCU POWER (three) – ON
     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
     CNTL PNL PWR – A/B/C

A7L 4. APDS POWER A DS, B DS, C DS (three) – ON
     A DS, B DS, C DS lt (three) – lt on

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 >>
* If CNTL PNL PWR B tlm blank:
* 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. \( \sqrt{\text{STATUS lt (eighteen) – lt off}} \)

2. \( \sqrt{\text{APDS POWER } A_{DS}, B_{DS}, C_{DS} \text{ (three) – OFF}} \)
   \( \sqrt{\text{A}_{DS}, B_{DS}, C_{DS} \text{ lt (three) – lt off}} \)

CRT \( \sqrt{\text{PWR (three) – blank}} \)

A7L 3. \( \sqrt{\text{CONTROL PANEL POWER A,B,C (three) – OFF}} \)

CRT \( \sqrt{\text{CNTL PNL PWR A,B,C (three) – blank}} \)

A7L 4. \( \sqrt{\text{HEATERS/DCU POWER (three) – OFF}} \)

CRT \( \sqrt{\text{HTR/DCU PWR (three) – blank}} \)

A6L 5. \( \sqrt{\text{PSU PWR MN A,MN B (two) – OFF}} \)

6. If post-undocking:
   \( \sqrt{\text{VEST DEP VLV SYS 1(SYS 2) VENT – CL (hold 5 sec, tb-CL)}} \)
   \( \sqrt{\text{VEST DEP VLV SYS 1(SYS 2) VENT ISOL – CL (hold 5 sec, tb-CL)}} \)
   \( \sqrt{\text{cb MNA DEP SYS 1 VENT – op}} \)
   \( \sqrt{\text{cb MNB DEP SYS 2 VENT – op}} \)
   \( \sqrt{\text{cb ESS 1BC DEP SYS 1 VENT ISOL – op}} \)
   \( \sqrt{\text{2CA DEP SYS 2 VENT ISOL – op}} \)
   \( \sqrt{\text{ML86B:C MNA EXT ARLK HTR VEST Z1/2/3 – op}} \)
DOCKING PREP

<table>
<thead>
<tr>
<th>SM 167 DOCKING STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A6L 1. LTS TRUSS AFT,FWD (two) – ON</td>
</tr>
<tr>
<td>VEST PORT,STBD (two) – ON (if reqd)</td>
</tr>
<tr>
<td>A7L 2. POWER ON pb – push</td>
</tr>
<tr>
<td>√ON lt – lt on</td>
</tr>
<tr>
<td>√RING ALIGNED lt – lt on</td>
</tr>
<tr>
<td>√INITIAL POSITION lt – lt on</td>
</tr>
<tr>
<td>√HOOKS 1,HOOKS 2 OPEN lt (two) – lt on</td>
</tr>
<tr>
<td>√LATCHES CLOSED lt – lt on</td>
</tr>
<tr>
<td>CRT √CLUTCH – blank/SLIP</td>
</tr>
</tbody>
</table>

UNDOCKING PREP

| A6L 1. LTS TRUSS FWD,AFT (two) – ON (as reqd) |
| VEST PORT,STBD – 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/SLIP):
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 *
* *
* If RING FORWARD POSITION lt failed on (ring stops after *
* 10 sec):
A7L *
* RING OUT pb – push *
* Within 10 sec:
A7L *
* 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:
A7L *
* 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:
  * √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:
  * √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 off
CRT √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

MIDDK  1. Disconnect bypass duct from middeck floor fitting. Remove cap from Airlock Fan outlet and temp stow. Unstow, install diffuser on middeck floor fitting

TNL EXT  2. Attach bypass duct to Airlock Fan outlet

MA73C:G  3. √cb AC1,2 ARLK TNL FAN A,B (six) – cl

MO13Q  4. AIRLK FAN A(B) – 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 airflow to window
     If required, tape diffuser open

AW18A  7. LTG FLOOD 1(3,4) – OFF

MO13Q  8. AIRLK 2 – OFF/ON

MIDDK  9. Close Inner Hatch:
            Position handle to preclosing posn per decal
            Hatch – rotate about hinge and push
            Handle – CCW to LATCH
            Lock lever to LOCKED

10. Equal vlv (two) – OFF, install caps

MO10W  11. √/4.7 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

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
6. ARLK 2 – ON/OFF
7. ARLK FAN A(B) – OFF
8. Disconnect bypass duct from Airlock Fan outlet
   MIDDK Remove diffuser from middeck floor fitting and temp stow
   Connect bypass duct to middeck floor fitting. Unstow, install cap on Airlock Fan outlet
9. As required, LTG FLOOD 1(3,4) – ON
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)
APDS OFF-NOMINAL

POWER FAILED OFF (STATUS LTS OFF) ........................................................................ 8-14
DAMPING FAILED ON .............................................................................................. 8-15
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    FINAL POSITION LT FAILED ON ...................................................................... 8-20
FORCE RING ALIGNMENT ....................................................................................... 8-20
CLUTCH NOT 'LOCK' .............................................................................................. 8-20
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    NOT CLOSED WITHIN SINGLE MTR TIME .................................................... 8-22
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    OPEN .............................................................................................................. 8-37
POWER FAILED OFF (STATUS LTS OFF)

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

A7L 1. CONTROL PANEL POWER A – OFF
    POWER ON pb – push
    If expected STATUS lts on:
    Continue in DOCKING SEQUENCE (Cue Card), as reqd >>

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

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

4. APDS CIRC PROT OFF pb – push
   \^{CIRCUIT PROTECT OFF lt – lt on}
   OPEN LATCHES pb – push
   \^{LATCHES CLOSED lt – lt off}
   APDS POWER C\_Ds – OFF
   A\_Ds,B\_Ds (two) – ON
   POWER ON pb – push
   If STATUS lt (eighteen) – lt off:
   APDS POWER B\_Ds – OFF
   C\_Ds – ON
   POWER ON pb – push
   APDS CIRC PROT OFF pb – push
   \^{CIRCUIT PROTECT OFF lt – lt on}
   Go to DOCKING SEQUENCE (Cue Card), step 17
DAMPING FAILED ON

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

**SM 167 DOCKING STATUS**

1. PSU PWR MN A,MN B (two) – OFF
   A6L
   CRT If DAMPING – ON (TLM failure only):
   A6L PSU PWR MN A,MN B (two) – ON
   CRT Continue approach or DOCKING SEQUENCE (Cue Card), as reqd >>

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

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

CAPTURE LT FAILED ON

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

**SM 167 DOCKING STATUS**

- If Pre-Contact:
  CRT If DAMPING – OFF:
  - Continue Approach >>
  If DAMPING – ON:
  A6L PSU PWR MN A,MN B (two) – OFF
  Continue Approach
  Post-Capture (no physical separation):
  PSU PWR MN A,MN B (two) – ON
  Continue in DOCKING SEQUENCE (Cue Card), as reqd
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**

<table>
<thead>
<tr>
<th></th>
<th>A7L</th>
<th>CRT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>POWER OFF pb – push</td>
<td>If RING FIXERS – ON:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A7L</td>
<td>POWER ON pb – push</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Continue Approach or <strong>DOCKING SEQUENCE</strong> (Cue Card), as reqd</td>
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<tr>
<th></th>
<th>A7L</th>
<th>CRT</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>2.</td>
<td>POWER ON pb – push</td>
<td>APDS POWER A_Ds – OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CRT</td>
<td>If RING FIXERS – ON:</td>
<td></td>
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<tr>
<td></td>
<td>A7L</td>
<td>APDS POWER A_Ds – ON</td>
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<tr>
<td></td>
<td></td>
<td>B_Ds – OFF</td>
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<tr>
<td></td>
<td>CRT</td>
<td>If RING FIXERS – OFF:</td>
<td></td>
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<td></td>
<td></td>
<td>Pre-Contact:</td>
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<td></td>
<td></td>
<td>Continue Approach</td>
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<td></td>
<td></td>
<td>Post-Capture, continue in <strong>DOCKING SEQUENCE</strong> (Cue Card), as reqd, with the following change:</td>
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<tr>
<td></td>
<td></td>
<td>After <strong>DOCKING SEQUENCE</strong> (Cue Card), step 16:</td>
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</tr>
<tr>
<td></td>
<td>A7L</td>
<td>APDS POWER A_Ds (B_Ds) – ON</td>
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<th>A6L</th>
<th>CRT</th>
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<tbody>
<tr>
<td>3.</td>
<td>APDS POWER B_Ds – ON</td>
<td>PSU PWR MN A,MN B (two) – OFF</td>
<td></td>
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<tr>
<td></td>
<td>A6L</td>
<td>PSU PWR MN A,MN B (two) – OFF</td>
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<tr>
<td></td>
<td></td>
<td>If post-contact:</td>
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<td></td>
<td>√MCC for subsequent steps</td>
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<td>Continue Approach</td>
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<td></td>
<td>Post-capture wait 7 seconds, then:</td>
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<tr>
<td></td>
<td>A7L</td>
<td>APDS POWER A_Ds,B_Ds,C_Ds (three) – OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A6L</td>
<td>PSU PWR MN A,MN B (two) – ON</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CRT</td>
<td>√DAMPING – ON</td>
<td></td>
</tr>
</tbody>
</table>

**DISABLE DAMPING**

<table>
<thead>
<tr>
<th></th>
<th>A6L</th>
<th>A7L</th>
<th>CRT</th>
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</thead>
<tbody>
<tr>
<td>4.</td>
<td>When no relative motion [PETAL POS BASE (three) not changing for 60 sec]:</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>PSU PWR MN A,MN B (two) – OFF</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>APDS POWER A_Ds,B_Ds,C_Ds (three) – ON</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>POWER ON pb – push</td>
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<td></td>
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</tbody>
</table>
COMMAND CLUTCH TO LOCK

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

RETRACT RING

A7L 6. RING IN pb – push
     APDS POWER A DS,B DS,C DS (three) – OFF
0:00 A6L  PSU PWR MN A,MN B (two) – ON
CRT  √RING DRV CMD – ON [PETAL POS BASE (three) – decr]
0:05 A6L  PSU PWR MN A,MN B (two) – OFF
A7L  APDS POWER 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
     APDS POWER A DS,B DS,C DS (three) – OFF
0:00 A6L  PSU PWR MN A,MN B (two) – ON
CRT  √RING DRV CMD – ON [PETAL POS BASE (three) – incr]
0:05 A6L  PSU PWR MN A,MN B (two) – OFF
A7L  APDS POWER 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
   √CIRCUIT PROTECT OFF lt – lt on
   RING OUT pb – push

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

A7L 1. POWER OFF pb – push
   Power ON pb – push
   FIXER OFF pb – push
   If FIXERS OFF lt – lt on:
   Continue in DOCKING SEQUENCE (Cue Card), as reqd >>

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
A6L 0:00 PSU PWR MN A,MN B (two) – ON
CRT 0:05 √CLUTCH – LOCK/blank

A6L 3. 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 0:00 PSU PWR MN A,MN B (two) – ON (ring will begin to drive in this step)
CRT √PETAL POS BASE (three) – decr
A7L 0:05 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
A7L RING OUT pb – push
   APDS POWER A DS,B DS,C DS (three) – OFF
   – ON
A6L 0:00 PSU PWR MN A,MN B (two) – ON (ring will begin to drive in this step)
CRT √PETAL POS BASE (three) – incr
A7L 0:05 POWER ON pb – push
CRT √RING DRV CMD – OFF

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

SM 167 DOCKING STATUS

A7L 1. POWER ON pb – push
   APDS CIRC PROT OFF pb – push
   \[CIRCUIT PROTECT OFF lt – lt on\]
   FIXER OFF pb – push
   \[FIXERS OFF lt – lt on\]
2. RING OUT pb – push
   CRT If PETAL POS BASE (three) incr:
   A7L POWER ON pb – push
   \[MCC\]
3. If PETAL POS BASE (three) not incr:
   If RING DRV CMD – ON:
   A7L 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

SM 167 DOCKING STATUS

A7L 1. POWER OFF pb – push
   ON pb – push
   If STATUS lt (eighteen) – lt off:
   CONTROL PANEL POWER A – OFF
   POWER ON pb – push
   If STATUS lt (eighteen) – lt off:
   Go to step 3
   Continue in DOCKING SEQUENCE (Cue Card), as reqd >>
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:
   \[LATCHES OPEN lt – lt on\]
   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 (\[^{\text{MCC}}\]):
   Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU E) 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

POWER ON pb – push

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

A7L  POWER OFF pb – push

FORCE RING ALIGNMENT

A7L  1. APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on

2. FIXER OFF pb – push
   √FIXERS OFF lt – lt on

0:00  3. RING OUT pb – push

CRT  √DRV CMD – ON [PETAL POS BASE (three) – incr]
   √FIXERS – OFF

0:05  4. When PETAL POS BASE (any) = 92%:
   A7L   RING FORWARD POSITION lt failed on (ring stops after 10 sec):
   * RING OUT pb – push
   * Within 10 sec:
   * APDS POWER A_DS,B_DS,C_DS (three) – OFF
   * APDS POWER A_DS,B_DS,C_DS (three) – ON
   * CIRC PROT OFF pb – push
   * √CIRCUIT PROTECT OFF lt – lt on

CRT  * When PETAL POS BASE (any) = 92%:
   A6L   PSU PWR MN A,MN B (two) – OFF

CRT  * When PETAL POS BASE (three) not changing for 30 sec:
   A6L   PSU PWR MN A,MN B (two) – ON

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

A7L  * 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’

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

CRT
If APDS CIRC PROT – ON:
A7L
   POWER OFF pb – push
   ON pb – push
   APDS CIRC PROT OFF pb – push

A7L
If APDS CIRCUIT PROTECT OFF lt – lt on or
CRT
APDS CIRC PROT – OFF:
   Continue sequence as required >>
   Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F) for RING OUT, OPEN HOOKS, OPEN LATCHES, and UNDOCKING pb commands

HOOKS 1(2) OPEN LT FAILED ON

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

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

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

<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 $A_{DS}$ – 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 $A_{DS}$ – ON</td>
</tr>
<tr>
<td>$B_{DS}$ – 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 $A_{DS}$ ($B_{DS}$) – ON &gt;&gt;</td>
</tr>
</tbody>
</table>

2. APDS POWER $A_{DS}$ ($B_{DS}$) – 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, 8-35, 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, 8-35, 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 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:
   · L APDS POWER $A_{DS}$ – ON >>

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

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
       √ CLOSED lt – lt on

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

0:20  4. When CAPTURE lt – lt on:
      POWER OFF pb – push
      ON pb – push
      √ CAPTURE lt – lt off

0:00  5. RING IN pb – push
0:10   POWER ON pb – push
      √ RING FINAL POSITION lt – lt off
      CRT √ DRV CMD – OFF
      A7L √ LATCHES CLOSED lt – lt on

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

OPEN ODS HOOKS

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

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

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

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

8. Interface clear of debris or other obstruction

RETRACT RING FOR SECOND MATING ATTEMPT:

0:00
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
   A7L
   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
    POWER ON pb – push
    A7L
    RING DRV CMD – OFF

0:00
11. OPEN LATCHES pb – push
    A7L
    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
    DRV CMD – OFF

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

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

15. FLT CNTLR PWR – OFF
    A6U
    Config DAP A,B to A12,B12
    DAP: A/AUTO/VERN

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, 8-30.

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
2. POWER ON pb – push
   SM 167 DOCKING STATUS
   RECAPTURE PMA PETALS
   3. CLOSE LATCHES pb – push
      ✓LATCHES OPEN lt – lt off
      ✓CLOSED lt – lt on
   4. APDS CIRC PROT OFF pb – push
      ✓CIRCUIT PROTECT OFF lt – lt on
      FIXER OFF pb – push
      ✓FIXERS OFF lt – lt on
      RING OUT pb – push
      ✓FINAL POSITION lt – lt off
   5. When CAPTURE lt – lt on:
      POWER OFF pb – push
      ON pb – push
      ✓CAPTURE lt – lt off

Cont next page
0:00  6. RING IN pb – push
     POWER ON pb – push
     √RING FINAL POSITION lt – lt off
     CRT  √DRV CMD – OFF
     A7L  √LATCHES CLOSED lt – lt on

     **WARNING**
     Vehicle separation may occur when ODS hooks opened or pyros discharged if RING FINAL POSITION lt is ON or LATCHES CLOSED lt is OFF. Be prepared to pick up in ANY ATTITUDE SEPARATION, (CONTINGENCY OPS) step 4, 5-23

RE-OPEN CLOSED HOOKS
A7L  7. APDS CIRC PROT OFF pb – push
     √CIRCUIT PROTECT OFF lt – lt on
     OPEN HOOKS pb – push

A7L  8. When good HOOKS 1(2) OPEN lt on
     and jammed HK2(1) POS not decr:
     CRT  POWER OFF pb – push
          ON pb – push

DISCHARGE ACTIVE HOOK PYROS
A6L  9. PYRO PWR MN A,MN C (two) – ON
A7L  PYROS A_p,B_p,C_p (three) – ON
     √A_p,B_p,C_p lt (three) – lt on
     PYRO CIRC PROT OFF pb – push
     √CIRCUIT PROTECT OFF lt – lt on

10. ACT HOOKS FIRING pb – push

11. PYRO CIRC PROT ON pb – push
     √CIRCUIT PROTECT OFF lt – lt off
     PYROS A_p,B_p,C_p (three) – OFF
     √A_p,B_p,C_p lt (three) – lt off
     A6L  PYRO PWR MN A,MN C (two) – OFF

EXTEND RING TO INITIAL POSITION FOR INTERFACE SEPARATION
A7L  12. APDS CIRC PROT OFF pb – push
     √CIRCUIT PROTECT OFF lt – lt on
     0:00  RING OUT pb – push
     √INTERF SEALED lt – lt off
     CRT  If interface separates [PETAL POS BASE (three) incr after 20 sec]:
          Go to step 19

RECONFIGURE AND DISCHARGE PASSIVE HOOK PYROS
A7L  13. POWER ON pb – push
     A6L  PSU PWR MN A,MN B (two) – OFF
     A7L  RING IN pb – push
          APDS POWER A_DS,B_DS,C_DS (three) – OFF
          – ON
     A6L  PSU PWR MN A,MN B (two) – ON
     CRT  When PETAL POS BASE (three) = -6% and not decr:
     A7L  POWER ON pb – push

Cont next page
A6L 14. PYRO PWR MN A,MN C (two) – ON
A7L PYROS $A_p, B_p, C_p$ (three) – ON
   $\sqrt{A_p, B_p, C_p}$ It (three) – It on
   PYRO CIRC PROT OFF pb – push
   $\sqrt{\text{CIRCUIT PROTECT OFF}}$ lt – lt on

15. PAS HOOKS FIRING pb – push

16. PYRO CIRC PROT ON pb – push
   $\sqrt{\text{CIRCUIT PROTECT OFF}}$ 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 17. $\sqrt{\text{APDS CIRCUIT PROTECT OFF}}$ lt – lt on
   0:00
   RING OUT pb – push
   $\sqrt{\text{INTERF SEALED}}$ lt – lt off
CRT If interface separates [PETAL POS BASE (three) incr after 20 sec]:
   Go to step 19

RECONFIGURE AND PREPARE FOR 96 BOLT EVA

A7L 18. POWER ON pb – push
   RING IN pb – push
CRT When PETAL POS BASE (three) = ~6% and not decr:
A7L POWER OFF pb – push
   Perform DOCKING MECHANISM POWERDOWN, 8-6, then:
   Go to 96 BOLT EVA TIMELINE (EVA, ORB CONT EVA) >>

FINAL PREPARATION FOR VEHICLE SEPARATION

A7L 19. $\sqrt{\text{RING INITIAL POSITION}}$ lt – lt on
CRT $\sqrt{\text{DRV CMD}}$ – OFF
   $\sqrt{\text{PETAL POS BASE}}$ (three) = 76 ± 3%

20. Go to step 3 of ANY ATTITUDE SEPARATION (CONTINGENCY OPS), 5-23. Expect no spring assisted separation
PMA 2/3 HOOKS OPEN – CONTINGENCY

NOTE
Procedure assumes PMA 2/3 hooks could not be opened nominally or ODS hooks were driven fully open and physical separation did not occur and PMA 2/3 were closed at some point during the mission.

To undock, the crew will start in the ANY ATTITUDE SEPARATION (AAS), 5-23, to prep for undocking, then transition to this procedure. Once in this procedure, steps 3-6 will recapture the PMA petals in preparation for firing the ODS hook pyros. Steps 7-9 re-open the ODS hooks. The capture latches maintain the connection between the two vehicles. Step 10 commands the ring out to verify that the initial problem still exists before firing the pyros. When the active docking ring is extended in step 10, separation is expected at the interface between the fixed shuttle APDS structural ring and the fixed PMA structural ring. Vehicles maintain a physical connection via the active docking ring until the capture latches are opened after returning to the AAS procedure in step 23. Steps 12-14 will discharge the passive hook pyros. Interface separation is attempted again in step 15. As in step 10, the vehicles will maintain a physical connection via the active docking ring capture latches. If there is no separation in step 15, the active hook pyros are discharged in steps 17-19. Interface separation is attempted again in step 20. As in step 10, the vehicles will maintain a physical connection via the active docking ring capture latches. In step 23, the crew will transition back to the AAS procedure where the capture latches will be opened and the actual vehicle separation performed.

Procedure also assumes that an EVA crew is prepared to immediately perform the 96 BOLT EVA if ODS pyros are discharged, and physical separation does not occur

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

A7L 2. POWER ON pb – push

SM 167 DOCKING STATUS

RECAPTURE PMA PETALS
3. CLOSE LATCHES pb – push
   ✓LATCHES OPEN lt – lt off
   ✓CLOSED lt – lt on

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

5. When CAPTURE lt – lt on:
   POWER OFF pb – push
   ✓ON 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 is ON or LATCHES CLOSED is OFF. Be prepared to pick up in ANY ATTITUDE SEPARATION,(CONTINGENCY OPS), step 4, 5-23

OPEN ODS HOOKS
7. APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on
0:00
8. OPEN HOOKS pb – push
   √HOOKS 1,HOOKS 2 CLOSED lt (two) – lt off
   CRT
   √HK1,HK2 POS (two) < 92% and decr

2:20  A7L
9. √HOOKS 1,HOOKS 2 OPEN lt (two) – lt on

ATTEMPT TO EXTEND RING TO INITIAL POSITION FOR INTERFACE SEPARATION
0:00  A7L
10. RING OUT pb – push
   √INTERF SEALED lt – lt off
   CRT
   If interface separates [PETAL POS BASE (three) incr after 20 sec]:
   Go to step 22

RECONFIGURE AND DISCHARGE PASSIVE HOOK PYROS
A7L
11. POWER ON pb – push
A6L  PSU PWR MN A,MN B (two) – OFF
A7L  RING IN pb – push
   APDS POWER $A_{DS},B_{DS},C_{DS}$ (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) – lt on
   PYRO CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on

13. PAS HOOKS FIRING pb – push
14. PYRO CIRC PROT ON pb – push
   √CIRCUIT PROTECT OFF lt – lt off
   PYROS $A_p,B_p,C_p$ (three) – OFF
   √$A_p,B_p,C_p$ lt (three) – lt off
A6L  PYRO PWR MN A,MN C (two) – OFF

REATTEMPT EXTENDING RING TO INITIAL POSITION FOR INTERFACE SEPARATION
A7L
15. √APDS CIRC PROT OFF lt – lt on
0:00
   RING OUT pb – push
   √INTERF SEALED lt – lt off
   CRT
   If interface separates [PETAL POS BASE (three) incr after 20 sec]:
   Go to step 22

Cont next page
RECONFIGURE AND DISCHARGE ACTIVE HOOK PYROS

A7L 16. POWER ON pb – push
A6L PSU PWR MN A,MN B (two) – OFF
A7L RING IN pb – push
   APDS POWER A\textsubscript{DS},B\textsubscript{DS},C\textsubscript{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 17. PYRO PWR MN A,MN C (two) – ON
A7L PYROS A\textsubscript{P},B\textsubscript{P},C\textsubscript{P} (three) – ON
   √A\textsubscript{P},B\textsubscript{P},C\textsubscript{P} lt (three) – lt on
   PYRO CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on

A7L 18. ACT HOOKS FIRING pb – push

A7L 19. PYRO CIRC PROT ON pb – push
   √CIRCUIT PROTECT OFF lt – lt off
   PYROS A\textsubscript{P},B\textsubscript{P},C\textsubscript{P} (three) – OFF
   √A\textsubscript{P},B\textsubscript{P},C\textsubscript{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. √APDS CIRCUIT PROTECT OFF lt – lt on
   0:00 RING OUT pb – push
   √INTERF SEALED lt – lt off
CRT If interface separates [PETAL POS BASE (three) incr after 20 sec]:
   Go to step 22

RECONFIGURE AND PREPARE FOR 96 BOLT EVA

A7L 21. POWER ON pb – push
   RING IN pb – push
CRT When PETAL POS BASE (three) = −6% and not decr:
A7L POWER ON pb – push
   Perform DOCKING MECHANISM POWERDOWN, 8-6, then:
   Go to 96 BOLT EVA TIMELINE (EVA, ORB CONT EVA) >>

FINAL PREPARATION FOR VEHICLE SEPARATION

~3:20 A7L 22. √RING INITIAL POSITION lt – lt on
CRT √DRV CMD – OFF
   √PETAL POS BASE (three) = 76 ± 3%

23. Go to step 3 of ANY ATTITUDE SEPARATION (CONTINGENCY OPS),
    5-23. Expect no spring assisted separation
APDS FAILED CAPTURE RECONFIG

SM 167 DOCKING STATUS

A7L

1. If LATCHES OPEN lt – lt on:
   0:00  CLOSE LATCHES pb – push
   \LATCHES OPEN lt – lt off
   0:05  \CLOSED lt – lt on

2. \APDS CIRCUIT PROTECT OFF lt – lt on

3. FIXER OFF pb – push
   \FIXERS OFF lt – lt on
   0:00  RING OUT pb – push
   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: *
   A7L  * POWER ON pb – push

6. \RING FINAL POSITION lt – lt on

5:00 CRT  \DRV CMD – OFF

0:00 A7L 7. APDS CIRCUIT PROT OFF pb – push
   \CIRCUIT PROTECT OFF lt – lt on
   RING OUT pb – push
   CRT  \CLUTCH – LOCK/blank

0:10 A7L  \RING FINAL POSITION lt – lt off

Cont next page
* If RING INITIAL POSITION lt failed on (ring stops after 1 sec, and Clutch drives to SLIP):
  * FIXER OFF pb – push
  * √FIXERS OFF lt – lt on
  * RING OUT pb – push
* 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
  * 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
  √PETAL POS BASE (three) – 76 ± 3%
  √CLUTCH – blank/SLIP
  * If CLUTCH – blank/blank:
  * √APDS CIRCUIT PROTECT OFF lt – lt on
    * RING OUT pb – push (expect 1 sec of drive),
    * wait 10 sec
  * If CLUTCH – LOCK/blank:
    * √RING DRV CMD – OFF
    * √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
  * If not CLUTCH – blank/SLIP:
    * √MCC

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 |
|     | 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 | √MCC |

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

| 2:20 | 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 |
| 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 |
|     | B OP,CL (two) – op |
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
    √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, *
   * 8-30 *

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,
   * 8-30

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
<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>POWER ON pb</strong></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><strong>APDS CIRCUIT PROTECT OFF</strong></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><strong>RING ALIGNED</strong></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><strong>RING INITIAL POSITION</strong></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><strong>FIXERS OFF</strong></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><strong>HOOKS 1(2) OPEN</strong></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><strong>LATCHES CLOSED</strong></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</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 It, 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>
</table>
| **APDS POWER**  
A<sub>DS</sub>, B<sub>DS</sub>, C<sub>DS</sub> | Failed ON (s) | One logic bus remains powered. Still at least two failures from any inadvertent ops |
| | Failed OFF (s) | Loss of one capture latch motor. Next failure results in loss of all APDS avionics logic | APDS POWER FAILED OFF |
| **A6L SYSTEM POWER**  
A(B) tb | Failed OFF (s) | 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 |
| **PYROS**  
A<sub>p</sub>, B<sub>p</sub>, C<sub>p</sub> | Failed ON (s) | One Pyro logic bus powered. Still more than two failures from charging pyros |
<p>| | Failed OFF (s) | Loss of Pyro logic redundancy |
| <strong>PYRO CIRCUIT PROTECT OFF</strong> | Failed ON (m) | Possible loss of Pyro charge/fire inhibits |
| | Failed OFF (m) | Loss of capability to arm/fire Pyros |</p>
<table>
<thead>
<tr>
<th>APDS TLM</th>
<th>APDS FAILURE</th>
<th>IMPACT</th>
<th>OFF NOMINAL PROCEDURE (IF APPLICABLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAMPING</td>
<td>Failed ON (s)</td>
<td>Mechanism may not have compliance on contact; load capability may be exceeded. Failed-on dampers slow ring drive to about single motor drive time</td>
<td>DAMPING FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>No impact for single failure. If all dampers failed, large rates/misalignments may cause mechanism to hit hard stops, exceeding its load capability</td>
<td></td>
</tr>
<tr>
<td>RING FIXERS</td>
<td>Failed ON (s)</td>
<td>Mechanism may not have compliance on contact; load capability may be exceeded</td>
<td>FIXERS FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>No impact for single fixer failure. For multiple failure case, alignment may be lost during ring retraction. [Detectable only during ring drive operations]</td>
<td></td>
</tr>
<tr>
<td>CLUTCH – SLIP</td>
<td>Failed ON (s)</td>
<td>If slip clutch locking mechanism failed in SLIP, resistance created by dampers and/or pusher springs will load actuator sufficiently to prevent ring motion</td>
<td>APDS DIRECT DRIVE USING BOB required to drive slip clutch to LOCK</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>Must verify clutch in SLIP prior to contact</td>
<td></td>
</tr>
<tr>
<td>CLUTCH – LOCK</td>
<td>Failed ON (s)</td>
<td>Must verify clutch in SLIP prior to contact, otherwise mechanism may not have compliance on contact; load capability may be exceeded</td>
<td>APDS DIRECT DRIVE USING BOB required to drive slip clutch to SLIP</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>If slip clutch locking mechanism failed in SLIP, resistance created by dampers and/or pusher springs will load ring actuator sufficiently to prevent ring motion</td>
<td></td>
</tr>
<tr>
<td>CAP MAN REL</td>
<td>Failed OP (s)</td>
<td>If latch is released, may be unable to draw interfaces together</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed ON (s)</td>
<td>One logic bus remains powered. Still at least two failures from any inadvertent ops</td>
<td></td>
</tr>
<tr>
<td>CNTL PNL PWR</td>
<td>Failed OFF (s)</td>
<td>Loss of pb command redundancy. CNTL PNL PWR A will remove power from columns 1 &amp; 3 of the STATUS light matrix. CNTL PNL PWR C will remove power from columns 2 and 4 of the STATUS lights matrix. (Pyro pbs are not affected)</td>
<td>Next failure may require APDS Direct Drive IFM to complete docking or separate, or require manual capture latch release</td>
</tr>
<tr>
<td>RNG DR BUS 1(2)</td>
<td>Failed OFF (s)</td>
<td>Loss of ring drive motor 1(2)</td>
<td></td>
</tr>
<tr>
<td>HKS DR BUS 1(2)</td>
<td>Failed OFF (s)</td>
<td>Loss of hook drive motor 1(2) [Affects both Hooks 1 &amp; 2]</td>
<td></td>
</tr>
<tr>
<td>DAMPER BUS 1(2)</td>
<td>Failed OFF (s)</td>
<td>BUS 1 (MN A): Dampers 1,2 failed. BUS 2 (MN B): Damper 3 failed</td>
<td></td>
</tr>
<tr>
<td>FIXER BUS 1(2)</td>
<td>Failed OFF (s)</td>
<td>BUS 1 (MN A): Fixers 1,2 failed. BUS 2 (MN B): Fixers 3,4,5 failed</td>
<td></td>
</tr>
</tbody>
</table>
CUE CARD CONFIGURATION

RCS BURN (+X, -X, Multi-axis) (Front) ................................................................. CC 9-3
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                                          (Back) .................................................. CC 9-6
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                                          (Back) .................................................. CC 9-12
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                                          (Back) .................................................. CC 9-14
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RNDZ REF DATA (Back) ................................................................................... CC 9-16
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V10 MONITOR CORRIDOR ............................................................................... CC 9-23
A31P PGSC DISPLAY OF C/L CAMERA CORRIDOR AND ALIGNMENT .......... CC 9-24
A31P PGSC CAMERA A/D RANGE RULER ....................................................... CC 9-25
RCS BURN (+X, -X, Multi-axis)

1. GNC, OPS 202 PRO
   GNC ORBIT MNVR EXEC
   √RCS SEL, ITEM 4 – (*)
2. If onboard computed burn:
   √TIG and TGT PEG 7 ΔVs per Final solution
   √Guidance option is LAMBERT
   If ground computed burn:
   √TGT data per Burn Pad (reload WT as reqd)
   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC
3. If +X burn:
   DAP: A/AUTO/ALT (B/ALT as reqd)
   MNVR – ITEM 27 EXEC (*)
   If RR ops:
   KU – AUTO TRK
   GNC 33 REL NAV
   INH Angles – ITEM 24 EXEC (*)
   TIG-0:30
4. FLT CNTLR PWR – ON
   DAP TRANS: as reqd
   If Multi-axis:
   DAP: A/AUTO/PRI
   If +X or -X:
   DAP: A/INRTL/PRI
   CAUTION
   LAMBERT burn must be completed by T1 TIG +1:30 to avoid guidance errors
   * If start of LAMBERT burn delayed: *
   * Retarget burn, then go to step 2 *
5. If VGO Z is neg, Z,X,Y seq; otherwise, X,Y,Z
   THC: Trim VGOs < 0.2 fps
   FLT CNTLR PWR – OFF
   DAP: ALT
   DAP TRANS: PULSE/PULSE/PULSE
   GNC, OPS 201 PRO
6. If +X burn:
   DAP: A/AUTO(B/AUTO/ALT as reqd)
   If RR ops, when ATT ERR < 30 deg:
   KU – GPC
   KU TRACK tb – gray
   GNC 33 REL NAV
   AUTO Angles – ITEM 23 EXEC (*)
7. When in attitude:
   DAP: A/AUTO/VERN (ALT)

(reduced copy)
RENDEZVOUS PRPLT PAD

When L or R RCS QTY < 1:
I'CNCT: 2 OMS to RCS (ORB PKT, RCS)

When G23 OMS/RCS QTY > 4:
I'CNCT TK SWITCH: (ORB PKT, RCS)

When G23 OMS/RCS QTY > 6:
I'CNCT RETURN (ORB PKT, RCS)

When L or R RCS QTY < 7 or when FRCS QTY < 8:

DAP: NO LO Z

When L or R RCS QTY < 9 or when FRCS QTY < 10:

If prior to Ti:
| Do not perform Ti
If after Ti, but prior to TORVA init (+X burns to start TORVA are complete):
| Go to RNDZ BREAKOUT (CONTINGENCY OPS), 5-18
If during TORVA:
| Go to SHUTTLE NOSE IN-PLANE BREAKOUT (CONTINGENCY OPS), 5-16
If stable on +VBAR:
| Go to VBAR BREAKOUT (CONTINGENCY OPS), 5-14

TOP, BACK OF 'RCS BURN (+X, -X, Multi-axis)'

HOOK VELCRO

HOOK VELCRO
KU OPS

1. CONFIGURE KU FOR RR TGT ACQ

   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, \(\text{MCC} \) >>

3. RR NAVIGATION

   CRT
   RADAR, ITEM 13 – (*)
   * If RATIO > 1.0: *
   * \(\text{MCC} \) *
   FLTR TO PROP – ITEM 8 EXEC (*)
   AUT RNG – ITEM 17 EXEC (*)
   RDOT – ITEM 20 EXEC (*)
   Angles – ITEM 23 EXEC (*) >>

4. CONFIGURE KU FOR COMM

   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)
RPM & CONT w/ RPM (h:mm:ss)

<table>
<thead>
<tr>
<th>CG to CG RNG (ft)</th>
<th>RPM &amp; CONT TORVA RDOT (ft/s)</th>
<th>DAP EVENT</th>
<th>NO- RPM RDOT (ft/s)</th>
<th>HHL RNG (ft) to ISS cg</th>
<th>Raw TCS RNG* (ft) (Ref1 #2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>-3.0 0.27:00</td>
<td>A/B/B2 AUTO/ VERN (PRI)</td>
<td>If RDOT falls below value for next gate, THC -Z (in) as req'd to maintain RDOT</td>
<td>-3.0</td>
<td>1900 HHL Report</td>
</tr>
<tr>
<td>1700</td>
<td>-2.4 0.29:00</td>
<td></td>
<td></td>
<td>-2.6</td>
<td>1690 1698</td>
</tr>
<tr>
<td>1500</td>
<td>-2.1 0.31:00</td>
<td></td>
<td></td>
<td>-2.3</td>
<td>1490 1498</td>
</tr>
<tr>
<td>1900</td>
<td>-1.3 0.36:00</td>
<td>MCC UPDATE: Go for RPM, Go to proceed inside 600 ft</td>
<td>If no-go to proceed inside 600 ft, perform CONTINGENCY</td>
<td>-1.5</td>
<td>950 955</td>
</tr>
<tr>
<td>900</td>
<td>-1.1 0.37:00</td>
<td>If Go for RPM, report to ISS: 10 min to RPM start</td>
<td></td>
<td>-1.3</td>
<td>890 895</td>
</tr>
<tr>
<td>800</td>
<td>-0.9 0.38:00</td>
<td>A/B/B9 ATU KD RDOT OUTPUT - LOW</td>
<td>When in Rbar attitude, config DAP to A9/B9</td>
<td>-0.7</td>
<td>540 536</td>
</tr>
<tr>
<td>700</td>
<td>-0.6 0.41:00</td>
<td>Null ISS rates in C/L camr</td>
<td>If Go for RPM, perform RPM SETUP</td>
<td>-0.6</td>
<td>490 486</td>
</tr>
<tr>
<td>650</td>
<td>-0.4 0.42:30</td>
<td>Report to ISS: Range 650 ft</td>
<td></td>
<td>-0.4</td>
<td>357 356</td>
</tr>
<tr>
<td>620</td>
<td>-0.4 &lt; Rdot &lt; -0.3</td>
<td>If Go for RPM</td>
<td>Null Xdot to 0 ± 0.1 ft/sec prior to mnvr start</td>
<td>-0.8</td>
<td>590 586</td>
</tr>
<tr>
<td>600</td>
<td>-0.3 &lt; Rdot &lt; -0.2</td>
<td></td>
<td>If req'd: stationkeep at 600-620 ft until RPM window opens</td>
<td>1:00:00</td>
<td>570 566</td>
</tr>
<tr>
<td>580</td>
<td>-0.2 &lt; Rdot &lt; -0.1</td>
<td></td>
<td></td>
<td>-0.2</td>
<td>540 536</td>
</tr>
<tr>
<td>600</td>
<td>-0.7 0.56:00</td>
<td>TORVA</td>
<td></td>
<td>-0.8</td>
<td>590 586</td>
</tr>
<tr>
<td>550</td>
<td>-0.6 0.57:00</td>
<td></td>
<td></td>
<td>-0.7</td>
<td>540 536</td>
</tr>
<tr>
<td>500</td>
<td>-0.4 0.58:00</td>
<td></td>
<td></td>
<td>-0.5</td>
<td>490 486</td>
</tr>
<tr>
<td>400</td>
<td>0.0 to -0.1</td>
<td>Maintain ISS within C/L camr</td>
<td></td>
<td>0.0 to -0.1</td>
<td>HHL Report</td>
</tr>
<tr>
<td>415-315</td>
<td>1:10:00</td>
<td>ESTABLISH VBAR</td>
<td></td>
<td>1:10:30</td>
<td>257-257</td>
</tr>
<tr>
<td>(350-250 DP-DP)</td>
<td>-0.2 1:10:30</td>
<td>Perform CONFIGURE FOR DOCKING</td>
<td></td>
<td>-0.2</td>
<td>357-257</td>
</tr>
</tbody>
</table>

* Raw TCS Range assumes ISS in docking attitude

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 635-535 (DP-DP), maintain ISS in C/L camr FOV

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

RPM SETUP

<table>
<thead>
<tr>
<th>RPM SETUP</th>
<th>AFT (FWD)</th>
<th>DAP/PTG</th>
<th>ISS Calls / Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>A PRIY OPTION – ITEM 16 EXEC (ALL)</td>
<td>ADI Pitch</td>
<td>DAU/PTG</td>
<td>Initiating RPM (with mark)</td>
</tr>
<tr>
<td>A PRI Y OPTION – ITEM 23 + 0.75 EXEC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A PRI ROT RATE – ITEM 10 + 0.75 EXEC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A + 15 + 0.75 EXEC</td>
<td>VERN (PRI)</td>
<td>KU OPS step 3 (cue card)</td>
<td></td>
</tr>
<tr>
<td>A/RAD PWR = 100 (10) (Rbar attitude)</td>
<td>VERN (PRI)</td>
<td>KU SEL – GPC</td>
<td></td>
</tr>
<tr>
<td>A/RAD PWR = 170 (80) FREE</td>
<td>VERN (PRI)</td>
<td>When Lock On Occurs:</td>
<td></td>
</tr>
<tr>
<td>A/RAD PWR = 235 (145) FREE</td>
<td>KU SEL – GPC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A/RAD PWR = 305 (215) FREE</td>
<td>KU OPS step 3 (cue card)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A/RAD PWR = 10 (280) FREE</td>
<td>KU OPS step 3 (cue card)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A/RAD PWR = 80 (60) FREE</td>
<td>KU OPS step 3 (cue card)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CONFIGURE FOR DOCKING

Perform AIRLOCK FAN ACT AND ODS VOLUME PREP (APDS), 6-10
Perform DOCKING MECHANISM POWERUP (APDS), 8-5
Perform DOCKING FUEL (APDS), 8-7

RPM START WINDOW (MET)

OPEN: ___ / ___ : ___ : ___
CLOSE: ___ / ___ : ___ : ___

(reduced copy)

TOP
## VBAR APPROACH

### Interface RNG (ft) | RDOT (ft/s) | MCC2 ET: h:mm:ss (doc.—FT) | DAP | EVENT | HHL RNG (to US Lab) (ft) | Raw TCS RNG* (Ref #1) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>-0.20</td>
<td>1:15:00 (-34.00)</td>
<td>√LO Z</td>
<td>MCC UPDATE: Go for docking</td>
<td>257</td>
<td>255</td>
</tr>
<tr>
<td></td>
<td>±0.05</td>
<td></td>
<td></td>
<td>Maintain ISS docking target within 8 deg Corridor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(170 ± 10)</td>
<td>-0.20</td>
<td>1:21:30 (-27.30)</td>
<td>√DAP: B</td>
<td>Note: DAP A allowed for ±X and ±Z THC</td>
<td>177</td>
<td>175</td>
</tr>
<tr>
<td>170</td>
<td></td>
<td></td>
<td></td>
<td>If reqd, THC: as reqd to null RDOT and perform VBAR stationkeeping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>-0.15</td>
<td>1:26:30 (-22.30)</td>
<td></td>
<td>Perform CONFIGURE KU FOR COMM (Cue Card, KU OPS)</td>
<td>117</td>
<td>115</td>
</tr>
<tr>
<td>75</td>
<td>-0.10</td>
<td>1:30:30 (-18.90)</td>
<td>√A10, B10 √DAP: B</td>
<td>Note: DAP A allowed for ±X and -Z THC (in) GNC 23 RCS (Maintain through contact)</td>
<td>82</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>±0.10</td>
<td></td>
<td></td>
<td>√RCS FWD – ITEM 1 EXEC (<em>) JET DES FT – ITEM 31 EXEC (</em>) F2F – ITEM 35 EXEC (*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 ± 5</td>
<td>0.0</td>
<td>1:38:00 (-11.00)</td>
<td>√A10, B10 √DAP: B</td>
<td>5° Corridor If Flyout Req'd: THC: +Z (out) as reqd to null RDOT Perform AUTO ANGULAR FLYOUT (Cue Card) outside 25 ft Review FAILED CAPTURE, steps 1 thru 3. CAUTION (Cue Card, DOCKING SEQUENCE) √A7L Panel Config Set EVENT TIMER for CAPTURE (counting up from 00:00)</td>
<td>32:42</td>
<td>30:40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HHL Report</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>-0.07</td>
<td>1:43:00 (-06.00)</td>
<td></td>
<td>5° Corridor THC: as reqd to establish RDOT = -0.07 ± 0.02 fps Report to MCC and ISS: Initiating final approach</td>
<td>37</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>±0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>↑</td>
<td>1:44:00 (-05.00)</td>
<td></td>
<td>Maintain GNC 23 RCS through contact</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>-0.10</td>
<td>1:47:20 (-01.40)</td>
<td>√A10 Z</td>
<td>ARM PCT F2(F4) SDFBK/THROT pb – AUTO – √It on</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>±0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-0.10</td>
<td>1:48:30 (-00.30)</td>
<td></td>
<td>Maintain 3 inch lateral alignment cylinder</td>
<td>N/A</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>±0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTACT</td>
<td>~2 in</td>
<td>1:49:00 (00.00)</td>
<td>√A6U PCT (SPARE pbi)</td>
<td>CAPTURE</td>
<td>N/A</td>
<td>5</td>
</tr>
<tr>
<td>or ~2 in</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### CAPTURE

**MS**
- START EVENT TIMER = 00:00:00
- √CAPTURE II – It on
- Notify ISS and MCC-H: "Capture Confirmed"
- DISARM PCT:
  - SDFBK/THROT pb – push (It off)
  - √ISS in FREE DRIFT (ISS indicator lights flashing)
    - IF NO INDICATION OF ISS FREE
    - DRIFT AT CAPTURE + 65 SEC:
      - Go to FAILED CAPTURE
    - √ISS in DRIFT

**A6U**
- When capture confirmed and ISS in FREE FLT CNTLR PWR – OFF
- Perform TCS DEACTIVATION (RNDZ TOOLS), T-20
- Go to DOCKING SEQUENCE (Cue Card)

### FAILED CAPTURE

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

2. √DAP: NO LO Z
   - IF VERN FAL:
     - DAP: PRI
   - If petals clear:
     - DAP: A(B)LVLH

3. THC: +Z (out) to establish 0.1 fps opening rate
   √DAP: B(LVLH)
   IF ISS in FREE DRIFT:
   Use ISS CG as corridor reference
   Maintain 8 degree corridor
   Inform MCC-H and ISS: Failed Capture
   Maintain opening rate of at least 0.1 fps

4. Go to VBAR CORRIDOR BACKOUT, CONTINGENCY OPS: 5-12

---

* Raw TCS Range assumes ISS in docking attitude
C/L CAMERA TARGET ALIGNMENT (+VBAR)

PITCH (P)
ITEM 15

Target Displaced DOWN
(Cross Displaced UP)

\[ P = \ldots \]

Target Displaced UP
(Cross Displaced DOWN)

\[ P = \ldots \]

3. \( P \text{ITCH} = 180 - P = \ldots(A) \)
5. \( P \text{ITCH} = P \text{ITCH} - P = \ldots(D) \)

3. \( P \text{ITCH} = 180 + P = \ldots(A) \)
5. \( P \text{ITCH} = P \text{ITCH} + P = \ldots(D) \)

ROLL (R)
ITEM 16

Rotated CW

\[ R = \ldots \]

\[ R = \ldots \]

3. \( Y \text{AW} = 360 - R = \ldots(B) \)
5. \( Y \text{AW} = Y \text{AW} - R = \ldots(E) \)

Rotated CCW

\[ R = \ldots \]

\[ R = \ldots \]

3. \( Y \text{AW} = 0 + R = \ldots(B) \)
5. \( Y \text{AW} = Y \text{AW} + R = \ldots(E) \)

YAW (Y)
ITEM 17

Target Displaced RIGHT
(Cross Displaced LEFT)

\[ Y = \ldots \]

\[ Y = \ldots \]

3. \( O \text{M} = 0 + Y = \ldots(C) \)
5. \( O \text{M} = O \text{M} + Y = \ldots(F) \)

Target Displaced LEFT
(Cross Displaced RIGHT)

\[ Y = \ldots \]

\[ Y = \ldots \]

3. \( O \text{M} = 360 - Y = \ldots(C) \)
5. \( O \text{M} = O \text{M} - Y = \ldots(F) \)

(reduced copy)
AUTO ANGULAR FLYOUT

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

1. RECORD ANGULAR MISALIGNMENT
√DAP: A10, B10
Read error from ISS centerline target
PITCH ________ (P)
YAW ________ (Y)
ROLL ________ (R)
Report misalignment to MCC
If all axes within 1.0 deg of zero, no mnvr reqd >>

2. CALCULATE UNIV PTG INPUTS
Use diagrams in TARGET ALIGNMENT (Cue Card) to determine
UNIV PTG inputs for step 3

3. EXECUTE ALIGNMENT MNVR
√GNC UNIV PTG
√TGT ID +2
√BODY VECT +5
PITCH +(A)
YAW +(B)
OM +(C)
TRK – ITEM 19 EXEC (CUR-*)

When mnvr cplt,

4. RECORD REMAINING ANGULAR MISALIGNMENT
Record error from ISS centerline target:
PITCH ________ (P)
YAW ________ (Y)
ROLL ________ (R)
If all axes within 1.0 deg of zero, no additional mnvr reqd >>

Otherwise,

5. REPEAT ALIGNMENT
a. Calculate UNIV PTG inputs:
   Use diagrams in TARGET ALIGNMENT (Cue Card) to
determine UNIV PTG inputs for step 5b
b. Execute alignment MNVR
   √GNC UNIV PTG
   √TGT ID +2
   √BODY VECT +5
   PITCH +(D)
   YAW +(E)
   OM +(F)
   TRK – ITEM 19 EXEC (CUR-*)
### Docking Sequence

**CAUTION**
If following failures occur during final approach (< 30 ft), **NO-GO** for docking. Initiate Corridor Backout. Then proceed with APDS OFF-NOMINAL procedures (APDS)

<table>
<thead>
<tr>
<th>Failure Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER Failed OFF (All STATUS lts OFF)</td>
<td>DAMPING tlm Failed ON</td>
</tr>
<tr>
<td>CAPTURE lt Failed ON</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
- CRT ON pb – push
Proceed with APDS OFF-NOMINAL procedures (APDS)

**Event Time**

<table>
<thead>
<tr>
<th>SM 167 Docking Status</th>
<th>Contact/Capture/Damping</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td>A7L 1. √CAPTURE lt – lt on (expect RING INITIAL POSITION lt off)</td>
</tr>
<tr>
<td>0:05</td>
<td>CRT 2. √DAMPING – ON</td>
</tr>
</tbody>
</table>

#### Disable and Release Dampers

3. When no relative motion [PETAL POS BASE (three) not changing for 60 sec]:
   - A7L  POWER ON pb – push
   - CRT √DAMPING – OFF
4. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   - A7L  FIXER OFF pb – push
   - CRT √FIXERS OFF lt – lt on
   - 0:00 RING IN pb – push
   - CRT √DRV CMD – OFF [PETAL POS BASE (three) – decr]
   - √CLUTCH – LOCK/blank
5. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   - CRT √RING DRV CMD – OFF
6. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   - A7L  APDS CIRC PROT OFF pb – push
   - CRT √CIRCUIT PROTECT OFF lt – lt on
   - 0:00 RING OUT pb – push
   - CRT √DRV CMD – ON [PETAL POS BASE (three) – incr]
7. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   - A7L  POWER OFF pb – push
   - CRT ON pb – push
   - √FIXERS OFF lt – lt off
   - CRT √RING DRV CMD – OFF
Retract Ring

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

0:00 A7L RING IN pb – push
CRT √ DRV CMD – ON [PETAL POS BASE (three) – decr]
√ FIXERS – ON
√ CLUTCH – LOCK/blank

CRT, A7L
* If PETAL POS BASE (three) > 20 % and RING ALIGNED lit off:
* A7L
* POWER ON pb – push
* Wait for ring alignment (up to 30 min)
* A7L, CRT
* When RING ALIGNED lit on and [PETAL POS BASE (three) not changing] for 30 sec:
* A7L
* RING IN pb – push

3:15 A7L 9. √ READY TO HOOK lit – lit on
CRT √ PETAL POS BASE (three) ≤ 7%

Close Hooks

0:00 A7L 10. √ HOOKS 1, HOOKS 2 OPEN lit (two) – lit off
CRT √ HK1, HK2 DRV CMD (two) – ON
√ POS (two) ≥ 5 % & incr
* If HK1(2) DRV CMD – OFF or HK1(2) POS not incr:
* A7L
* CLOSE HOOKS pb – push
* If HOOKS 1(2) CLOSED lit failed ON:
* √ POWER ON pb – push

0:20 CRT 11. √ RING DRV CMD – OFF
* If RING DRV CMD – ON 20 sec after hooks begin:
* √ drivings in step 10:
* A7L
* √ POWER ON pb – push

≤ 1:30 A7L 12. √ INTERF SEALED lit – lit on (expect intermittent lit initially)

2:20 CRT 13. √ HOOKS 1, HOOKS 2 CLOSED lit (two) – lit on
√ HK1, HK2 POS (two) = 92-93%
√ IND (two) – blank/CL
√ ODS INDIV HK CL (twelve) – CL

Load Relieve Capture Latches (Extend Ring)

A7L 14. APDS CIRCUIT PROT OFF pb – push
√ CIRCUIT PROTECT OFF lit – lit on

0:00 CRT 15. RING OUT pb – push
√ DRV CMD – ON

0:10 A7L 16. POWER ON pb – push
CRT √ RING DRV CMD – OFF

Open Capture Latches

0:00 A7L 17. OPEN LATCHES pb – push
√ LATCHES CLOSED lit – lit off

0:05 √ OPEN lit – lit on

Retract Ring to FNL POS

0:00 18. RING IN pb – push
CRT √ DRV CMD – ON [PETAL POS BASE (three) – decr]
√ FIXERS – ON

0:10 A7L √ FINAL POSITION lit – lit on
CRT √ PETAL POS BASE (three) = 5 ± 3%

0:20 √ RING DRV CMD – OFF

Power Off

A7L 19. POWER OFF pb – push
√ STATUS lit (eighteen) – lit off

20. Go to TERMINATE RNDZ OPS 22A 4-22 >>
<table>
<thead>
<tr>
<th>TIME BETWEEN 1 FT MARKS (SEC)</th>
<th>RANGE RATE (FT/SEC)</th>
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<tbody>
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<tr>
<td>3</td>
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<tr>
<td>20</td>
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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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<th>ΔRng (m)</th>
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<th>600</th>
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<td>0.56</td>
<td>0.28</td>
<td>0.14</td>
<td>0.06</td>
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**NOTE:**
If RPOP is available, use RPOP subtended angle function.
# GPC/MDM Failure Response During Rndz

## GPC1 (3232*)

<table>
<thead>
<tr>
<th>FF1</th>
<th>GPC</th>
<th>MDM</th>
<th>Immediate Action</th>
<th>Major Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPC1</td>
<td>FF1</td>
<td></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></td>
<td>2. Work appropriate ORB PKT procedure</td>
<td>2. -Z ST↓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. If not recovered: Use -Y ST, if reqd</td>
<td></td>
</tr>
<tr>
<td>FA1</td>
<td></td>
<td></td>
<td>Pre-MC4: DAP: ALT/AUTO Post-MC4: DAP: PRI/AUTO</td>
<td>VERNs↓</td>
</tr>
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</table>

## GPC2 (1313*)

<table>
<thead>
<tr>
<th>FA2</th>
<th>GPC</th>
<th>MDM</th>
<th>Immediate Action</th>
<th>Major Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA2</td>
<td></td>
<td></td>
<td>Pre-MC4: DAP: ALT/AUTO Post-MC4: DAP: PRI/AUTO</td>
<td>VERNs↓</td>
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## GPC3 (1212*)

<table>
<thead>
<tr>
<th>FF3</th>
<th>GPC</th>
<th>MDM</th>
<th>Immediate Action</th>
<th>Major Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPC3</td>
<td>FF3</td>
<td></td>
<td>1. Pre-MC4: DAP: ALT/AUTO Post-MC4: DAP: PRI/AUTO</td>
<td>1. VERNs↓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. If RR NAV, INH RR to NAV</td>
<td>2. RR → NAV/RPOP↓ (Panel A2 OK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. If -Y ST NAV, INH ST to NAV</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. Work appropriate ORB PKT procedure</td>
<td>3. A6 DAP lights latched (go out with MDM pwr fail)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. If not recovered: Work RR FAIL procedures</td>
<td>4. -Y ST↓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5. Also for loss of GPC3: R OMS GMBL PRI/SEC↓</td>
</tr>
</tbody>
</table>

## GPC4 (1212*)

<table>
<thead>
<tr>
<th>PL</th>
<th>GPC</th>
<th>MDM</th>
<th>Immediate Action</th>
<th>Major Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPC4</td>
<td>PL</td>
<td></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>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. No Ku self-test</td>
</tr>
</tbody>
</table>

* Expect this NBAT if GPC fail

## MALFUNCTION

<table>
<thead>
<tr>
<th>Malfunction</th>
<th>&quot;&quot;</th>
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</thead>
</table>

## NOTES

1. GPC assignments assume 1233 NBAT
2. 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)
3. If any GNC GPC fails, VERNs↓
4. If IMUs not commfaulted, THCs are normally GO
5. Loss of FF2, FF4, FA3, and FA4 do not impact Rndz (unless other failures)
Note: Fabricate As Transparency

C/L CAMERA

CORRIDOR AND ALIGNMENT

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

C/L CAMERA  ZOOM CALIBRATION (RING READY FOR DOCK)

CTVC AT HFOV = 40.0 DEG
Note: Fabricate As Transparency

CTVC FULL NO ZOOM

<p>| | |</p>
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<tr>
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<tbody>
<tr>
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<td>5</td>
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</tr>
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</tbody>
</table>

feet

Use Bottom/Back Of ISS Ring

Use Top/Front Of ISS Ring

<table>
<thead>
<tr>
<th></th>
<th>RR</th>
<th></th>
<th>RR</th>
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<tbody>
<tr>
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<td>15</td>
<td>0.07</td>
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</tbody>
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760 PGSC CAMERA AID
RANGE RULER

CC 9-21
RNDZ-12a:1118/O/A
CC 9-21
Note: Fabricate As Transparency
## RCS Failure Response During Prox Ops

**NOTE:** If multiple cases apply, perform cases in order.

<table>
<thead>
<tr>
<th>CASE</th>
<th>IMMEDIATE ACTIONS/PROCEDURES REFERENCE</th>
<th>FLT RULES</th>
</tr>
</thead>
<tbody>
<tr>
<td>2FxD</td>
<td>* DO NOT PERFORM LOW Z +Z (BRAKING) PULSES *&lt;br&gt;  - If during RPM,&lt;br&gt;</td>
<td>RPM R&lt;250</td>
</tr>
<tr>
<td></td>
<td>- DAP: FREE&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>- FLT CNTLR PWR – OFF&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>- MCC for further actions&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>- If on Vbar and RNG &gt; 75 ft,&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>- DAP: No LOW Z&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>- DAP: B/VERN (PRI)&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>- DAP: AUTO&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>- THC: +Z (out) at 10 sec intervals as reqd to&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>- establish 0.1 fps opening&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>- If RNG &lt; 75 ft,&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>- DAP: No LOW Z&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>- DAP: B/VERN (PRI)&lt;br&gt;</td>
<td>NO-GO</td>
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<tr>
<td></td>
<td>- DAP: AUTO&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>- THC: +Z (out) as reqd to establish 0.1 fps opening&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>Do not perform PCT&lt;br&gt;</td>
<td>NO-GO</td>
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<tr>
<td></td>
<td>DAP disables ±Y translation&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>Perform LOSS OF BOTH FxD JETS (SAME SIDE)&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td></td>
<td>(CONTINGENCY OPS), 5-39&lt;br&gt;</td>
<td>NO-GO</td>
</tr>
<tr>
<td>VERN</td>
<td>DAP: PRI/AUTO&lt;br&gt;</td>
<td>NO-GO</td>
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<td>Perform LOSS OF VRCS (CONTINGENCY OPS), 5-41&lt;br&gt;</td>
<td>GO</td>
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<tr>
<td>Y</td>
<td>NOTE: DAP disables ±Y translation&lt;br&gt;</td>
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<td>Perform LOSS OF FORWARD SIDE-FIRING JETS&lt;br&gt;</td>
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<td>(CONTINGENCY OPS), 5-37&lt;br&gt;</td>
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<tr>
<td>+X</td>
<td>Do not perform LOW Z +Z (braking) pulses&lt;br&gt;</td>
<td>NO-GO</td>
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<td>Perform DEGRADED +X TRANSLATION (CONTINGENCY&lt;br&gt;</td>
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<td>OPS), 5-35&lt;br&gt;</td>
<td>NO-GO</td>
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<tr>
<td>-X</td>
<td>Perform DEGRADED -X TRANSLATION (CONTINGENCY&lt;br&gt;</td>
<td>GO</td>
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<td>OPS), 5-36&lt;br&gt;</td>
<td>GO</td>
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<tr>
<td>1FxD</td>
<td>Review IMMEDIATE ACTIONS for 2FxD CASE&lt;br&gt;</td>
<td>NO-GO</td>
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<td>Perform LOSS OF ONE FxD JET (CONTINGENCY OPS), 5-38&lt;br&gt;</td>
<td>NO-GO</td>
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**Diagram:**

- Two of F1F, F2F, F3F<br>  - F2D and F4D<br>  - VERN F5L<br>  - Y F1L and F3L<br>  - 1FxD F1D or F3D<br>  - Vern L5L or L5D<br>  - Vern R5R or R5D<br>  - +X L1A and L3A<br>  - +X R1A and R3A
**RCS/DPS/EPS Failure Impacts**

<table>
<thead>
<tr>
<th>GPC</th>
<th>MDM</th>
<th>DC SUBBUS</th>
<th>MAIN</th>
<th>CNTL</th>
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<tbody>
<tr>
<td>FF1</td>
<td>F1F</td>
<td>F1C</td>
<td>MN A DA1</td>
<td>AB2</td>
</tr>
<tr>
<td>FF2</td>
<td>F2F</td>
<td>F2C</td>
<td>MN B DA2</td>
<td>BC2</td>
</tr>
<tr>
<td>FF3</td>
<td>F3F</td>
<td>F3C</td>
<td>MN C DA3</td>
<td>BC1</td>
</tr>
<tr>
<td>FF4</td>
<td>F4F</td>
<td>F4C</td>
<td>N/A REDUNDANT POWER</td>
<td>CA2</td>
</tr>
</tbody>
</table>

**TOP**

BACK OF 'RCS FAILURE RESPONSE DURING PROX OPS'

<table>
<thead>
<tr>
<th>CASE</th>
<th>1 JET</th>
<th>2 JETS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RCS/DPS/EPS Failures**

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.