Rendezvous

STS-122

Mission Operations Directorate
Flight Design and Dynamics Division

Final
October 3, 2007

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

Verify this is the correct version for the pending operation (training, simulation or flight).
Electronic copies of FDF books are available. URL: http://mod.jsc.nasa.gov/do3/FDF/index.html
List of Implemented Change Requests (482s):
RNDZ-1295B
RNDZ-1296

Incorporate the following:
1. Replace v thru x
2. Replace 4-11 thru 4-14, 4-17 thru 4-20
3. Replace 8-3 & 8-4
   After 8-12, add 8-12a & 8-12b

Prepared by: [Signature] 11/03/07
Book Manager

Approved by: [Signature] 11-13-07
Lead, Rendezvous Guidance and Procedures
Group

Accepted by: [Signature] 11/3/07
Chief, Orbit Dynamics Branch

Encl: 18 pages

File this PCN immediately behind the front cover as a permanent record
MISSION OPERATIONS DIRECTORATE

RENDZVOUS
STS-122

FINAL
October 3, 2007

PREPARED BY:

Nick O'Dosey
Book Manager

APPROVED BY:

Steve R. Walker
Lead, Rendezvous Guidance and Procedure Group

ACCEPTED BY:

R. T. Gavin
Chief, Orbit Dynamics Branch

This document is under the configuration control of the Crew Procedures Control Board (CPCB). All proposed changes must be submitted via FDF Workflow Crew Procedure Change Request (CR) to DO3/FDF Manager.

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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-1E 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.
ACRONYMS

AZ, AZM  Azimuth
D/N  Day/Night
EL, ELEV  Elevation
IAH  Inertial
LOS  Line of Sight
LVLH  Local Vertical, Local Horizontal
R  Range
\( \dot{R} \)  Range Rate
R, RBAR  Radius Vector (toward Earth)
RNDZ  Rendezvous
RR  Rendezvous Radar
SK  Stationkeeping
ST, STRK  Star Tracker
\( \vec{V}, VBAR \)  Velocity Vector (direction of orbital travel)
\( \pm X, Y, ZLV \)  \( \pm X, Y, \) or \( Z \) Local Vertical (\( \pm X, Y, \) or \( Z \) toward Earth)
X, Y, ZPOP  X, Y, or Z orbiter body axis Perpendicular to Orbit Plane
(aligned with the angular momentum vector)
\( \pm X, Y, ZVV \)  \( \pm X, Y, \) or \( Z \) orbiter body axis along the LVLH Velocity Vector
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<td>C/L CAMERA ZOOM CALIBRATION (RING READY FOR DOCK)</td>
<td>CC 9-19</td>
<td>RNDZ-10a/122/O/A</td>
</tr>
<tr>
<td>FLIGHT SUB ANG RULER</td>
<td>CC 9-20</td>
<td>RNDZ-13a/122/O/A</td>
</tr>
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<td>V10 MONITOR CORRIDOR</td>
<td>CC 9-21</td>
<td>RNDZ-14a/122/O/A</td>
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<td>A31P PGSC DISPLAY OF C/L CAMERA CORRIDOR AND ALIGNMENT</td>
<td>CC 9-22</td>
<td>RNDZ-15a/122/O/A</td>
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<td>A31P PGSC CAMERA A/D RANGE RULER</td>
<td>CC 9-23</td>
<td>RNDZ-16a/122/O/A</td>
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<td>RCS FAILURE RESPONSE DURING PROX OPS</td>
<td>CC 9-25</td>
<td>RNDZ-17a/122/O/A</td>
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<td>CC 9-26</td>
<td>RNDZ-17b/122/O/A</td>
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* – Omit from flight book
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<td>POST-CONTACT THRUST (PCT) REFERENCE DATA</td>
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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>
<tr>
<td>FAILURE</td>
<td>RESPONSE</td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>No sensor data (RR, STRK, or COAS) during RNDZ and no visual acquisition</td>
<td>Breakout Burn by MC2 + 20 min</td>
</tr>
<tr>
<td>Good sensor data (RR, STRK, or COAS) during RNDZ, but no visual or RR acquisition</td>
<td>Breakout Burn by MC2 + 24 min</td>
</tr>
<tr>
<td>Target &gt; 30 deg from COAS horizontal at start of radar fail correction</td>
<td>Breakout ASAP; use RNDZ BREAKOUT (CONTINGENCY OPS), 5-18, until RBAR arrival</td>
</tr>
<tr>
<td>Prop quantities violate bingo numbers on RNDZ PRPLT PAD (Cue Card) or Orbiter systems malfunctions require breakout</td>
<td>Breakout per overview on 1-2</td>
</tr>
<tr>
<td>SYSTEMS:</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>DPS: &lt; 2 GNC GPCs</td>
<td>PROX OPS within 250 ft not permitted</td>
</tr>
<tr>
<td>GNC: Loss of redundant +Z Trans or PRCS TRANS, any axis ↓ or PRCS ROT, any axis ↓ or AFT THC (-Z sense), &gt; 1 TX contact ↓, all TY contacts ↓, all TZ contacts ↓ or AFT RHC, all channels, any axis ↓ or &lt; 2 IMUs</td>
<td>PROX OPS within 250 ft not permitted</td>
</tr>
<tr>
<td>Both Left Aft firing jets ↓ or Both Right Aft firing jets ↓</td>
<td>Continue Approach, per DEGRADED +X TRANSLATION (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>Two Forward firing jets ↓</td>
<td>Continue Approach, per DEGRADED -X TRANSLATION (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>Both Forward Right firing jets ↓ or Both Forward Left firing jets ↓</td>
<td>PROX OPS within 250 ft not permitted. Approach or Backout to 250 ft per LOSS OF FORWARD SIDE FIRING JETS (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>One Forward Down firing jet ↓</td>
<td>Continue Approach per LOSS OF ONE FxD JET (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>Both Forward Down firing jets same side ↓</td>
<td>PROX OPS within 250 ft not permitted. Approach or Backout to 250 ft per LOSS OF BOTH FxD JETS (SAME SIDE) (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>Loss of VRCS</td>
<td>Use ALT in place of VERN during RNDZ, approach outside 2000 ft, and sep Use PRI in place of VERN during approach inside 2000 ft, and flyaround See LOSS OF VRCS (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>MECH: 1 KU ANTENNA STOW MOTOR ↓</td>
<td>Normal ops</td>
</tr>
</tbody>
</table>
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

Vbar
-50
-100
-150
-200
-250 kft

Rbar

kft
10
20
30
40
<table>
<thead>
<tr>
<th>MC2 ET (h:mm)</th>
<th>Range (ft)</th>
<th>Rdot (fps)</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0:27</td>
<td>-3.0</td>
<td>MANUAL PHASE TAKEOVER (POST-MC4)</td>
</tr>
<tr>
<td>2</td>
<td>0:29</td>
<td>-2.4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0:31</td>
<td>-2.1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0:36</td>
<td>-1.3</td>
<td>TRANSITION TO LOWZ</td>
</tr>
<tr>
<td></td>
<td>0:37</td>
<td>-1.1</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</td>
<td>0:46</td>
<td>0.0</td>
<td>STATIONKEEP TO AVOID SHADOWING IF REQUIRED</td>
</tr>
<tr>
<td>6</td>
<td>1:00</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>620</td>
<td>-0.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>-0.15</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1:11</td>
<td>-0.7</td>
<td>RELOAD DAP A9, LOAD UNIV PTG P=179 DEG, REESTABLISH RDOT PER TORVA ICs INITIATE TORVA: DAP A, ITEM 19 (+X PULSES AS RFQ’D TO NUII TARGET MOTION IN CAMFRA)</td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>-0.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>550</td>
<td>-0.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VBAR APPROACH

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

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 2</td>
<td>UNDOCKING; DAP B/ALT MODE TO LVLH; MAINTAIN CORRIDOR</td>
</tr>
<tr>
<td>0:01</td>
<td></td>
<td>SELECT VFRNS; 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>50</td>
<td></td>
<td>RESELECT -X JETS (F1F, F2F)</td>
</tr>
<tr>
<td>0:07</td>
<td>75</td>
<td>TRANSITION TO LOWZ</td>
</tr>
<tr>
<td>3 0:29 [1:15]*</td>
<td>&gt;400 (CG-CG)</td>
<td>SEP1: 1.5 FPS +X RADIAL BURN [IF PROP AVAILABLE, PERFORM 1/4 LAP TORS BETWEEN 400 AND 600 FT (CG-CG); NULL OPENING RATE OUTSIDE 600 FT; PERFORM 3/4 LAP TORS BETWEEN 600 AND 700 FT; THEN PERFORM SEP1]</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
UNDOCKING/SEPARATION TIMELINE
UNDOCKING/SEPARATION PAD [4A]

Nominal Undocking Time: [ ] [ ] [ ]

Orbiter Weight: [ ] [ ] [ ] [ ] [ ]

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

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

- **-00:45**
  - √DPS config for Undocking Ops - STRING 1233
  - CONFIGURE FOR SEPARATION [SA]
  - UNDOCKING PREP (APDS), 8-7
  - MCC UPDATE
    - ORB SV
    - TGT SV
    - Covar Matrix
  - ENABLE RENDEZVOUS NAV [SB]

- **-00:40**
  - On RPOP PGSCs:
    - Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-8, then:
    - Perform RPOP OPS, (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
    - Perform HHL CHECKOUT (RNDZ TOOLS), 7-6
  - MCC UPDATE
    - Undocking Time [4A]
  - UNDOCKING PREP (APDS), 8-7
  - Perform DOCKING MECHANISM POWERUP (APDS), 8-5
  - Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZ TOOLS), 7-2

- **-00:35**
  - Perform HHL CHECKOUT (RNDZ TOOLS), 7-6

- **-00:30**
  - Perform DOCKING MECHANISM POWERUP (APDS), 8-5
  - UNDOCKING PREP (APDS), 8-7

- **-00:25**
  - Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZ TOOLS), 7-2

- **-00:20**
  - √MCC
    - DAP: FREE
    - O14:F: RUDA 1A L2/R2 MANF DRIVER - OFF
    - O15:F: RJD MANF L5/R5 DRIVER - OFF
    - O16:F: Pri RJD LOGIC (eight) - ON
    - √MCC FOR GO TO POWER UP Vern and Pri DRIVERS (Pri in [6A]),
      - RJD MANF L5/R5 DRIVER - ON
      - Wait 5 sec,
    - DAP: AUTO

- **-00:15**
  - √DPS config for Undocking Ops - STRING 1233
  - CONFIGURE FOR SEPARATION [SA]
  - √DAP config: A12
  - √DAP: A(B)/AUTO/VERN(ALT)
  - √FLT CNTLR PWR - OFF

- **-00:10**
  - √DPS config for Undocking Ops - STRING 1233
  - CONFIGURE FOR SEPARATION [SA]
  - √DAP config: A12
  - √DAP: A(B)/AUTO/VERN(ALT)
  - √FLT CNTLR PWR - OFF

- **-00:05**
  - √DPS config for Undocking Ops - STRING 1233
  - CONFIGURE FOR SEPARATION [SA]
  - √DAP config: A12
  - √DAP: A(B)/AUTO/VERN(ALT)
  - √FLT CNTLR PWR - OFF

- **-00:00**
  - Set TiG to Undocking Time and update Orbiter Weight per [4A]
  - Enter any non-zero ∆V
  - LOAD – ITEM 22 EXEC
  - TIMER – ITEM 23 EXEC
  - OPS 201 PRO
  - √TRK - ITEM 19 EXEC (CUR - +)
  - √ERR TOT - ITEM 23 EXEC (+)
  - OPS 202 PRO

- **-00:15**
  - √DPS config for Undocking Ops - STRING 1233
  - CONFIGURE FOR SEPARATION [SA]
  - √DAP config: A12
  - √DAP: A(B)/AUTO/VERN(ALT)
  - √FLT CNTLR PWR - OFF

- **-00:20**
  - √DPS config for Undocking Ops - STRING 1233
  - CONFIGURE FOR SEPARATION [SA]
  - √DAP config: A12
  - √DAP: A(B)/AUTO/VERN(ALT)
  - √FLT CNTLR PWR - OFF

- **-00:25**
  - √DPS config for Undocking Ops - STRING 1233
  - CONFIGURE FOR SEPARATION [SA]
  - √DAP config: A12
  - √DAP: A(B)/AUTO/VERN(ALT)
  - √FLT CNTLR PWR - OFF

- **-00:30**
  - √DPS config for Undocking Ops - STRING 1233
  - CONFIGURE FOR SEPARATION [SA]
  - √DAP config: A12
  - √DAP: A(B)/AUTO/VERN(ALT)
  - √FLT CNTLR PWR - OFF

- **-00:35**
  - √DPS config for Undocking Ops - STRING 1233
  - CONFIGURE FOR SEPARATION [SA]
  - √DAP config: A12
  - √DAP: A(B)/AUTO/VERN(ALT)
  - √FLT CNTLR PWR - OFF

- **-00:40**
  - √DPS config for Undocking Ops - STRING 1233
  - CONFIGURE FOR SEPARATION [SA]
  - ADDS
  - √DAP config: A12
  - √DAP: A(B)/AUTO/VERN(ALT)
  - √FLT CNTLR PWR - OFF

- **-00:45**
  - √DPS config for Undocking Ops - STRING 1233
  - CONFIGURE FOR SEPARATION [SA]
  - ADDS
  - √DAP config: A12
  - √DAP: A(B)/AUTO/VERN(ALT)
  - √FLT CNTLR PWR - OFF
UNDOCKING OPERATIONS

1. PREP FOR UNDOCKING
   When MCC-H and ISS issue GO for Undocking:
   CRT
   ORB TO TGT - ITEM 10 EXEC
   O14, All DDU cbs (six) – cl
   O15, A6U FLT CNTLR PWR - ON

2. RECONFIGURE DAP
   CRT
   Config DAP A,B to A9,B9
   X Jets ROT ENA – ITEM 7 EXEC (no *)

3. COMMAND UNDOCKING
   CRT
   A7L
   * If HOOKS 1(2) OPEN it failed on:
   * APDS POWER A05 - OFF (A05 and failed lts off)
   APDS CIRC PROT OFF pb - push
   * CIRCUIT PROTECT OFF lt - lt on
   -02:20 > UNDOCKING pb - push
   √H Hooks 1, HOOKS 2 CLOSED lt (two) - lt off [HK1,HK2 POS (two) < 92% + decr]

3. COMMAND UNDOCKING
   CRT
   A7L
   * If HOOKS 1(2) fail to drive (HK1(2) DRV CMD - OFF):
   * OPEN HOOKS pb - push
   * If HOOKS 1(2) appear to stop before reaching end of travel
   * [HK1(2) Pos > 4% + n ot decr]:
   * Allow for single motor drive time (~4:40) before performing
   * POWER OFF pb - push
   * ON pb - push

4. POST UNDOCKING
   CRT
   A7L
   √RCS FWD – ITEM 1 EXEC (+)
   JET DES F1F – ITEM 31 EXEC (no *)
   P2F – ITEM 35 EXEC (no *)

5. POWER OFF
   A7L
   POWER OFF pb - push
   √STATUS lt (eighteen) - lt off
   GO TO SEP/FLYAROUND
UNDOCKING / SEPARATION TIMELINE

-00:15
PET

-00:10
MCC UPDATE
GO for Undocking

-00:05
UNDOCKING OPERATIONS [6A]

00:00
UNDOCK COMPLETE

00:05
A9(B9)

00:10
A12

00:15
MCC: GO FOR UNDOCKING
UNDOCKING / SEPARATION TIMELINE

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 10A
   NOTE: DAP A allowed for all THC Inputs
3. When RNG > 250 ft: Set RPOP POR: ORB CG - TGT CG
   Set RPOP Overlay: Flyaround Zone [Shift][F7]
   Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6
4. When RNG = 450 ± 50 FT (CG-CG)

   GNC UNIV PTG
   TGT ID  √+2
   BODY VECT √+5
   P √-90 (-RBAR)
   Y √+0
   OM √+0
   √ERR TOT - ITEM 23 (+)
   TRK – ITEM 19 EXEC (CUR - +)
   If no flyaround, Go to SEP 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
R1 O2 TK3 HTR A – OFF
Go to FLIGHT PLAN
FLYAROUND

Flyaround terminate criteria per 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 +270 (-VBAR)
   TRK - ITEM 19 EXEC (CUR - *)
   When RNG > 600 ft (CG-CG):
   THC: Maintain flyaround range of 650 ± 50 ft (CG-CG)

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

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

5. Prior to +Vbar crossing (Aft ADI P = 180):
   [GNC UNIV PTG]
   P +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

HHL RANGE CONVERSION

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

TCS/Reflector Visibility During Flyaround for Flight ISS-1E (STS-122)

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

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

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

IF NO RADAR LOCK-ON WITHIN 2 MIN

- KU sel - AUTO TRK
- SLEW EL,AZ to 0,0 deg
- KU SEARCH - SEARCH (tb–gray)

When lock on occurs:

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

When RESIDs small and stable,

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

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

**Burn Attitude**

- \(R\) 24
- \(P\) 25
- \(Y\) 26

**ΔVTOT**

**TGO**

**VGO**

\(X\) ( )

\(Y\) ( )

\(Z\) ( )

**NOTES**

- TRIM LOAD
- RCS SEL
- TV ROLL
- OMS BOTH
- \(\Delta V_X\)
- \(\Delta V_Y\)
- \(\Delta V_Z\)

**OMS GMBL CK:**

- PRE
- POST-BURN

**RCS I’CNCT:**

- L OMS → RCS
- R OMS → RCS
- NONE

**Down Mode Options:**

- 2 OMS → 1 OMS
- 1 OMS → RCS
- NONE

**Orbit Burn Monitor**

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

**Max TIG Slip**

- MIN

**Do Not Update TIG**

**Update TIG After**

**MIN**
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
R 24
P 25
Y 26

ΔVTOT
TGO

VGO X ( )
VGO Y ( )
VGO Z ( )

HA
HP

TGT ( )

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

PRE
POST-BURN

RCI CNCT:
L OMS → RCS
R OMS → RCS
NONE

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

NOTES

OMS HE REG TEST:
A
B

-X RCS BURNS:

BURN ATT
LVLH ATT

-AX RCS BURNS:

GPC FILL-INS _ ( )

ORBIT BURN MONITOR
CRIT BURN
NON-CRIT BURN

MAX TIG SLIP ___ MIN

DO NOT UPDATE TIG
UPDATE TIG AFTER ___ MIN

NOTES
### ORBIT MANEUVER PAD FOR __________

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**TRIM LOAD**

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**TGT PEG**

| ΔVX | 19 |
| ΔVY | 20 |
| ΔVZ | 21 |

**BURN ATT**

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<tr>
<th>ΔVTOT</th>
<th>TGO</th>
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**RCS I’CNCT:**

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<th>L PRI</th>
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<td>R SEC</td>
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**DON'T MODE OPTIONS:**

| 2 OMS → 1 OMS |
| 1 OMS → RCS |
| NONE |

**ORBIT BURN MONITOR**

**GPC FILL-INS**

| CRIT BURN |
| NON-CRIT BURN |

**MAX TIG SLIP __ MIN**

| DO NOT UPDATE TIG |
| UPDATE TIG AFTER __ MIN |

---

**NOTES**
### ORBIT MANEUver Pad FOR __________

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| TRIM LOAD | P 6 | ( ) | ( ) | . |   |   |   |   |   |   |   |   |
| LY        | 7 | ( ) | ( ) | . |   |   |   |   |   |   |   |   |
| RY        | 8 | ( ) | ( ) | . |   |   |   |   |   |   |   |   |
| WT        | 9 |   |   |   |   |   |   |   |   |   |   |   |

| TGT PEG 7 | ΔVX | 19 | ( ) | . |   |   |   |   |   |   |   |   |
| ΔVY      | 20 | ( ) | . |   |   |   |   |   |   |   |   |   |
| ΔVZ      | 21 | ( ) | . |   |   |   |   |   |   |   |   |   |

#### BURN ATT

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#### RCS I’CNCT:

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#### DOWN MODE OPTIONS:

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#### OMS HE REG TEST:

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#### -X RCS BURNS:

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#### ORBIT BURN MONITOR

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#### NOTES

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

---

NOTES

---

3-10

RNDZ/122/FIN
### ORBIT MANEUVER PAD FOR ___________

<table>
<thead>
<tr>
<th>OMS BOTH 1</th>
<th>L 2</th>
<th>R 3</th>
<th>RCS SEL 4</th>
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<tr>
<td></td>
<td></td>
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<td>+X</td>
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<th>TGT PEG 7</th>
<th>ΔVX 19</th>
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### BURN ATT

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<tr>
<th>R 24</th>
<th>VGO X (       )</th>
<th>VGO Y (       )</th>
<th>VGO Z (       )</th>
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<tr>
<td>PRE</td>
<td>POST-BURN</td>
<td>RCS I'CNCT:</td>
<td>L OMS → RCS</td>
<td>R OMS → RCS</td>
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<tr>
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<td></td>
<td>NONE</td>
<td>2 OMS → 1 OMS</td>
<td>1 OMS → RCS</td>
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### ORBIT BURN MONITOR

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<thead>
<tr>
<th>GPC FILL-INS</th>
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<tr>
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<td>MAX TIG SLIP</td>
<td>DO NOT UPDATE TIG</td>
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<td>__ MIN</td>
<td>UPDATE TIG AFTER __ MIN</td>
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### NOTES

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<td></td>
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<td></td>
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<td>Y</td>
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<th>DOWN MODE OPTIONS:</th>
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<td>2 OMS → 1 OMS</td>
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<td>1 OMS → RCS</td>
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3-12  RNDZ/122/FIN
This Page Intentionally Blank
Rendezvous Timeline

AFT FLT STATION CONFIG FOR RNDZ

O14,16:E
- cb MNA,C DDU AFT (two) - cl

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

R13
- √KU ANT - GND

A1U
- PWR - STBY
- sel - MAN SLEW
- MODE - RDR PASSIVE
- RADAR OUTPUT - HI
- CNTL - PNL (wait 3 seconds)
- PWR - ON
- SIG STRENGTH sel - KU
- SLEW RATE - as reqd

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

CRT
- SM ANTENNA
- 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)
RENNDEZVOUS TIMELINE

PET

-03:00

CDR AFT FLT STATION CONFIG FOR RNDZ [A]

A7 (B7)

-02:55

PLT RNDZ OPS INITIALIZATION [A]

-02:50

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

-02:45

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)

-02:40

MCC UPDATE

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

-02:35

MCC UPLINK

ORB SV

TGT SV

Drag K-factor

-02:30

RNDZ OPS INITIALIZATION [A]

\DPS Config for Rndz Ops - String 1233

\SM2 TIME

Set SM TIMER counting to Ti TIG per burn Pad, 3-6

Config DAP A,B to A7,B7

Record nominal TIGs in burn solution blocks per Execute Package:

NCC TIG pg 4-11

MC1 TIG pg 4-17

MC2 TIG pg 4-18

\GNC 55 GPS STATUS

DES RCVR, ITEM 27 - (+)

\INH GPS to G&C, ITEM 33 - (+)

NAV, ITEM 36 - (+)
**RENDEZVOUS TIMELINE**

- **PET**
  - **-02:30**
    - A7(B7)
    - TIG-5 MIN
  - **-02:25**
    - If reqd.
    - NH TIG
    - Postburn DAP: A/LVLH/VERN(ALT)
  - **-02:20**
    - NH TIG
  - **-02:15**
    - PLT ENABLE RENDEZVOUS NAV [7A]
    - MS PGSCs setup per PGSC Usage Chart (if available) or UTILITY OUTLET PLUG-IN
    - PLT, 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
    - MS Perform HHL CHECKOUT (RNDZ TOOLS), 7-6
  - **-02:10**
  - **-02:05**
  - **-02:00**

**ENABLE RENDEZVOUS NAV [7A]**

1. **GNC_33 REL NAV**
   - CRT RNDZ NAV ENA - ITEM 1 EXEC (*)
   - √ SV SEL, ITEM 4 - PROP
   - √ S TRK, ITEM 12 - (*)

2. **GNC_34 ORBIT_TGT**
   - TGT NO - ITEM 1 +1 EXEC
   - Set BASE TIME to Ti TIG, (Ti Burn Pad, 3-6)
   - LOAD - ITEM 26 EXEC

**MCC UPDATE**

Final NC Burn Pad, 3-3
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

Load Target Track [9A]

DAP: A/LVLH/VERN(ALT)

CRT CNCL - ITEM 21 EXEC
TGT ID +1

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

Target NCC Burn [11A] (Preliminary), 4-11

MCC Update

LOAD TARGET TRACK [9A]

√DAP: A/LVLH/VERN(ALT)

GNC UNIV PTG

CRT CNCL - ITEM 21 EXEC
TGT ID +1

Z AXIS

Y STRK

BODY VECT +3 (-Z)
+4
+0

P

+90
+90

Y

+280.57

OM

+90
+90

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

Target NCC Burn [11A] (Preliminary), 4-11

MCC Update

LOAD TARGET TRACK [9A]

√DAP: A/LVLH/VERN(ALT)

GNC UNIV PTG

CRT CNCL - ITEM 21 EXEC
TGT ID +1

Z AXIS

Y STRK

BODY VECT +3 (-Z)
+4
+0

P

+90
+90

Y

+280.57

OM

+90
+90

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

Target NCC Burn [11A] (Preliminary), 4-11

MCC Update

LOAD TARGET TRACK [9A]

√DAP: A/LVLH/VERN(ALT)

GNC UNIV PTG

CRT CNCL - ITEM 21 EXEC
TGT ID +1

Z AXIS

Y STRK

BODY VECT +3 (-Z)
+4
+0

P

+90
+90

Y

+280.57

OM

+90
+90

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

Target NCC Burn [11A] (Preliminary), 4-11

MCC Update
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 (+)
  - MCC for NAV selected IMU ____

  **GNC 33 REL NAV**
  - If first NAV pass, ____________
  - If previous NAV, ____________

  **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 = _______ _______ _______
  - Record init RESID 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

  **GNC 33 REL 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:
  - **GNC 22 S TRK/COAS_CNTL**
    - Z(-Y) BREAK TRK - ITEM 8(7) EXEC
    - Repeat Step 2
  - **GNC 22 S TRK/COAS_CNTL**
    - When S PRES - (+), if RESID V or H still > 0.6 and stable:
      - Perform S TRK NAV - HIGH FLTR MINUS PROP (CONTINGENCY OPS), 5-9

END S TRK NAV

**GNC 33 REL NAV**
- INH Angles - ITEM 24 EXEC (+)

**GNC 21 IMU ALIGN**
- IMU DES - ITEM 7(8,9) EXEC (no *)
### Rendezvous Timeline

#### Target NCC Burn **11A**

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

- **TGT Set data:**
  - **ΔTIG** +57.7
  - **Δε** -48.6
  - **Δφ** +0.0
  - **Δθ** +1.2

  **COMPUTE T1** - **ITEM 28 EXEC**
  - Record solution in PAD

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

**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

---

### MCC Update

- **Nav Selected IMU**
- **Ground CCR**
- **RCC BURN Solution**
  - **ΔVx**
  - **ΔVy**
  - **ΔVz**
  - **ΔVT**

**FINAL - GROUND LIMITS**
- **ΔVx** (0.8)
- **ΔVy** (1.4)
- **ΔVz** (2.3)

---

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<tr>
<th>TIG</th>
<th>PRELIMINARY</th>
<th>INTERMEDIATE</th>
<th>FINAL</th>
<th>GROUND</th>
<th>FINAL - GROUND LIMITS</th>
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**RENDZVOUS TIMELINE**

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<td>-01:30</td>
<td>PLT STAR TRACKER NAV <strong>10A</strong></td>
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<td>MCC UPDATE Nav Selected IMU</td>
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<td>When NAV converged (SV UPDATES small and stable):</td>
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<tr>
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<td>CDR TARGET NCC BURN <strong>11A</strong> (Intermediate)</td>
</tr>
<tr>
<td>-01:20</td>
<td>PLT END S TRK NAV <strong>10B</strong></td>
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<td>TARGET NCC BURN <strong>11A</strong> (Final)</td>
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<td>PLT TARGET NCC BURN <strong>11A</strong> (Final)</td>
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<td>-01:10</td>
<td>PET STAR TRACKER NAV <strong>10A</strong></td>
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<td>PLT END S TRK NAV <strong>10B</strong></td>
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<td>TARGET NCC BURN <strong>11A</strong> (Final)</td>
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<td>Perform +X Burn, RCS BURN (Cue Card)</td>
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<tr>
<td>-01:00</td>
<td>CDR Perform RCS BURN (Cue Card)</td>
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---

**TIG-10 MIN**

- If no comm
  - * If ΔVT > 6 fps:
    - END S TRK NAV **10B**
    - TARGET NCC BURN **11A** (Final)
    - Perform RNDZ OMS BURN (CONTINGENCY OPS), 5-4
  - * If ΔVT > 4 fps:
    - END S TRK NAV **10B**
    - TARGET NCC BURN **11A** (Final)

**TIG-5 MIN**

- PET STAR TRACKER NAV **10A**
- PLT TARGET NCC BURN **11A** (Final)
-Z AXIS TARGET TRACK

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

C3 DAP: B/AUTO/ALT

CRT TRK - ITEM 19 EXEC (CUR - *)

When MNVR cmplt.
DAP: A/AUTO/VERN(ALT)
When NAV converged (SV UPDATES small and stable):

**PLT** TARGET Ti BURN (Intermediate)
<table>
<thead>
<tr>
<th>PREL FLTR</th>
<th>INTER FLTR</th>
<th>FINAL FLTR</th>
<th>GND</th>
<th>PROP (If Req'd)</th>
<th>FINAL - GROUND LIMITS</th>
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<tbody>
<tr>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>ΔVX (1.3)</td>
</tr>
<tr>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>ΔVY (1.3)</td>
</tr>
<tr>
<td>( )</td>
<td>( )</td>
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<td>( )</td>
<td>( )</td>
<td>ΔVZ (1.1)</td>
</tr>
<tr>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td></td>
</tr>
</tbody>
</table>

ΔVX (1.3)  
ΔVY (1.3)  
ΔVZ (1.1)

FINAL Ti Burn Pad, 3-7
RENDEZVOUS TIMELINE

4-15

MCC for burn type. If no comm:
If $\Delta V > 6$, at TIG-17:
| Perform RNDZ OMS BURN (CONTINGENCY OPERATIONS), 5-4
If $4 \leq \Delta V \leq 6$, at TIG-17:
| Perform $+x$ RCS burn, RCS BURN (Cue Card)
If $\Delta V < 4$, at TIG-5:
| Perform multi-axis RCS burn, RCS BURN (Cue Card)

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-17
If Ti is multi-axis burn, delay final targeting until TIG-5

PLT TARGET Ti BURN [15A] (Final)

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

GO for Ti

MCC UPDATE

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

TIG-17
If Ti is multi-axis burn, delay final targeting until TIG-5

PLT TARGET Ti BURN [15A] (Final)

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

GO for Ti

MCC UPDATE

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

TARGET Ti BURN [15A] (Final)

CRT OPS 202 PRO

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

GNC 33 REL NAV

$\sqrt{SV}$ SEL correct

GNC 34 ORBIT TGT

TGT NO - ITEM 1 +1 0 EXEC

$\sqrt{TGT}$ Set data:
| T1 TIG = BASE TIME
| EL = 0
| $\Delta T = +76.9$
| $\Delta X = 0.9$
| $\Delta Y = 0$
| $\Delta Z = +1.8$

COMPUTE Ti - ITEM 28 EXEC

Record solution in PAD

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

| Ti TIG |
POST Ti NAV [16A]

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

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

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

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

<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>-0.1 ± (0.5)</td>
<td></td>
</tr>
<tr>
<td>ΔVY</td>
<td>( ) *</td>
<td>( )</td>
<td>-0.1 ± (0.5)</td>
<td></td>
</tr>
<tr>
<td>ΔVZ</td>
<td>( ) *</td>
<td>( )</td>
<td>-0.3 ± (1.6)</td>
<td></td>
</tr>
<tr>
<td>ΔVT</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

- **TARGET MC 1 BURN** [17A] (Preliminary)
- **TARGET MC 1 BURN** [17A] (Intermediate)
- **TARGET MC 1 BURN** [17A] (Final)

---

**TARGET MC 2** [17B] (Preliminary)

- **TARGET MC 2** [17B] (Preliminary)

---

**RENNRECUZOUS TIMELINE**

<table>
<thead>
<tr>
<th>PET</th>
<th>00:00</th>
<th>PLT</th>
<th>TARGET MC 1 BURN [17A] (Preliminary)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7(B7)</td>
<td></td>
<td>CDR</td>
<td>POST Ti NAV [16A]</td>
</tr>
<tr>
<td>00:05</td>
<td></td>
<td>When MNVR to att cmplt:</td>
<td></td>
</tr>
<tr>
<td>00:10</td>
<td></td>
<td>PLT</td>
<td>TARGET MC 1 BURN [17A] (Intermediate)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MS</td>
<td>√Time of OOP null</td>
</tr>
<tr>
<td>00:15</td>
<td></td>
<td>PLT</td>
<td>TARGET MC 1 BURN [17A] (Final) Perform RCS BURN (Cue Card)</td>
</tr>
<tr>
<td>00:20</td>
<td></td>
<td>TIG-3 MIN</td>
<td></td>
</tr>
<tr>
<td>00:25</td>
<td></td>
<td>When Y = 0:</td>
<td></td>
</tr>
<tr>
<td>00:30</td>
<td></td>
<td>PLT</td>
<td>MANUAL OUT-OF-PLANE NULL [19A]</td>
</tr>
</tbody>
</table>
### TARGET MC 2 BURN (Intermediate)

**CRT**
- SV SEL correct
  - GNC 34 ORBIT TGT
    - TGT NO - ITEM 1 +1 2 EXEC
    - COMPUTE T1 - ITEM 28 EXEC

Record solution in PAD

### TARGET MC 2 BURN (Final)

**CRT**
- SV SEL correct
  - GNC 34 ORBIT TGT
    - TGT NO - ITEM 1 +1 2 EXEC

**√** TIG change

**IF TIG CHANGE < -3 OR > +7 MIN**
- Set BASE TIME to (Nominal MC 2 TIG -3 or +7 min as appropriate)
- LOAD - ITEM 26 EXEC
- TGT NO - ITEM 1 +1 9 EXEC

**√** TGT Set data:
- T1 TIG = BASE TIME
- ΔT = +27.0
- ΔX = +0.9
- ΔY = +0.3
- ΔZ = +1.8

**COMPUTE T1** - ITEM 28 EXEC

Record solution in PAD

**GNC 33 REL NAV**

**CRT** FLTR TO PROP - ITEM 8 EXEC

### MC 2 BURN SOLUTION

<table>
<thead>
<tr>
<th>PRELIMINARY</th>
<th>INTERMEDIATE</th>
<th>FINAL</th>
<th>TIG SLIP (COMPUTED-NOM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔVX</td>
<td></td>
<td></td>
<td>+0.0 ± (0.3)</td>
</tr>
<tr>
<td>ΔVY</td>
<td></td>
<td></td>
<td>+0.0 ± (0.2)</td>
</tr>
<tr>
<td>ΔVZ</td>
<td></td>
<td></td>
<td>+0.3 ± (2.4)</td>
</tr>
<tr>
<td>ΔVT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MEAN ± (3σ VARIATION)**

### -Z AXIS TARGET TRACK

**CRT**
- GNC UNIV PTG
  - GNC 34 REL NAV
    - INH Angles - ITEM 24 EXEC (+)
  - GNC 21 IMU ALIGN
    - IMU DES - ITEM 7(8,9) EXEC (no +)

**DAP:** B/AUTO/ALT

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

### NIGHTTIME STRK OPS

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) +1 EXEC

3. Perform **STAR TRACKER NAV** steps 2 and 3

---

**RENDEZVOUS TIMELINE**

4-18
### RENDEZVOUS TIMELINE

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>00:30</td>
<td>PET</td>
</tr>
<tr>
<td>00:35</td>
<td>MC2 ET</td>
</tr>
<tr>
<td>00:40</td>
<td>MC2 ET</td>
</tr>
<tr>
<td>00:45</td>
<td>PLT TARGET MC 2 BURN (Final)</td>
</tr>
<tr>
<td>00:50</td>
<td>PLT TARGET MC 3 BURN (Preliminary)</td>
</tr>
<tr>
<td>00:55</td>
<td>PLT END STAR TRACKER NAV (18C)</td>
</tr>
<tr>
<td>01:00</td>
<td>PLT END STAR TRACKER NAV (18C)</td>
</tr>
</tbody>
</table>

**Manual Out-of-Plane Null (19A)**

**Target MC 2 (19B)**

**Target MC 3 (19B)**

<table>
<thead>
<tr>
<th>TIG</th>
<th>PRELIMINARY</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔX</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>ΔY</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>ΔVZ</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>ΔVT</td>
<td>( )</td>
<td>( )</td>
</tr>
</tbody>
</table>

**MC 3 Burn Solution**

**If Initial RR Acq Post-MC2**

- CDR Perform Late RR NAV (20E)

**If -Y S TRK Track**

- END STAR TRACKER NAV (18C)

**If -Z Axis Target Track**

- END STAR TRACKER NAV (18C)
MC 4 BURN SOLUTION

<table>
<thead>
<tr>
<th></th>
<th>PRELIMINARY</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TIG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FINAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔVX</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔVY</td>
<td></td>
<td>*</td>
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<td></td>
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<tr>
<td>ΔVZ</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔVT</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MEAN ± 3σ VARIATION

ΔVX: +1.3 ± (2.6)
ΔVY: -0.0 ± (0.5)
ΔVZ: +0.9 ± (3.1)

TARGET MC 4 BURN

CRT

✓ SV SEL correct

GNC 34 ORBIT TGT

TGT NO - ITEM 1 + 1 EXEC

GNC 33 REL NAV

TGT NO - ITEM 1 + 1 EXEC

EXEC

TGT Set data:

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

ESTABLISH RBAR

A6U

FLT CNTLR PWR - ON

GNC UNIVERSAL PTG

TRK - ITEM 19 EXEC (CUR - *)

DAP: A/AUTO/VERN(PRI)

THC: as reqd to control TGT motion in COAS

CONFIG FOR RBAR

GNC UNIVERSAL PTG

✓ ERR TOT - ITEM 23 EXEC (+)

When ERR <2 deg each axis

GNC 20 DAP CONFIG

Config DAP A, B to A8, B8

GNC UNIVERSAL PTG

TGT ID +2
BODY VECT +270
P +2
Y +0
OM +0

Do not initiate Target Track until ESTABLISH RBAR

LATE RADAR NAV

GNC 33 REL NAV

CRT

FLTR TO PROP - ITEM 8 EXEC

SV SEL, ITEM 4 - PROP

✓ - 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 MC3+18 IF NO VISUAL ACQUISITION OR
   TARGET > 30 DEG FROM COAS HORIZONTAL
   CDR

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

2. At MC2 TIG + 19:00:

   A6U

   FLT CNTLR PWR - ON

   ✓ SENSE - Z

   DAP: A/LVLH/PRI

   ✓ COAS for TGT vertical position

   THC: +X or -X per COAS LOGIC:
   If TGT = N deg high in COAS, perform 2N +X (up) pulses
   If TGT = N deg low in COAS, perform 1N -X (down) pulses

   DAP: A/LVLH/VERN(PRI)

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

   Following radar fail X correction,

   THC: As reqd to control out of plane motion and manage RDOT

   Perform CONFIG FOR RBAR

3. At MC2 TIG + 24:00 or 2000 ft, whichever comes first:

   GNC UNIVERSAL 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)

RENDEZVOUS TIMELINE

4-20

RNDZ/122/FIN 1
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>01:00</td>
<td>PET</td>
<td>A7(B7)</td>
</tr>
<tr>
<td>01:05</td>
<td>MC2 ET</td>
<td>00:15</td>
</tr>
<tr>
<td>01:10</td>
<td>IF NO RR INTO NAV</td>
<td>CDR Go to RADAR FAIL PROCEDURES [20D]</td>
</tr>
<tr>
<td>01:15</td>
<td>TIG-3 MIN</td>
<td>PLT TARGET MC3 BURN [19B] (Final)</td>
</tr>
<tr>
<td>01:20</td>
<td></td>
<td>Perform RCS BURN (Cue Card)</td>
</tr>
<tr>
<td>01:25</td>
<td></td>
<td>PLT TARGET MC 4 BURN [20A] (Final)</td>
</tr>
<tr>
<td>01:30</td>
<td></td>
<td>CDR CONFIG FOR RBAR [20B]</td>
</tr>
<tr>
<td>01:35</td>
<td></td>
<td>MS Perform HHL OPS (RNDZ TOOLS), 7-7</td>
</tr>
<tr>
<td>01:40</td>
<td></td>
<td>HHL REPORT R and Rdot</td>
</tr>
<tr>
<td>01:45</td>
<td>TIG-3 MIN</td>
<td>PLT TARGET MC 4 [20A] (Final)</td>
</tr>
<tr>
<td>01:50</td>
<td></td>
<td>Perform RCS BURN (Cue Card)</td>
</tr>
<tr>
<td>01:55</td>
<td></td>
<td>MC 3 TIG</td>
</tr>
<tr>
<td>02:00</td>
<td></td>
<td>CDR ESTABLISH RBAR [20C]</td>
</tr>
<tr>
<td>02:05</td>
<td></td>
<td>Perform APPROACH (Cue Card)</td>
</tr>
</tbody>
</table>

**Manual Trajectory Control**
TERMINATE RNDZ OPS [22A]

1. ORBITER CONFIG FOR MATED ATTITUDE CONTROL
   PLT
   O14:F, Pri RJD LOGIC, DRIVER (sixteen) – OFF
   O15:F, RJDA 1A L2/R2 MANF DRIVER – ON
   O16:F
   O14:E, All DDU cbs (six) – op
   O15:E, O16:E
   CDR A6U
   √ FLT CNTLR PWR - OFF
   PLT
   CRT -GNC_23_RCS-
   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_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 - ITEM 27 (no *)
   [GNC 33 REL NAV]
   RNDZ NAV ENA - ITEM 1 EXEC (no *)

   RETURN TO FLIGHT PLAN

2. ORBITER CONFIG FOR MATED OPS
   MS
   A6L
   √ return to flight plan
   CRT -Z COAS - OFF
   [GNC_23_RCS]
   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 - ITEM 27 (no *)
   [GNC 33 REL NAV]
   RNDZ NAV ENA - ITEM 1 EXEC (no *)

   RETURN TO FLIGHT PLAN
CONTINGENCY OPS

RNDZ OMS BURN ............................................................................................................... 5-3
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TGT ITER ........................................................................................................................ 5-30
LOSS OF COMM .............................................................................................................. 5-31
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  -X TRANSLATION .................................................................................................... 5-36
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  ONE FxD JET .............................................................................................................. 5-38
  BOTH FxD JETS (SAME SIDE) ................................................................................ 5-39
VRCS ............................................................................................................................... 5-41
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**
   - **CRT1**
     - **1:** GNC 20 DAP CONFIG
     - **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**
   - **TIG-3**
     - F6,F8 FLT CNTLR PWR (two) – ON
     - Perform OMS2/ORBIT OMS BURNS (Cue Card)

4. **OMS POST BURN RECONFIGURATION**
   - **F6,F8**
     - FLT CNTLR PWR (two) – OFF
     - O8 L,R OMS He PRESS/VAP ISOL (four) – CL
   - **C3**
     - DAP: B/INRTL/ALT
     - DAP TRANS: PULSE/PULSE/PULSE
     - **CRT1**
       - RCS SEL – ITEM 4 EXEC (*)
       - Perform OMS TVC GMBL CK per Burn Pad
         - * If down arrow(s) or M(s), *
         - * select good GMBL  *
   - GNC, OPS 201 PRO

Cont next page
5. MNVR TO POST BURN ATTITUDE

[1: GNC UNIV PTG]
\[\sqrt{\text{Desired UNIV PTG load active}}\]

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 (*)
[1: GNC 33 REL NAV]

[1: GNC UNIV PTG]

When in attitude and rates nulled:

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

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

   On MCC GO (if no comm, continue):
2. CHECK FOR S TRK FALSE LOCK
   2: GNC 22 S TRK/COAS CNTL
   If -Z S TRK, perform COAS visual check:
   NOTE
   GNC 33 REL NAV: COAS X (+up) and COAS Y (+left)
   provide approx TGT position in COAS based on -Z
   S TRK measurement

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

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

4. RESUME PASS
   Continue with pass per STAR TRACKER NAV, step 3 10A, then:
   After S TRK pass, on MCC GO:
   NOTE
   SELF-TEST may fail. √MCC for S TRK status
   2: GNC 22 S TRK/COAS CNTL
   CRT2 -Z(-Y) SELF-TEST – ITEM 2(1) EXEC (*)
S TRK NAV – HIGH FLTR MINUS PROP

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

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

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

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

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

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

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

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

NOTE

Do not execute MC1 or Out-Of-Plane null.
Prior COAS cal reqd to perform COAS NAV.
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
\textbullet SENSE: -Z
\textbullet DAP: B7/AUTO/VERN(ALT)

\textbf{CRT}
\textbf{GNC 22 STRK/COAS CNTL}
\textbf{COAS: SIGHT MODE – ITEM 22 EXEC (*)}
\textbf{REQD ID – ITEM 21 +1 EXEC}
\textbf{POS-Z: ITEM 27 (*)}

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

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

2. COAS MARKS

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

\textbf{CRT}
\textbf{GNC 33 REL NAV}
If X and Y RESID magnitudes ≥ 1.0:
\textbullet MCC
If X and Y RESID magnitudes < 1.0:
\textbullet FOR – ITEM 25 EXEC
\textbullet SV UPDATE – non-zero (within 8 sec), then
\textbullet 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
\textbullet DAP: A7/AUTO/VERN(ALT)
\textbullet FLT CNTLR PWR – OFF
\textbf{CRT}
\textbf{GNC 22 STRK/COAS CNTL}
\textbf{COAS: DES – ITEM 25 EXEC (*)}

Resume rendezvous timeline
BACKOUT/BREAKOUTS
VBAR CORRIDOR BACKOUT

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

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

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

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

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

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

When RNG > 50 ft:
   DAP config: A9/B9
   RCS F – ITEM 1 EXEC (*)
   JET DES F1F – ITEM 31 EXEC (no *)
   JET DES 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 +180 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

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

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

   When RNG > 75 ft:
   If single -X jet configuration:
   GNC 23 RCS
   RCS F – ITEM 1 EXEC (*)
   JET DES F1F – ITEM 31 EXEC (no *)
   F2F – ITEM 35 EXEC (no *)
   Config DAP A,B to A9,B9
   DAP: LO Z

   When RNG > 150 ft
   2. 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 NR PWR – OFF

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

GNC, OPS 202 PRO

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

√MCC for breakout direction and TV ROLL

**NOTE**

Posigrade burn will be performed if second docking attempt desired

Set TIG to (±\(X\)) burn + 30 min

If Posigrade Sep:

- TGT PEG 7 \(\Delta VX\) – ITEM 19 +4.3 EXEC
- \(\Delta VY\) – ITEM 20 +3.6 EXEC
- \(\Delta VZ\) – ITEM 21 +0 EXEC

If Retrograde Sep:

- TGT PEG 7 \(\Delta VX\) – ITEM 19 -4.3 EXEC
- \(\Delta VY\) – ITEM 20 +3.6 EXEC
- \(\Delta VZ\) – ITEM 21 +0 EXEC

TV ROLL – ITEM 5 +_ _ _ EXEC

LOAD – ITEM 22 EXEC

TIMER – ITEM 23 EXEC

Config DAP A,B to A7,B7

At TIG -8 min:

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

At TIG -0:30:

- DAP TRANS:  as reqd
- DAP:  A/INRTL/PRI

F7 FLT CNTLR PWR – ON

At THC:  Trim VGOs \(\leq 0.2\) fps

F7 FLT CNTLR PWR – OFF

DAP TRANS:  PULSE/PULSE/PULSE

DAP:  A/INRTL/VERN(ALT)

GNC, OPS 201 PRO

On MCC call:

- Go to **TERMINATE SEP OPS** 8C 2-8
RNDZ BREAKOUT

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

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

2. 3 FPS RETROGRADE
CRT
OPS 202 PRO
GNC ORBIT MNVR EXEC
√RCS SEL – ITEM 4 (*)
Set TIG to current time
TGT PEG 7 \( \Delta VX \) – ITEM 19 –3 EXEC
\( \Delta VY \) – ITEM 20 +0 EXEC
\( \Delta VZ \) – 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 [10A], 2-10
  Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6

2. PERFORM RADIAL BURN ON ±VBAR

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

FLT CNTLR PWR – OFF
DAP: A/INRTL/VERN(ALT)
Record Radial Burn TIG ___ / ___ : ___ :

Inform MCC when burn complete

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

Cont next page
3. **PERFORM FINAL BURN**

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

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

If performing emergency deorbit:
- \[\text{MCC/PGSC for deorbit burn TIG/PAD}\]
- 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:
- \[\text{MCC for +X burn TIG and direction}\]
  - **NOTE:** Posigrade burn should be performed if second docking attempt desired or if deorbit same day

<table>
<thead>
<tr>
<th>GNC, OPS 202 PRO</th>
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<tbody>
<tr>
<td>GNC ORBIT MNVR EXEC</td>
</tr>
<tr>
<td>RCS SEL – ITEM 4 EXEC (*)</td>
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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 < 5° per axis (as read in C/L camr)

1. INSTALL RNDZ TOOLS
   If rendezvous tools already installed, go to step 2
   Perform C/L CAM INSTALL (PHOTO/TV, CENTERLINE (C/L) CAMR)
   Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZ TOOLS), 7-2
   If reqd, install -Z COAS
   If RPOP setup reqd:
   - [GNC 33 REL NAV]
   - ORB TO TGT – ITEM 10 EXEC
   - RNDZ NAV ENA – ITEM 1 EXEC (*)
   - Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-8, then:
   - Perform RPOP OPS (RNDZ TOOLS), 7-9, 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 √DAP: FREE
   √SENSE: -Z
   AFT ADI ATT – LVLH
   ERR – MED
   RT – MED
   [GNC 20 DAP CONFIG]
   Config DAP A,B to A9/B9
   X Jets ROT ENA – ITEM 7 EXEC (no *)
   DAP: B/FREE/ALT, no LO Z
   √DAP TRANS: PULSE/PULSE/PULSE
   [GNC 23 RCS]
   Reselect manually deselected primary jets (no *) except 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 \(-0.12 \leq \text{ROLL, PITCH, YAW RATE} \leq 0.12\)
  - 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 \(-0.12 \leq \text{ROLL, PITCH, YAW RATE} \leq 0.12\)
  - Perform UNDOCKING OPERATIONS 6A, 2-6, step 3

4. **INITIAL SEPARATION SEQUENCE**

**A6U** FLT CNTLR PWR – ON

When capture latches/hooks open:

If no spring-assisted separation:

- DAP: B/FREE/ALT, no LO Z
- THC: +Z (out) 4 pulses at 10 sec intervals
- Do not attempt to maintain 8 degree corridor

If spring-assisted separation:

- When petals clear:
  - DAP: B/LVLH/ALT, no LO Z
  - THC: as reqd to maintain target within 8 deg corridor on C/L camera

At physical sep +1:00:

- DAP: LVLH/VERN (PRI)
- THC: as reqd to maintain target within 8 degree corridor on C/L camera
- THC: +Z (out) pulses at 10 sec intervals to establish RDOT > 0.1 fps, then
  - no +Z (out) pulses until 30 ft step

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

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

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

At physical sep +3:00 and when RNG > 30 ft (DP to DP):

- THC: +Z (out) as reqd at 10 sec intervals to establish and maintain RDOT > 0.2 fps

When RNG > 50 ft (DP to DP):

- 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 ___ / ___ : ___ : ___
8. **PERFORM FINAL BURN**

 √MCC for final burn engine selection and breakout direction

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

If single OMS burn:

 √MCC for burn TIG

 Perform RNDZ OMS BURN, 5-4

If + X burn:

 If posigrade sep desired:

 - If $\Delta VY$ from Out-of-Plane burn (step 4) was positive:
   - TV ROLL – ITEM 5 +2 7.0 EXEC
   - TGT PEG 7 $\Delta VX$ – ITEM 19 +7.0 EXEC
   - $\Delta VY$ – ITEM 20 +0 EXEC
   - $\Delta VZ$ – ITEM 21 +0 EXEC

 If retrograde sep desired:

 - If $\Delta VY$ from Out-of-Plane burn (step 4) was positive:
   - TV ROLL – ITEM 5 +9 0 EXEC
   - TGT PEG 7 $\Delta VX$ – ITEM 19 +7.0 EXEC
   - $\Delta VY$ – ITEM 20 +0 EXEC
   - $\Delta VZ$ – ITEM 21 +0 EXEC

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

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

 At TIG -0:30:

 F6 FLT CNTLR PWR – ON
 DAP: A/INRTL/PRI

 At TIG:

 THC: trim VGOs $\leq$ 0.2 fps

 F6 FLT CNTLR PWR – OFF
 DAP: A/INRTL/VERN(ALT)
 GNC, OPS 201 PRO

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

1. **OPS 202 PRO**

   **GNC ORBIT MNVR EXEC**

   Load Ti Delay Pad, 3-7

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

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

   If RCS:
   Perform RCS BURN (Cue Card)

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

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

   **GNC 34 ORBIT TGT**

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

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

   **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

/ : : :

#### PRELIMINARY / INTERMEDIATE

<table>
<thead>
<tr>
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<tr>
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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

   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 Tî TIG (Tî 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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<th>-Y (STRK)</th>
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   TRK – ITEM 19 (CUR-*)

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

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

   GNC 33 REL NAV

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

When in Lambert Targeting and TGT ITER occurs:
If PRED MATCH other than 999999 (all 9s):
- √MCC and read down PRED MATCH from SPEC 34 (MCC has delta Vs)
  On MCC GO or if no comm:
    - Recall TGT set and recompute
  If TGT ITER recurs and PRED MATCH less than 400:
    - Contact MCC and read down PRED MATCH from SPEC 34
    On MCC GO or if no comm:
      - Load current delta Vs and execute as Lambert burn >>
    If TGT ITER recurs and PRED MATCH greater than 400:
      - Contact MCC and read down PRED MATCH from SPEC 34
      On MCC GO or if no comm:
        - Load ground solution and execute as EXT DV burn
          (If MC burn, uplink of ground solution reqd) >>
        - If ground solution not available: No burn >>
If PRED MATCH 999999 (all 9s):
  On MCC GO or if no comm:
    - Load ground solution and execute as EXT DV burn
      (If MC burn, uplink of ground solution reqd) >>
    - If ground solution not available: No burn >>
LOSS OF COMM

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

Ground-Targeted Burns
1. If NH or NC PADs not available, do not perform burn.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

\begin{verbatim}
DAPS A9, B9 PITCH AND YAW TO ALL
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
\end{verbatim}
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 [9A], 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

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<tr>
<th>CONFIG PITCH OPTION TO TAIL A</th>
<th>REGAIN Y CONTROL C</th>
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<tr>
<td><strong>[GNC 20 DAP CONFIG]</strong></td>
<td>√MCC for which jet to reselect</td>
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<tr>
<td>A PRI P OPTION – ITEM 15 EXEC (twice)(TAIL)</td>
<td><strong>[GNC 23 RCS]</strong></td>
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<tr>
<td>B PRI P OPTION – ITEM 35 EXEC (twice)(TAIL)</td>
<td>RCS FWD – ITEM 1 EXEC (*)</td>
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<td>JET DES FxD – ITEM XX EXEC (no *)</td>
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<td><strong>NOTE: Do not perform any THC: -Z (in) commands</strong></td>
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<th>CONFIG YAW OPTION TO ALL B</th>
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<td><strong>[GNC 20 DAP CONFIG]</strong></td>
<td>Deselect manually reselected jet</td>
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<td><strong>[GNC 23 RCS]</strong></td>
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<td>B PRI Y OPTION – ITEM 36 EXEC (ALL)</td>
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<td>JET DES FxD – ITEM XX EXEC (*)</td>
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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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**REFERENCE DATA**
**POST-CONTACT THRUST (PCT) REFERENCE DATA**

**PBI FUNCTION WHENEVER IN OPS 2:**

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

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

- PCT firing sequence can also be aborted by taking RHC/THC out of detent
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TCS REFLECTOR VISIBILITY DURING APPROACH

Some arrays and radiators are not shown for clarity of the TCS reflector information.

Expected TCS/Ref1 Acquisition Range
Ref1 #2 at TCS max range limit of 5000-6000 ft
NOTE: Ref1 #5 might be acquired before Ref1 #2 (based on planar reflector performance flight history)

Ref1 #3 becomes less visible as Orbiter Y-LVLH position becomes more positive (into the page)

ISS NOT TO SCALE
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 indicators.

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

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

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

LEDs

Bottom View

Side View

Location wrt Orbiter Structure:
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* Full Truss from S5 to P6  
** Half Truss is the Port side of ISS from P6 to center of ISS
RENNDEZVOUS TOOLS

CCTV CONFIG FOR DOCKING/UNDOCKING ................................................................. 7-2
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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
   CAMERANumber ZOOM OVERLAY
   Centerline 40.0° (Corridor) Corridor
   10.1° (full zoom) Grid

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)
Contact ring tangent line

Camera FOV

Camr A,D Range Ruler View Approach Config
RNDZ TOOLS CHECKOUT

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

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

3. Perform WINDECOM OPS – ACT (ORB OPS, PGSC)

4. Perform RPOP INITIALIZATION, 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. \sqrt{Windows system tray for PC card icon to verify good connection to MCIU/Quatech card}
2. \sqrt{TX/RX end of TCS data cable connected to MCIU/Quatech card COM2}
3. \sqrt{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. \sqrt{MCC}

**RPOP NOT RECEIVING PCMMU DATA**
1. \sqrt{Windows system tray for PC card icon to verify good connection to MCIU/Quatech card}
2. \sqrt{Correct end of RS-422 Y data cable connected to MCIU/Quatech card COM4}
3. \sqrt{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. \sqrt{MCC}

**RPOP NOT RECEIVING HHL DATA**
1. \sqrt{HHL cable securely connected to HHL unit and COM1}
2. \sqrt{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. \sqrt{MCC}

**RPOP NOT RECEIVING TCS DATA (TCS CADS IS RECEIVING DATA ON SAME PGSC)**
1. \sqrt{RPOP configured to receive TCS data via DLL}
2. Quit and restart RPOP
3. Reboot RPOP PGSC and restart RPOP and TCS CADS
4. \sqrt{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
       - √ Range from overhead window to S0 Truss Segment = ~44 ft
     - Velocity check:
       - Depress trigger for 5 sec
       - √ Velocity = 0.0 fps
   - Report range and velocity discrepancies to MCC
   - Self-Test: Press and hold Test Mode button, `8.8.8.8`. Select range

HAND-HELD LIDAR STOW

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

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

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

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

   NOTE
   Time synchronized on [OK]

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

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

   NOTE
   If no target state vector on board, expect error message
   If RNDZ NAV not enabled, expect bad relative state
1. Select desired trajectory/sensor data as needed (F1 thru F4 keys)
   Reference TRAD FAIL RANGE AND RANGE RATE DETERMINATION, 7-21,
   for recommended RPOP and TRAD configuration

2. Configure HHL settings
   
   Appropriate aimpoint configuration per table

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

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

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

4. Adjust configuration as required
   Use [SHIFT]/[F1] thru [SHIFT]/[F4] to show/hide trajectory plots
   NOTE: cannot hide currently selected trajectory/sensor
   Use [CNTL]/[F8] to cycle through Points of Reference (POR)
   Use [F11] to cycle thru declutter levels
   Use [F12] to snap a range ruler mark; [SHIFT]/[F12] to delete it
   Use [SPACEBAR] to toggle on-screen Function Key Menu ON/OFF
   Move axes or zoom in/out per RPOP KEYSTROKE SUMMARY, 7-15
   For other options, reference RPOP FUNCTION KEY SUMMARY, 7-11

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

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

5. To exit RPOP program – [SHIFT]/[F10]
**Configure TCS reflectors**

[CNTL][F10]  **RPOP Configuration**

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

- Select appropriate Reflector No.
- **NOTE:** for a single TCS unit, TCS No. selection is irrelevant

**Configure RPOP Guidance, if desired for approach**

[CNTL][F5]  **Select Guidance Type**

Select desired flight phase to start prox ops guidance sequence

- If +Rbar Acquisition,
  - If no RPM, uncheck “with RPM” option
  - If RPM stationkeeping (SK) required,
    - Select “with SK until MET”
    - Enter RPM start window open time (per APPROACH cue card)

**Update target attitude**

√MCC for target attitude data

[SHIFT][F6]  **Enter Target Vehicle Attitude Info**

- Input appropriate reference frame and attitude (PYR Seq)
  - Pitch>_____  Yaw>_____  Roll>_____
- Input appropriate attitude rate mode and rates
- **NOTE:** nominal dock and undock settings are “LVLH to Tgt Body”,
  - 0 / 0 / 0 deg attitude, and “LVLH Hold” rate

**Input subtended angle data**

[F5]  **Rdot**

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

**Configure comm ports**

[CNTL][F10]  **RPOP Configuration**

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

- Configure com ports and DLL
- **NOTE:** TCS source must be set to DLL
  - HHL source must be set to COM1
  - PCMMU source if TLMServer (network or serial) is DLL
  - PCMMU source if no TLMServer (serial) is COM4

*For assistance with other options, √MCC, [F10]  **Help**, or RPOP FUNCTION*
*KEY SUMMARY, 7-11*
### RPOP FUNCTION KEY SUMMARY

#### TRAJECTORY DATA KEYS (Columns F1 → F4)

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

**NOTE**

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

<table>
<thead>
<tr>
<th>Key</th>
<th>Function Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>[F5]</strong></td>
<td>RDOT WINDOW&lt;br&gt;(Rdot)&lt;br&gt;Toggles display of Rdot Window</td>
</tr>
<tr>
<td><strong>[SHIFT]/[F5]</strong></td>
<td>ORBITER ATTITUDE&lt;br&gt;(Orb Att)&lt;br&gt;Update orbiter attitude and attitude rate</td>
</tr>
<tr>
<td><strong>[CTRL]/[F5]</strong></td>
<td>GUIDANCE&lt;br&gt;(Guid)&lt;br&gt;Select guidance cues on demand&lt;br&gt;Available options are:&lt;br&gt;+Rbar acquisition – provides THC recommendations for acquiring the &lt;br&gt;+Rbar. Includes options for targeting pre-TORVA conditions, pre-RPM conditions, or a pre-RPM stationkeep&lt;br&gt;TORVA – provides THC recommendations for performing the +Rbar to +Vbar transfer&lt;br&gt;+Vbar Acquisition – provides THC recommendations for acquiring the +Vbar in preparation for final approach&lt;br&gt;Glideslope Approach – provides THC recommendations for flying the final approach along a glideslope&lt;br&gt;CW Targeting – given a burn time, transfer time, and desired LVLH position, CW Targeting will provide required THC inputs&lt;br&gt;LVLH Velocity Null – provides THC recommendations for nulling LVLH velocities in each direction&lt;br&gt;Average Rdot – information for timed approach</td>
</tr>
<tr>
<td><strong>[F6]</strong></td>
<td>SUBTENDED ANGLE&lt;br&gt;(Sub Ang)&lt;br&gt;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><strong>[SHIFT]/[F6]</strong></td>
<td>TARGET ATTITUDE&lt;br&gt;(Tgt Att)&lt;br&gt;Update Target attitude and attitude rate</td>
</tr>
<tr>
<td><strong>[CTRL]/[F6]</strong></td>
<td>PCMMU MODE&lt;br&gt;(PCMMMU)&lt;br&gt;No PCM mode (displays No PCM)&lt;br&gt;Requires orbiter attitude data to be entered manually with each sensor mark&lt;br&gt;PCM MODE (displays PCM)&lt;br&gt;Orbiter attitude is automatically computed using PCMMU data</td>
</tr>
<tr>
<td><strong>[F7]</strong></td>
<td>VIEW&lt;br&gt;(View)&lt;br&gt;If Tgt-Centered LVLH, cycle through views: XZ, XY, YZ&lt;br&gt;If Orb-Centered LVLH, cycle through views: XZ, XY, YZ, CAM&lt;br&gt;View identification displayed upper left-hand corner of Trajectory Display</td>
</tr>
<tr>
<td><strong>[SHIFT]/[F7]</strong></td>
<td>OVERLAY&lt;br&gt;(Ovrlay)&lt;br&gt;Cycle through displays of overlays</td>
</tr>
<tr>
<td><strong>[F8]</strong></td>
<td>REFERENCE FRAME&lt;br&gt;(Tgt/Orb)&lt;br&gt;Toggle display between Tgt-Centered LVLH plot and Orb-Centered LVLH plot</td>
</tr>
<tr>
<td><strong>[SHIFT]/[F8]</strong></td>
<td>LO Z&lt;br&gt;(Low Z)&lt;br&gt;Toggle jet-select between No Low Z and Low Z for making THC “What If” inputs. Displays Low Z</td>
</tr>
<tr>
<td><strong>[CTRL]/[F8]</strong></td>
<td>POINT OF REFERENCE&lt;br&gt;(POR)&lt;br&gt;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>
GENERAL FUNCTION KEYS (Columns F5 → F12) (Cont)

[F9] THC CLEAR
(THC Clr) Clear THC “What if” inputs from the Prime Trajectory

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

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

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

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

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

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

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

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

   Update MET...
   Change the mission elapsed time

   Altitude...
   Change altitude of target vehicle

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

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

   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)

<table>
<thead>
<tr>
<th>Key</th>
<th>Function Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[F11]</td>
<td>DECLUTTER</td>
</tr>
<tr>
<td></td>
<td>Cycle RPOPs display through three different levels of declutter</td>
</tr>
<tr>
<td>[F12]</td>
<td>RANGE RULER SNAP</td>
</tr>
<tr>
<td></td>
<td>Computes range rate based on time between snaps and assumed delta range interval.</td>
</tr>
<tr>
<td></td>
<td>Feature available only if I-loaded delta range interval has non zero value</td>
</tr>
<tr>
<td>[SHIFT]/[F12]</td>
<td>RANGE RULER CLEAR</td>
</tr>
<tr>
<td></td>
<td>Clears range ruler display from screen. Feature available only if I-loaded delta</td>
</tr>
<tr>
<td></td>
<td>range interval has non zero value</td>
</tr>
</tbody>
</table>
RPOP KEYSTROKE SUMMARY

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

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

<table>
<thead>
<tr>
<th>Keystroke</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>[CTRL]/[HOME]</td>
<td>Resume autoscaling and reset scale</td>
</tr>
<tr>
<td>[SPACEBAR]</td>
<td>Toggle on-screen Function Key Menu ON/OFF</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Keystroke</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
Config... – Reconfigure the Trajectory Data Source for this function key

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

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

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

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

CCTV

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

   STOPHUTTLE 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: Passed</td>
<td>Off</td>
</tr>
<tr>
<td>Z Latch: Passed</td>
<td>Off</td>
</tr>
<tr>
<td>CW Laser: Passed</td>
<td>Off</td>
</tr>
<tr>
<td>Pulse Laser: Passed</td>
<td>Off</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**

   ![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 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, *
   * \(\sqrt{\text{MCC}}\) *

   **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: *
   * > Commands > Lock Z Axis *
   * **Latch** *
   * Otherwise *
   * \(\sqrt{\text{MCC}}\) *

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>
<th>AUTOSAFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW Laser</td>
<td>-40.0</td>
<td>45.0</td>
<td>50.0</td>
</tr>
<tr>
<td>APD</td>
<td>-40.0</td>
<td>65.0</td>
<td>70.0</td>
</tr>
<tr>
<td>CPU</td>
<td>-40.0</td>
<td>80.0</td>
<td>85.0</td>
</tr>
<tr>
<td>DC Power</td>
<td>-40.0</td>
<td>80.0</td>
<td>85.0</td>
</tr>
<tr>
<td>Galvos</td>
<td>-40.0</td>
<td>80.0</td>
<td>85.0</td>
</tr>
</tbody>
</table>

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

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

*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>Rdot window: HHL Dt NOTE: Configure HHL angle source to Dock Cam and lock angles to 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rdot window: HHL/ Dt</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>Rdot window: HHL/Dt NOTE: Configure HHL angle source to Dock Cam and lock angles to 0</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></td>
<td>Rdot window: HHL/ Dt</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>Rdot window: Subtended angles Spec 33: Raw Radar*</td>
</tr>
<tr>
<td>NOTE: Spec 33: FLTR, and State data: HHL can be suspect</td>
<td></td>
<td></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>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></td>
<td>Rdot window: Subtended Angle</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
<table>
<thead>
<tr>
<th>Phase</th>
<th>Prime Source: Configuration</th>
<th>Backup Source: Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Manual Takeover thru ~1200 ft</strong>&lt;br&gt;Note: Transition from phase 1 to 2 should be gradual. Start transition at ~1500 ft and complete it prior to 1000 ft braking gate&lt;br&gt;Note: RPOP state data is bad</td>
<td><strong>Spec 33</strong>: FLTR&lt;br&gt;Rdot window: HHL/Dt&lt;br&gt;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”&lt;br&gt;TCS CADS: Raw TCS (pulse active)&lt;br&gt;Note: Range data good, rdot can be quite noisy&lt;br&gt;Rdot window: Generic&lt;br&gt;Note: Manually enter raw TCS range marks. RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
<td><strong>TCS CADS</strong>: Raw TCS (pulse active)&lt;br&gt;Note: Range data good, rdot can be quite noisy&lt;br&gt;Rdot window: HHL/Dt&lt;br&gt;Note: RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
</tr>
<tr>
<td><strong>2. ~1200 ft thru TCS CW lock-on (~800 ft)</strong>&lt;br&gt;Note: RPOP State data is bad</td>
<td><strong>Rdot window</strong>: HHL/Dt&lt;br&gt;Note: RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
<td><strong>TCS CADS</strong>: Raw TCS (pulse active)&lt;br&gt;Note: Range data good, rdot can be quite noisy&lt;br&gt;Rdot window: Generic&lt;br&gt;Note: Manually enter raw TCS range marks. RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
</tr>
<tr>
<td><strong>3. TCS CW lock-on (~800 ft) thru Vbar arrival</strong>&lt;br&gt;Note: RPOP State data is bad</td>
<td><strong>TCS CADS</strong>: Raw TCS (cw active)&lt;br&gt;Note: Check Orb Att = (90/0/0), and set TCS frequency to 30 sec [CNTRL F10]&lt;br&gt;Rdot window: HHL/Dt&lt;br&gt;Note: RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
<td><strong>Rdot window</strong>: HHL/Dt&lt;br&gt;Note: RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
</tr>
<tr>
<td><strong>4. Vbar arrival thru 15 ft</strong>&lt;br&gt;Note: RPOP State data is bad</td>
<td><strong>TCS CADS</strong>: Raw TCS (cw active) and/or&lt;br&gt;State Data: TCS AUTO&lt;br&gt;Note: Check Orb Att = (90/0/0), and set TCS frequency to 30 sec [CNTRL F10]&lt;br&gt;Rdot window: HHL/Dt</td>
<td><strong>Rdot window</strong>: HHL/Dt&lt;br&gt;Note: RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
</tr>
<tr>
<td><strong>5. 15 ft thru dock</strong>&lt;br&gt;Note: RPOP State data is bad</td>
<td><strong>TCS CADS</strong>: TCS Raw (cw active)&lt;br&gt;Rdot window: Range Ruler (F12)</td>
<td><strong>Rdot window</strong>: Range Ruler (F12)&lt;br&gt;Note: RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
</tr>
</tbody>
</table>

*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*

**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><strong>1. Manual Takeover thru ~1200 ft</strong>&lt;br&gt;(noisy RR angles)</td>
<td><strong>Spec 33</strong>: SV, Raw RR&lt;br&gt;For Range: HHL (back of unit): Raw HHL&lt;br&gt;For Rdot: HHL (back of unit): Raw HHL*&lt;br&gt;Note: HHL will not work if the aimpoint surface is closer than 12 feet (5 ft DP-DP)</td>
<td>For range – HHL (back of unit): Raw HHL&lt;br&gt;For Rdot – Rdot vs. ΔRng/Δt Cue Card: Record Raw HHL range and times on cue card</td>
</tr>
<tr>
<td><strong>2. ~1200 ft thru 15 ft</strong></td>
<td><strong>For Range</strong>: HHL (back of unit): Raw HHL (short pulls)&lt;br&gt;For Rdot: HHL (back of unit): Raw HHL (long pulls)&lt;br&gt;Note: HHL will not work if the aimpoint surface is closer than 12 feet (5 ft DP-DP)</td>
<td>For range – Subtended Angle table (6-13): COAS or Centerline Cam subtended angle&lt;br&gt;For Rdot – Rdot vs. ΔRng/Δt Cue Card: Record subtended angle range and times on cue card</td>
</tr>
<tr>
<td><strong>3. 15 ft thru dock</strong></td>
<td><strong>For Range</strong>: Range Ruler Overlay&lt;br&gt;For Rdot: HHL (back of unit): Raw HHL*&lt;br&gt;Note: HHL will not work if the aimpoint surface is closer than 12 feet (5 ft DP-DP)</td>
<td>For Range – Range Ruler Overlay&lt;br&gt;For Rdot: Range Ruler Overlay&lt;br&gt;Note: HHL will not work if the aimpoint surface is closer than 12 feet (5 ft DP-DP)</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

- Docking Mechanism Initialization ................................................................. 8-4
- Powerup ........................................................................................................... 8-5
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- Prep .................................................................................................................. 8-7
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- Airlock Prep for Ingress – Bypass Config ....................................................... 8-12
  - Booster Fan Active ...................................................................................... 8-12a
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 (two) – ctr (tb-CL)
   cb ESS 1BC DEP SYS 1 VENT ISOL – op
   2CA DEP SYS 2 VENT ISOL – op
   MN A DEP SYS 1 VENT – op
   B DEP SYS 2 VENT – op
   √VEST DEP VLV SYS 1,SYS 2 VENT tb (two) – bp
   √ISOL tb (two) – bp

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

[SM 167 DOCKING STATUS]

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

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

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

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

CRT

A7L
DOCKING MECHANISM POWERDOWN

1. √STATUS lt (eighteen) – lt off
2. APDS POWER $A_D, B_D, C_D$ (three) – OFF
   √$A_D, B_D, C_D$ lt (three) – lt off
3. CONTROL PANEL POWER A,B,C (three) – OFF
   √CNTL PNL PWR A,B,C (three) – blank
4. HEATERS/DCU POWER (three) – OFF
   √HTR/DCU PWR (three) – blank
5. PSU PWR MN A,MN B (two) – OFF
6. If post-undocking:
   VEST DEP VLV SYS 1(SYS 2) VENT – CL (tb-CL)
   MNA DEP SYS 1 VENT – op
   √MNB DEP SYS 2 VENT – op
   ESS 1BC DEP SYS 1 VENT ISOL – op
   √2CA DEP SYS 2 VENT ISOL – op
   MNA EXT ARLK HTR VEST Z1/2/3 – op
   MNB EXT ARLK HTR VEST Z1/2/3 – cl
DOCKING PREP

SM 167 DOCKING STATUS

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

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

CRT  √CLUTCH – blank/SLIP

UNDOCKING PREP

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

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

**SM 167 DOCKING STATUS**

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

### CRT
- √CLUTCH – LOCK/blank

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

### 0:00 3. RING OUT pb – push
- √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,* and CLUTCH – blank/SLIP):
- * FIXER OFF pb – push
- * √FIXERS OFF lt – lt on
- * RING OUT pb – push

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

### CRT
- * 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 – lt on:
- * RING OUT pb – push

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

* If CLUTCH – blank/blank: *
A7L * √APDS CIRCUIT PROTECT OFF lt – lt on *
* RING OUT pb – push (expect 1 sec of drive), wait *
* 10 sec *
CRT * √RING DRV CMD – OFF *
* *
* If CLUTCH – LOCK/blank: *
A7L * √RING INITIAL POSITION lt – lt on *
* √FIXERS OFF lt – lt off *
* √APDS CIRCUIT PROTECT OFF lt – lt on *
* RING OUT pb – push (expect 1 sec of drive), wait *
* 10 sec *
CRT * √RING DRV CMD – OFF *
* *
* If not CLUTCH – blank/SLIP: *
A7L * √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. ARLK 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 air flow to window
   If required, tape diffuser open

**AW18A**
7. LTG FLOOD 1(3,4) – OFF

**MO13Q**
8. ARLK 2 – OFF/ON

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

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

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

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

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

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

[SM 177 EXTERNAL AIRLOCK]

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

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

AIRLOCK PREP FOR INGRESS – BYPASS CONFIG

Inner Hatch

1. Equal vlv caps (two) – remove

2. Equal vlv (two) – NORM

3. √Hatch ΔP < 0.2 psid

4. Open Hatch per decal

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

6. ARLK 2 – ON/OFF

7. ARLK FAN A(B) – OFF

TNL EXT

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

AW18A

9. As required, LTG FLOOD 1(3,4) – ON

EXT A/L

10. Unstrap centerline camera diffuser flex duct from camera bracket

Stow duct along Stbd top of EXT A/L wall (in straps)

11. √Airflow at top of external airlock halo

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

Inner Hatch
1. Equal vlv caps (two) – remove
2. Equal vlv (two) – NORM
3. √Hatch ΔP < 0.2 psid
4. Open Hatch per decal
5. Equal vlv (two) – OFF, reinstall caps

MO13Q 6. AIRLK 2 – ON/OFF
7. ARLK FAN A(B) – OFF

TNL EXT MIDDK 8. Remove diffuser cap from Aft Middeck Floor Fitting. Unstow fwd flex duct from Tunnel extension wall. Attach one end to airlock booster fan muffler inlet. Attach free end to Aft Middeck Floor Fitting
9. Remove mylar sleeve/tape from outer screen of Fwd Middeck Floor Fitting and temp stow

MO13Q 10. AIRLK FAN A(B) – ON

AW18A 11. As required, LTG FLOOD 1(3,4) – ON

EXT A/L 12. Unstrap Centerline Camera diffuser flex duct from camera bracket
Stow duct along stbd top of EXT A/L wall (in straps)
13. √Airflow at top of external airlock halo
14. Go to P/TV02 DOCK, DEACTIVATION, step 2 (PHOTO/TV, SCENES)
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</tbody>
</table>
POWERS 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.

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\textsubscript{OS} – 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\textsubscript{OS} – ON
   B\textsubscript{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\textsubscript{DS} – OFF
   A\textsubscript{OS},B\textsubscript{DS} (two) – ON
   POWER ON pb – push
   If STATUS lt (eighteen) – lt off:
   APDS POWER B\textsubscript{DS} – OFF
   C\textsubscript{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
A6L 1. PSU PWR MN A,MN B (two) – OFF
   CRT If DAMPING – ON (TLM failure only):
   A6L PSU PWR MN A,MN B (two) – ON
   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
   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

<table>
<thead>
<tr>
<th>SM 167 DOCKING STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. POWER OFF pb – push</td>
</tr>
<tr>
<td>CRT If RING FIXERS – ON:</td>
</tr>
<tr>
<td>A7L POWER ON pb – push</td>
</tr>
<tr>
<td>Continue Approach or DOCKING SEQUENCE (Cue Card), as reqd &gt;&gt;</td>
</tr>
</tbody>
</table>

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

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

DISABLE DAMPING
4. When no relative motion [PETAL POS BASE (three) not changing for 60 sec]:
   A6L PSU PWR MN A,MN B (two) – OFF
   A7L APDS POWER A_{DS},B_{DS},C_{DS} (three) – ON
   POWER ON pb – push

Cont next page
COMMAND CLUTCH TO LOCK

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

RETRACT RING

A7L 6. RING IN pb – push
     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:

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

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

3. APDS CIRC PROT OFF pb – push
   
   CIRCUIT PROTECT OFF lt – lt on
   
   RING OUT pb – push

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

   A7L
   
   POWER OFF pb – push

   Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F) to drive slip clutch to SLIP

FIXERS OFF LT FAILED OFF

**SM 167 DOCKING STATUS**

A7L

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

2. If not CLUTCH – LOCK/blank

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

   A7L
   
   RING IN pb – push
   
   POWER ON pb – push

   0:00

   A6L
   
   PSU PWR MN A,MN B (two) – ON

   0:05

   CRT
   
   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

   0:00

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

   CRT
   
   PETAL POS BASE (three) – decr

   0:05

   A7L
   
   POWER ON pb – push

   CRT
   
   RING DRV CMD – OFF

   A6L

   4. PSU PWR MN A,MN B (two) – OFF

   APDS CIRC PROT OFF pb – push

   CRT

   CIRCUIT PROTECT OFF lt – lt on

   A7L

   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 (ring will begin to drive in this step)

   CRT

   PETAL POS BASE (three) – incr

   0:05

   A7L

   POWER ON pb – push

   CRT

   RING DRV CMD – OFF

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

**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

CRT 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 A₀₇₅ – OFF
   RING IN pb – push
   CRT If RING DRV CMD – OFF:
   A7L  APDS POWER A₀₇₅ – ON
        C₀₇₅ – 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 A₀₇₅ (C₀₇₅) – ON
   OPEN LATCHES pb – push
   After 5 sec:
   √LATCHES OPEN lt – lt on
   APDS POWER A₀₇₅ (C₀₇₅) – OFF
   Go to DOCKING SEQUENCE (Cue Card), step 18 >>

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

4. Go to FAILED CAPTURE (VBAR APPROACH, Cue Card) to undock
RING FINAL POSITION LT FAILED ON

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

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

In step 11, to stop ring drive
POWER ON pb – push
CRT  In step 18, when PETAL POS BASE (three) = 5 ± 3% and not changing for 10 sec:
A7L  POWER OFF pb – push

FORCE RING ALIGNMENT

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

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

0:00  3. RING OUT pb – push
CRT   √ DRV CMD – ON [PETAL POS BASE (three) – incr]
      √ FIXERS – OFF

0:05  √ CLUTCH – LOCK/blank
A7L   √ RING INITIAL POSITION lt – lt on (√off at ~0:30)

* If RING FORWARD POSITION lt failed on (ring stops after 10 sec):
*    RING OUT pb – push
*    Within 10 sec:
*       APDS POWER A<sub>DS</sub>,B<sub>DS</sub>,C<sub>DS</sub> (three) – OFF
*       APDS POWER A<sub>DS</sub>,B<sub>DS</sub>,C<sub>DS</sub> (three) – ON
*       CIRC PROT OFF pb – push
*       CIRCUIT PROTECT OFF lt – lt on

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

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

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

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

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

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

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

APDS CIRCUIT PROTECT OFF LT FAILED OFF

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

HOOKS 1(2) OPEN LT FAILED ON

| NOTE |
| The following procedure should be performed immediately after DOCKING SEQUENCE (Cue Card) completed or prior to undocking as applicable |
| A7L | 1. POWER ON pb – push |
| | APDS POWER A_{DS} – OFF |
| | If HOOKS 1(2) OPEN lt – lt off: |
| | Go to nominal UNDOCKING OPERATIONS per nominal mission timeline with APDS POWER A_{DS} – OFF >> |
| A7L | 2. Prior to nominal undocking: |
| | Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F) to open affected hooks |
HOOKS 1(2) NOT CLOSED WITHIN SINGLE MTR TIME

**SM 167 DOCKING STATUS**

<table>
<thead>
<tr>
<th>CRT</th>
<th>1. If no hook motion when commanded:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7L</td>
<td>APDS POWER A&lt;sub&gt;DS&lt;/sub&gt; – OFF</td>
</tr>
<tr>
<td></td>
<td>CLOSE HOOKS pb – push</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CRT</th>
<th>If no hook motion after 10 sec:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7L</td>
<td>APDS POWER A&lt;sub&gt;DS&lt;/sub&gt; – ON</td>
</tr>
<tr>
<td></td>
<td>B&lt;sub&gt;DS&lt;/sub&gt; – OFF</td>
</tr>
<tr>
<td></td>
<td>CLOSE HOOKS pb – push</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CRT</th>
<th>If Hook Pos increasing after 10 sec:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Continue in DOCKING SEQUENCE (Cue Card) with the</td>
</tr>
<tr>
<td></td>
<td>following change:</td>
</tr>
<tr>
<td></td>
<td>After step 16:</td>
</tr>
<tr>
<td>A7L</td>
<td>APDS POWER A&lt;sub&gt;DS&lt;/sub&gt; (B&lt;sub&gt;DS&lt;/sub&gt;) – ON &gt;&gt;</td>
</tr>
</tbody>
</table>

2. APDS POWER A<sub>DS</sub> (B<sub>DS</sub>) – 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
   \`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

8-23 RNDZ/122/FIN
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
   \[\sqrt{A_{DS}, B_{DS}, C_{DS}}\] It (three) – It on
   CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF It – It on
   OPEN LATCHES pb – push

**A7L, CRT**
If LATCHES OPEN It – It 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 $A_{DS}, B_{DS}, C_{DS}$ It 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.

Successful completion of this procedure ends with Shuttle resuming attitude control

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

SM 167 DOCKING STATUS

RECAPTURE PMA PETALS

A7L 2. POWER ON pb – push
0:00 CLOSE LATCHES pb – push
√LATCHES OPEN lt – lt off
0:05 √CLOSED lt – lt on

3. APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on
   FIXER OFF pb – push
   √FIXERS OFF lt – lt on
0:00 RING OUT pb – push
   √FINAL POSITION lt – lt off
0:20 4. When CAPTURE lt – lt on:
   POWER OFF pb – push
   ON pb – push
   √CAPTURE lt – lt off
0:00 5. RING IN pb – push
0:10 POWER ON pb – push
   √RING FINAL POSITION lt – lt off
   CRT
   √DRV CMD – OFF
A7L √LATCHES CLOSED lt – lt on

WARNING

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

OPEN ODS HOOKS

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

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

0:00
7. RING OUT pb – push
   CRT
   A7L
   DRV CMD – ON
   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
   A7L
   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
   A7L
   DRV CMD – ON

0:10
POWER ON pb – push
   CRT
   RING DRV CMD – OFF

0:00
OPEN LATCHES pb – push
   CRT
   A7L
   LATCHES CLOSED lt – lt off

0:05
OPEN lt – lt on

0:00
RING IN pb – push
0:10
FINAL POSITION lt – lt on
0:20
CRT
   DRV CMD – OFF

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

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

A6U
15. Perform TERMINATE RNDZ OPS 22A, 4-22, step 1

16. Return to FLIGHT PLAN
ODS HOOKS OPEN – CONTINGENCY

NOTE
Procedure assumes PMA 2/3 hooks have not been closed at any time during the mission, and either ODS hooks could not be opened nominally or ODS hooks were driven full open and physical separation did not occur. If PMA 2/3 hooks have been closed at any point during the mission, go to PMA 2/3 HOOKS OPEN – CONTINGENCY, 8-30.

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

A7L

2. POWER ON pb – push

SM 167 DOCKING STATUS

RECAPTURE PMA PETALS
3. CLOSE LATCHES pb – push
   √LATCHES OPEN It – It off
   √CLOSED It – It on

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

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

Cont next page
0:00
6. RING IN pb – push
POWER ON pb – push
:\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 deco:
A7L POWER OFF pb – push
ON pb – push

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

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

**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 deco:
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
  $\sqrt{A_p, B_p, C_p}$ lt (three) – lt 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
~3:20
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
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

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 CIRCUIT PROTECT OFF lt – lt on

0:00
   RING OUT pb – push
   √INTERF SEALED lt – lt off
   CRT
   If interface separates [PETAL POS BASE (three) incr after 20 sec]:
   Go to step 22

Cont next page
RECONFIGURE AND DISCHARGE ACTIVE HOOK PYROS

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

18. ACT HOOKS FIRING pb – push

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

REATTEMPT EXTENDING RING TO INITIAL POSITION FOR INTERFACE SEPARATION

A7L 20. \sqrt{APDS CIRCUIT PROTECT OFF} lt – lt on
  0:00 RING OUT pb – push
  \sqrt{INTERF SEALED} lt – lt off
CRT If interface separates [PETAL POS BASE (three) incr after 20 sec]:
  Go to step 22

RECONFIGURE AND PREPARE FOR 96 BOLT EVA

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

FINAL PREPARATION FOR VEHICLE SEPARATION

~3:20 A7L 22. \sqrt{RING INITIAL POSITION} lt – lt on
CRT \sqrt{DRV CMD} – OFF
  \sqrt{PETAL POS BASE} (three) = 76 ± 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
    * \RING INITIAL POSITION lt – lt on (for ~16 sec), then lt off
  * When PETAL POS BASE (three) = 98 ± 2%:
  * After 10 sec:

CRT * \RING DRV CMD – OFF

A7L * RING OUT pb – push

4:50 CRT * When PETAL POS BASE (three) = 5 ± 3% and not decr:

A7L * POWER ON pb – push

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
  * \RING FINAL POSITION lt – lt on (for ~16 sec), then lt off

4:50 CRT * When PETAL POS BASE (three) = 5 ± 3% and not decr:

A7L * RING FINAL POSITION lt – lt off
5:00 CRT \DRV CMD – OFF

0:00 A7L 7. APDS CIRC PROT OFF pb – push
CRT \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

At 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 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

If not CLUTCH – blank/SLIP:

- MCC

9. POWER OFF pb – push

- STATUS lt (eighteen) – lt off
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

CRT
1. √ODS CONN X3,X4 (two) – ON

A6L
2. √cb PMA 2/3 GRP 1,2 HOOKS (eight) – op
   √PMA 2/3 HOOKS SYS A, SYS B (two) – ctr
   √GRP 1 tb – bp
   √GRP 2 tb – bp

TO CLOSE HOOKS 1, PERFORM STEPS 3 THRU 6

3. cb PMA 2/3 GRP 1 HOOKS SYS A OP,CL (two) – cl
   B OP,CL (two) – cl
   √PMA 2/3 HOOKS GRP 1 tb – OP

CRT
   √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: 

*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

    CRT √HK2 IND OP – 1,2
         √CL – blank
         √HK CLS 2/4/6, 8/10/12 (two) – blank

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

0:00 A6L 8. PMA 2/3 HOOKS SYS A, SYS B (two) – CL
    √GRP 2 tb – bp

    CRT √HK2 CMD CL – 1,2
         √IND OP – blank

2:20 A6L 9. √PMA 2/3 HOOKS GRP 2 tb – CL
    CRT √HK2 IND CL – 1,2
         √CMD CL – blank
         √HK CLS 2/4/6, 8/10/12 (two) – CL

A6L 10. PMA 2/3 HOOKS SYS A, SYS B (two) – ctr
          cb PMA 2/3 GRP 2 HOOKS SYS A OP, CL (two) – op
          B OP, CL (two) – op
### 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.

<table>
<thead>
<tr>
<th>SM 167 DOCKING STATUS</th>
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<tbody>
<tr>
<td>A6L</td>
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<tr>
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<tr>
<td>TO OPEN HOOKS 1, PERFORM STEPS 2 THRU 5</td>
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<tr>
<td>2. cb PMA 2/3 GRP 1 HOOKS SYS A OP, CL (two) – cl</td>
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<tr>
<td>CRT</td>
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</tbody>
</table>

* 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 | 5. PMA 2/3 HOOKS SYS A, SYS B (two) – ctr |
| | cb PMA 2/3 GRP 1 HOOKS SYS A OP, CL (two) – op |
| | cb PMA 2/3 GRP 1 HOOKS SYS B OP, CL (two) – op |
| | Perform PMA 2/3 HOOKS OPEN – CONTINGENCY, * |
| | 8-30 |

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 * PMA 2/3 HOOKS SYS A, SYS B (two) – ctr  *
   * 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
# APDS Failure/Impact Matrix

<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>POWER ON pb</td>
<td>Failed ON (m)</td>
<td>Continuous PWR ON will inhibit ring, damping, and fixer commands. Relays may overheat preventing future powerup. [Detectable only during powerup or ring drive operations]</td>
<td>RING DRV CMD OFF</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>If all STATUS lts are off, loss of all logic power to APDS. Docking system cannot be operated</td>
<td>POWER FAILED OFF (STATUS LTS OFF)</td>
</tr>
<tr>
<td>APDS CIRCUIT PROTECT OFF</td>
<td>Failed ON (m)</td>
<td>RING OUT, OPEN LATCHES, OPEN HOOKS, and UNDOCKING pb commands are enabled</td>
<td>APDS CIRCUIT PROTECT OFF LT FAILED OFF</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>No RING OUT, OPEN LATCHES, OPEN HOOKS, or UNDOCKING pb capability</td>
<td></td>
</tr>
<tr>
<td>RING ALIGNED</td>
<td>Failed ON (m)</td>
<td>Prime alignment cue lost. Use CRT RING ALIGN and PETAL POS BASE 1,2,3 indications as backup. Erroneous ind possible with significant pitch motion (sensors rotated 360°)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>Prime alignment cue lost. Use CRT RING ALIGN and PETAL POS BASE 1,2,3 indications as backup</td>
<td></td>
</tr>
<tr>
<td>RING INITIAL POSITION</td>
<td>Failed ON (s)</td>
<td>Ring will only drive for 1 sec with RING OUT pb commands. Slip clutch will drive alternately between the SLIP and LOCK positions</td>
<td>Starred blocks in the DOCKING RING EXTENSION and DOCKING MECHANISM DEMATE/REMate</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>INITIAL CONTACT lt disabled. Slip clutch will not drive to SLIP</td>
<td>APDS DIRECT DRIVE USING BOB required to drive slip clutch</td>
</tr>
<tr>
<td>FIXERS OFF</td>
<td>Failed ON (m)</td>
<td>IFM may be required to drive clutch to SLIP if failure occurs during ring extension. During docking, only centering springs maintain alignment during ring retraction</td>
<td>FIXERS OFF LT FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Unable to inhibit fixer operation during manual ring drive</td>
<td>FIXERS OFF LT FAILED OFF</td>
</tr>
<tr>
<td>HOOKS 1(2) OPEN</td>
<td>Failed ON (s)</td>
<td>Logic prevents hooks from driving open</td>
<td>HOOKS 1(2) OPEN LT FAILED ON [UNDOCKING]</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Hooks will not stop driving at Open position</td>
<td></td>
</tr>
<tr>
<td>LATCHES CLOSED</td>
<td>Failed ON (s)</td>
<td>If ring retraction to Final Position is attempted, ring will stall against capture latches if latches are failed closed. No impact if latches open on SPEC 167</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>No impact to nominal sequence. [May not be able to recapture, if reqd, if capture latches are not closed. Multiple failures reqd to inadvertently drive a latch motor open]</td>
<td></td>
</tr>
</tbody>
</table>
### APDS FAILURE/IMPACT MATRIX (Cont)

<table>
<thead>
<tr>
<th>APDS Status</th>
<th>APDS FAILURE</th>
<th>IMPACT</th>
<th>OFF NOMINAL PROCEDURE (IF APPLICABLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>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 Must use visual cues (no sep) and DAMPING indication to verify capture</td>
<td></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>READY TO HOOK LT FAILED ON</td>
</tr>
<tr>
<td>READY TO HOOK</td>
<td>Failed ON (s)</td>
<td>Hooks will begin driving closed with RING IN pb command</td>
<td>Manual CLOSE HOOKS pb command required to drive hooks closed per starred block on DOCKING SEQUENCE (Cue Card)</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Auto hook drive disabled. Ring will not stop driving at In-Between Hooks position</td>
<td></td>
</tr>
<tr>
<td>INTERF SEALED</td>
<td>Failed ON (s)</td>
<td>No impact to APDS operations. Indication is not used by any logic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>No impact to APDS operations. Indication is not used by any logic</td>
<td></td>
</tr>
<tr>
<td>HOOKS 1(2) CLOSED</td>
<td>Failed ON (s)</td>
<td>Logic prevents associated hooks from driving closed</td>
<td>HOOKS 1(2) CLOSED LT FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Hooks will not stop driving when closed position reached</td>
<td>HOOKS 1(2) NOT CLOSED WITHIN SINGLE MTR TIME if hooks not verified closed via CRT</td>
</tr>
<tr>
<td>LATCHES OPEN</td>
<td>Failed ON (s)</td>
<td>Ring will drive in once CAPTURE is achieved, or immediately if CAPTURE already present</td>
<td>LATCHES OPEN LT FAILED OFF</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>If Latches failed closed, ring will stall against Latches if Ring commanded to Final Position</td>
<td></td>
</tr>
<tr>
<td>RING FINAL POSITION</td>
<td>Failed ON (s)</td>
<td>During ring retraction, ring will only drive 10 sec 1st time. After 2nd Ring In command, ring will not stop driving at In-Between Hooks position and/or Final Position</td>
<td>RING FINAL POSITION LT FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>During Ring retraction to Final Position, ring will not stop driving at Final Position</td>
<td></td>
</tr>
</tbody>
</table>
### APDS FAILURE/IMPACT MATRIX (Cont)

<table>
<thead>
<tr>
<th>APDS Status It</th>
<th>APDS FAILURE</th>
<th>IMPACT</th>
<th>OFF NOMINAL PROCEDURE (IF APPLICABLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>APDS POWER A_{DS}, B_{DS}, C_{DS}</strong></td>
<td>Failed ON (s)</td>
<td>One logic bus remains powered. Still at least two failures from any inadvertent ops</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>Loss of one capture latch motor. Next failure results in loss of all APDS avionics logic</td>
<td>APDS POWER FAILED OFF</td>
</tr>
<tr>
<td><strong>A6L SYSTEM POWER A(B) tb</strong></td>
<td>Failed OFF (s)</td>
<td>Loss of redundancy to APDS logic busses, Control Panel Power busses, and PMA hook power. Loss of some docking lights and vestibule depress valves capability</td>
<td></td>
</tr>
<tr>
<td><strong>PYROS A_{p}, B_{p}, C_{p}</strong></td>
<td>Failed ON (s)</td>
<td>One Pyro logic bus powered. Still more than two failures from charging pyros</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>Loss of Pyro logic redundancy</td>
<td></td>
</tr>
<tr>
<td><strong>PYRO CIRCUIT PROTECT OFF</strong></td>
<td>Failed ON (m)</td>
<td>Possible loss of Pyro charge/fire inhibits</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Loss of capability to arm/fire Pyros</td>
<td></td>
</tr>
</tbody>
</table>
## APDS FAILURE/IMPACT MATRIX (TLM)

<table>
<thead>
<tr>
<th>APDS TLM</th>
<th>APDS FAILURE</th>
<th>IMPACT</th>
<th>OFF NOMINAL PROCEDURE (IF APPLICABLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DAMPING</strong></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><strong>RING FIXERS</strong></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><strong>CLUTCH – SLIP</strong></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><strong>CLUTCH – LOCK</strong></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><strong>CAP MAN REL</strong></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><strong>CNTL PNL PWR</strong></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><strong>RNG DR BUS 1(2)</strong></td>
<td>Failed OFF (s)</td>
<td>Loss of ring drive motor 1(2)</td>
<td></td>
</tr>
<tr>
<td><strong>HKS DR BUS 1(2)</strong></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><strong>DAMPER BUS 1(2)</strong></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><strong>FIXER BUS 1(2)</strong></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>
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CUE CARD CONFIGURATION

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(Back) .................................................................................................................. CC 9-6
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RCS BURN (+X, -X. Multi-axis)

1. GNC, OPS 202 PRO
   \text{GNC ORBIT MNVR EXEC}
   \sqrt{\text{RCS SEL, ITEM 4 – (*)}}

2. If onboard computed burn:
   \sqrt{\text{TIG and TGT PEG 7 } \Delta \text{Vs per Final solution}}
   \sqrt{\text{Guidance option is LAMBERT}}
   \text{If ground computed burn:}
   \sqrt{\text{TGT data per Burn Pad (reload WT as reqd)}}
   \text{LOAD – ITEM 22 EXEC}
   \text{TIMER – ITEM 23 EXEC}

3. If +X burn:
   \text{DAP: } A/\text{AUTO}/\text{ALT (B/ALT as reqd)}
   \text{MNVR – ITEM 27 EXEC (\*)}
   \text{If RR ops:}
   \text{KU – AUTO TRK}
   \text{GNC 33 REL NAV}
   \text{INH Angles – ITEM 24 EXEC (\*)}

TIG-0:30

4. FLT CNTLR PWR – ON
   \text{DAP TRANS: as reqd}
   \text{If Multi-axis:}
   \text{DAP: } A/\text{AUTO/}PRI
   \text{If +X or -X:}
   \text{DAP: } A/\text{INRTL/}PRI

TIG

5. If VGO Z is neg, Z,X,Y seq;
   otherwise, X,Y,Z
   \text{THC: Trim VGOs < 0.2 fps}
   \text{FLT CNTLR PWR – OFF}
   \text{DAP: ALT}
   \text{DAP TRANS: PULSE/PULSE/PULSE}
   \text{GNC, OPS 201 PRO}

6. If +X burn:
   \text{DAP: } A/\text{AUTO(B/AUTO/ALT as reqd)}
   \text{If RR ops, when ATT ERR < 30 deg:}
   \text{KU – GPC}
   \sqrt{\text{KU TRACK tb – gray}}
   \text{GNC 33 REL NAV}
   \text{AUTO Angles – ITEM 23 EXEC (\*)}

7. When in attitude:
   \text{DAP: } A/\text{AUTO/VERN(ALT)}
RENDÉZVOUS PRPTL 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)’
1. CONFIGURE KU FOR RR TGT ACQ

- KU ANT ENA – ITEM 2 EXEC (*)
- INH RNG, ITEM 18 – (*)
- RDOT, ITEM 21 – (*)
- Angles, ITEM 24 – (*)
- GNC 33 REL NAV
- CRT
  - √ SV SEL, ITEM 4 – FLTR
  - INH RNG, ITEM 18 – (*)
  - RDOT, ITEM 21 – (*)
  - Angles, ITEM 24 – (*)
- KU ANT ENA – ITEM 2 EXEC (*)
- GNC I/O RESET
- A2 DIGI-DIS sel – R/RDOT
- A1U KU PWR – STBY
  - MODE – RDR PASSIVE
  - RDR OUTPUT – HI
  - CNTL – PNL (wait 3 sec)
  - PWR – ON
- KU SEL – GPC >>

2. AUTO TRK ACQ

- KU SEL – AUTO TRK
- SLEW – as reqd (as seen in COAS)
- EL, AZ angles < 30 deg
- KU SEARCH – SEARCH (tb–gray)
- Repeat slew and search as reqd
- If acquisition not successful, √MCC >>

3. RR NAVIGATION

- GNC 33 REL NAV
- CRT
  - √ RADAR, ITEM 13 – (*)
  - √ MCC – (*)
  - If RATIO > 1.0: *
  - √ 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

- GNC 33 REL NAV
- CRT
  - INH RNG – ITEM 18 (*)
  - RDOT – ITEM 21 (*)
  - Angles – ITEM 24 (*)
  - KU ANT ENA – ITEM 2 (no *)
- A1U KU PWR – STBY
  - MODE – COMM
  - √ sel – GPC
  - CNTL – CMD
- A2 DIGI-DIS sel – EL/AZ

(reduced copy)
### Approach

<table>
<thead>
<tr>
<th>CG to CG RNG (ft)</th>
<th>RPM &amp; CONT ORVA RDOM (ft/s)</th>
<th>MCCZ ET w/RPM (h:mm:ss)</th>
<th>DAP</th>
<th>EVENT</th>
<th>NORD RDOM (ft/s)</th>
<th>HHL RNG (ft) (to ISS cg)</th>
<th>Raw TCS RNG* (ft) (Ref 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>-3.0</td>
<td>0:27:00</td>
<td></td>
<td>A/A/B</td>
<td>AUTO/VERN (PRI)</td>
<td>-3.0</td>
<td>1990 HHL Report</td>
</tr>
<tr>
<td>1700</td>
<td>-2.4</td>
<td>0:29:00</td>
<td></td>
<td></td>
<td></td>
<td>-2.6</td>
<td>1690 1698</td>
</tr>
<tr>
<td>1500</td>
<td>-2.1</td>
<td>0:31:00</td>
<td></td>
<td></td>
<td></td>
<td>-2.3</td>
<td>1490 1498</td>
</tr>
<tr>
<td>1000</td>
<td>-1.3</td>
<td>0:38:00</td>
<td></td>
<td>MCC UPDATE: Go for RPM, Go to proceed within 600 ft</td>
<td>1.5</td>
<td>990 985</td>
<td></td>
</tr>
</tbody>
</table>

#### Rpm Setup

- **ZNC 20 DAP CONF**
  - A PRI RUT RATE – ITEM 10 + 0.75 EXEC
  - A VERN ROT RATE – ITEM 23 + 0.75 EXEC
  - A PRI Y OPTION – ITEM 16 EXEC (ALL)

- **TNCZ UNIV PTG**
  - P = ITEM 15 + 145.0 EXEC
  - THC: center Node 1 in centerline camr ± 5 deg

- **TNCZ 33 REL NAV**
  - INH RING, RDOT, ANGLES
  - A1U KU sel - AUTO TRK

#### Contingency 600 ft Torva

**If no-go to proceed inside 600 ft, perform Contingency 600 ft Torva**

### Approach CUE Card

- Continue Approach cue card with the following deltas:
  - Initiate Torva at range 700 ft Rdot -0.3 ft/s (alt range 650 ft Rdot -0.1 ft/s)
  - Maintain RNG > 600 ft (CG-CG) until Vbar arrival
  - On Vbar, stationkeep RNG 630-530 (DP-DP), maintain ISS in C/L camr FOV

- On MCC GO, perform Configure for Docking and Vbar Approach (cue Card)

#### Configure for Docking

- Perform AIRLOCK FAN ACT AND ODS VOLUME PREP (APDS), 8-10

#### Vbar Approach

- Perform Airlock Fan Act and Ods Volume Prep (APDS), 8-10

#### Rpm Start Window (Met)

**Open:** / / / 

**Close:** / / /
### VBAR APPROACH

<table>
<thead>
<tr>
<th>Interface RNG (ft)</th>
<th>RDOT (ft/s)</th>
<th>MCC ET h:mm:ss (doc.–PET)</th>
<th>DAP</th>
<th>EVENT</th>
<th>HHL RNG (to Node 2) (ft)</th>
<th>Raw TCS RNG* (Ref #1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>-0.20 ±0.05</td>
<td>1:15:00 (-34:00)</td>
<td>(\angle) Z</td>
<td>MCC UPDATE: Go for docking</td>
<td>257</td>
<td>255</td>
</tr>
<tr>
<td>((170 ± 10)) 170</td>
<td>-0.20 ±0.05 1:21:30 (-27:30)</td>
<td></td>
<td>DAP: B</td>
<td>Maintain ISS docking target within 8 deg Corridor</td>
<td>177</td>
<td>175</td>
</tr>
<tr>
<td>110</td>
<td>-0.15 ±0.05</td>
<td>1:26:30 (-22:30)</td>
<td></td>
<td>Note: DAP A allowed for (\pm)X and (\pm)Z THC</td>
<td>117</td>
<td>115</td>
</tr>
<tr>
<td>75</td>
<td>-0.10 ±0.05</td>
<td>1:30:30 (-18:30)</td>
<td>No LO Z A10,B10</td>
<td>Perform CONFIGURE KU FOR COMM (Cue Card, KU OPS)</td>
<td>82</td>
<td>80</td>
</tr>
<tr>
<td>30 ± 5</td>
<td>0 ±0.02 1:38:00 (-11:00)</td>
<td>(\angle)A10,B10 DAP: B</td>
<td>5° Corridor If Flyout Reqd. THC: (\pm)Z (out) as reqd to null RDOT Perform AUTO ANGULAR FLYOUT (Cue Card) outside 25 ft</td>
<td>REVIEW FAILED CAPTURE, steps 1 thru 3, CAUTION (Cue Card, DOCKING SEQUENCE) (\angle)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>30</td>
<td>-0.07 ±0.02</td>
<td>1:43:00 (-08:00)</td>
<td>(\angle)A10,B10 DAP: B</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>25</td>
<td>↑ 1:44:00 (-05:00)</td>
<td></td>
<td></td>
<td>Maintain (\angle)GCC 23 RCS through contact</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>-0.10 ±0.03</td>
<td>1:47:20 (-01:40)</td>
<td>No LO Z ARM PCT F2(F4) SPDBK/THROT pb – AUTO – (\angle) on</td>
<td></td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>-0.10 ±0.03</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>CONTACT or ~2 in</td>
<td>-0.10 ±0.03</td>
<td>1:49:00 (00:00) PCT (SPARE pbi)</td>
<td>CAPTURE</td>
<td></td>
<td>N/A</td>
<td>5</td>
</tr>
</tbody>
</table>

* Raw TCS Range assumes ISS in docking attitude

---

**CAPTURE**

**MS A7L F4**

\(\angle\)CAPTURE It – \(\angle\) it on  
Notify ISS and MCC-H: “Capture Confirmed”  
DISARM PCT: SPDBK/THROT pb – push (it off)  
\(\angle\)ISS in FREE DRIFT (ISS indicator lights flashing)

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

**A6U**

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

---

**FAILED CAPTURE**

1. APDS CIRC PROT OFF pb – push  
\(\angle\)CIRCUIT PROTECT OFF It – \(\angle\) it on  
OPEN LATCHES pb – push  
\(\angle\)LATCHES CLOSED It – \(\angle\) it off  
\(\angle\)OPEN It – \(\angle\) it on  

2. DAP: NO LO Z  
\* IF VERN FAIL:  
\* DAP: PRI

If petals clear:  
DAP: A(B)/LVLH

3. THC: \(\pm\)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

(reduced copy)
C/L CAMERA TARGET ALIGNMENT (+VBAR)

PITCH (P)

ITEM 15

Target Displaced DOWN
(Cross Displaced UP)

P = _____
P = _____

3. PITCH = 179 - P=_____(A)
5. PITCH = PITCH - P=_____ (D)

Target Displaced UP
(Cross Displaced DOWN)

P = _____
P = _____

3. PITCH = 179 + P=_____(A)
5. PITCH = PITCH + P=_____ (D)

ROLL (R)

ITEM 16

Rotated CW

R = _____
R = _____

3. YAW = 360 - R =_____ (B)
5. YAW = YAW - R =_____ (E)

Rotated CCW

R = _____
R = _____

3. YAW = 0 + R =_____ (B)
5. YAW = YAW + R =_____ (E)

YAW (Y)

ITEM 17

Target Displaced RIGHT
(Cross Displaced LEFT)

Y = _____
Y = _____

3. OM = 0 + Y =_____ (C)
5. OM = OM + Y =_____ (F)

Target Displaced LEFT
(Cross Displaced RIGHT)

Y = _____
Y = _____

3. OM = 360 - Y =_____ (C)
5. OM = OM - Y =_____ (F)
AUTO ANGULAR FLYOUT

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

1. RECORD ANGULAR MISALIGNMENT
\(\sqrt{DAP}: A10, B10\)
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
\(\sqrt{TGT ID} +2\)
\(\sqrt{BODY VECT} +5\)
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
   \(\sqrt{TGT ID} +2\)
   \(\sqrt{BODY VECT} +5\)
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>POWER Failed OFF (All STATUS lts OFF)</th>
<th>DAMPING tm Failed ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPTURE lt Failed ON</td>
<td>FIXERS tm Failed ON</td>
</tr>
</tbody>
</table>

CAUTION
If any Docking Sequence command occurs out of order or if any STATUS lt functions erroneously:
- A7L  POWER OFF pb – push
- 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 – ON [PETAL POS BASE (three) – decr]
   - √CLUTCH – LOCK/blank

5. POWER ON pb – push
   - A7L  FLYER OFF pb – push
   - CRT  √RING DRV CMD – OFF

6. On MCC GO [PETAL POS BASE (three) not changing for 30 sec]:
   - A7L  APDS CIRC PROT OFF pb – push
   - CRT  √CIRCUIT PROTECT OFF lt – lt on
   - 0:00  RING OUT pb – push
   - CRT  √DRV CMD – ON [PETAL POS BASE (three) – incr]

7. POWER OFF pb – push
   - A7L  ON pb – push
   - CRT  √RING DRV CMD – OFF
   - CRT  √FIXERS OFF lt – lt off
### Retract Ring

- **A7L,CRT 8.** On MCC GO (RING ALIGNED lt on and [PETAL POS BASE (three) not changing] for 30 sec):
  - **0:00 A7L**
    - RING IN pb – push
  - **CRT**
    - DRV CMD – ON [PETAL POS BASE (three) – decr]
    - FIXERS – ON
    - CLUTCH – LOCK/blank
  - **CRT,A7L**
    - If PETAL POS BASE (three) > 20 \% and RING ALIGNED lt off:
    - POWER ON pb – push
  - **A7L**
    - Wait for ring alignment (up to 30 min)
  - **A7L,CRT**
    - When RING ALIGNED lt on and [PETAL POS BASE (three) not changing] for 30 sec:
    - RING IN pb – push
  - **A7L**

- **3:15 A7L 9.** READY TO HOOK lt – lt on
  - CRT
    - PETAL POS BASE (three) ≤ 7%}

### Close Hooks

- **0:00 A7L 10.** √HOKS 1,HOKS 2 OPEN lt (two) – lt 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 HOKS pb – push
      - If HOOKS 1(2) CLOSED lt failed ON:
        - Perform HOOKS 1(2) CLOSED LT FAILED ON, 8-23
      - **CRT,A7L**
  - **0:20 CRT 11.** √RING DRV CMD – OFF
    - If RING DRV CMD – ON 20 sec after hooks begin:
    - **A7L**
      - POWER ON pb – push
    - **≤ 1:30 A7L 12.** √INTERF SEALED lt – lt on (expect intermittent lt initially)
    - **2:20**
    - **CRT**
      - HK1,HK2 POS (two) = 92 - 93\%
      - IND (two) – blank/CL
      - ODS INDIV HK CL (twelve) – CL

### Load Relieve Capture Latches (Extend Ring)

- **A7L 14.** APDS CIRC PROT OFF pb – push
  - **CRT**
    - CIRCUIT PROTECT OFF lt – lt on
    - **0:00**
    - **15.** RING OUT pb – push
    - **CRT**
      - DRV CMD – ON
    - **0:10 A7L 16.** POWER ON pb – push
    - **CRT**
      - RING DRV CMD – OFF

### Open Capture Latches

- **0:00 A7L 17.** OPEN LATCHES pb – push
  - LATCHES CLOSED lt – lt off
  - OPEN lt – lt on
  - **0:05**

### Retract Ring to FNL POS

- **0:00 A7L 18.** RING IN pb – push
  - **CRT**
    - DRV CMD – ON [PETAL POS BASE (three) – decr]
    - FIXERS – ON
    - **0:10 A7L**
      - FINAL POSITION lt – lt on
    - **CRT**
      - PETAL POS BASE (three) = 5 ± 3\%
      - **0:20**
      - RING DRV CMD – OFF

### Power Off

- **A7L 19.** POWER OFF pb – push
  - STATUS lt (eighteen) – lt off
  - **20.** Go to TERMINATE RNDZ OPS P2A 4-22 >>
### STOPWATCH RDOT CONVERSION

<table>
<thead>
<tr>
<th>TIME BETWEEN 1 FT MARKS (SEC)</th>
<th>RANGE RATE (FT/SEC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.50</td>
</tr>
<tr>
<td>3</td>
<td>0.33</td>
</tr>
<tr>
<td>4</td>
<td>0.25</td>
</tr>
<tr>
<td>5</td>
<td>0.20</td>
</tr>
<tr>
<td>5.5</td>
<td>0.18</td>
</tr>
<tr>
<td>6</td>
<td>0.17</td>
</tr>
<tr>
<td>6.5</td>
<td>0.15</td>
</tr>
<tr>
<td>7</td>
<td>0.14</td>
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<tr>
<td>7.5</td>
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<tr>
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<tr>
<td>9</td>
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<tr>
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<tr>
<td>11</td>
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<tr>
<td>12</td>
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<td>16</td>
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<td>18</td>
<td>0.056</td>
</tr>
<tr>
<td>20</td>
<td>0.050</td>
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</tbody>
</table>

**NOTE**

HHL SPECS state that the HHL will not work if the aimpoint surface is closer than 12 ft from the HHL unit; therefore, no HHL use should be expected at an HHL range less than 12 ft (5 ft interface-to-interface).
### RDOT vs DELTA RNG/DELTA TIME

<table>
<thead>
<tr>
<th>ΔT (m:ss)</th>
<th>1000</th>
<th>800</th>
<th>600</th>
<th>500</th>
<th>400</th>
<th>300</th>
<th>250</th>
<th>200</th>
<th>150</th>
<th>100</th>
<th>50</th>
<th>25</th>
<th>10</th>
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</thead>
<tbody>
<tr>
<td>0:45</td>
<td>8.9</td>
<td>6.7</td>
<td>5.6</td>
<td>4.4</td>
<td>3.3</td>
<td>2.2</td>
<td>1.1</td>
<td>0.56</td>
<td>0.22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0:50</td>
<td>10.0</td>
<td>8.0</td>
<td>6.0</td>
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<td>4.0</td>
<td>3.0</td>
<td>2.0</td>
<td>1.0</td>
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<td>0.20</td>
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</tr>
<tr>
<td>0:55</td>
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<tr>
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<td>5.0</td>
<td>3.8</td>
<td>3.1</td>
<td>2.5</td>
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<td>2.2</td>
<td>1.7</td>
<td>1.1</td>
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<td>0.11</td>
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<td>4.0</td>
<td>3.0</td>
<td>2.5</td>
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<td>2:40</td>
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<td>0.56</td>
<td>0.28</td>
<td>0.14</td>
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</tbody>
</table>

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

### TIME DELTA RANGE DELTA RANGE

<table>
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<th>DELTA TIME</th>
<th>RANGE</th>
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</table>
**GPC/MDM FAILURE RESPONSE DURING RNDZ**

**NOTES**
1. Perform appropriate ORB PKT procedure in parallel with IMMEDIATE ACTIONS on card as soon as practical
2. Use this card during Rndz T/L thru MC4 burn (if RR FAIL PROCEDURES, thru RR fail correction burn)
3. GPC assignments assume 1233 NBAT
4. Do NOT restring for Non-Universal I/O Errors. Otherwise, a restring for GPC 1,2,3 fails will recover everything (see expected restring below)
5. If any GNC GPC fails, VERNs ↓
6. If IMUs not commfaulted, THC's are normally GO
7. Loss of FF2, FF4, FA3, and FA4 do not impact Rndz (unless other failures)

<table>
<thead>
<tr>
<th>GPC</th>
<th>MDM</th>
<th>IMMEDIATE ACTION</th>
<th>MAJOR IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPC1 (3232*)</td>
<td>FF1</td>
<td>1. If -Z ST NAV, INH ST to NAV Use -Y ST, if reqd</td>
<td>1. C3 DAP lights latched (go out with MDM pwr fail) 2. -Z ST ↓</td>
</tr>
<tr>
<td></td>
<td>FA1</td>
<td>DAP: ALT/AUTO</td>
<td>VERNs ↓</td>
</tr>
<tr>
<td>GPC2 (1313*)</td>
<td>FA2</td>
<td>DAP: ALT/AUTO</td>
<td>VERNs ↓</td>
</tr>
</tbody>
</table>

**Man OMS Shutdown**

| GPC3 (1212*) | FF3 | 1. DAP: ALT/AUTO 2. If RR NAV, INH RR to NAV 3. If -Y ST NAV, INH ST to NAV 4. If RR not recovered: Work RR FAIL procedures | 1. VERNs ↓ 2. RR ¬→ NAV/RPOP ↓ (Panel A2 OK) 3. A6 DAP lights latched (go out with MDM pwr fail) 4. -Y ST ↓ 5. Also for loss of GPC3: R OMS GMBL PRI/SEC ↓ |

**Loss of Alt DAP**

| GPC4 (1212*) | PL | If Ku breaks lock: Ku sel – AUTO TRK | 1. GPC Ku ptg ↓, slew in AUTO TRK if Ku breaks lock 2. No Ku self-test |

* Expect this NBAT if GPC fail

| MALFUNCTION | >> |

---

**RNDZ-7a/122/O/B**
**RNDZ REF DATA**

<table>
<thead>
<tr>
<th>FF1</th>
<th>FF3</th>
<th>FA1</th>
<th>DSC OF2</th>
</tr>
</thead>
<tbody>
<tr>
<td>F MANF 1 JETS</td>
<td>VERN</td>
<td>L/R MANF 1 JETS</td>
<td>VERN &amp; F MANF 3,4 RM</td>
</tr>
<tr>
<td>C3 DAP LTS</td>
<td>MOUNT</td>
<td>L OMS GMBL PRI</td>
<td>F RCS OX, FU QTY</td>
</tr>
<tr>
<td>IMU 1</td>
<td>A6 DAP LTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Z STRK</td>
<td>IMU 3</td>
<td>A6 DAP LTS</td>
<td></td>
</tr>
<tr>
<td>L OMS GMBL PRI ENA</td>
<td>RR → NAV/RPOP</td>
<td>L OMS GMBL PRI</td>
<td></td>
</tr>
<tr>
<td>L ADI sw, ATT REF</td>
<td>-Y STRK</td>
<td></td>
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</tr>
<tr>
<td>F, A THC contact 1</td>
<td>R OMS GMBL SEC ENA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L RHC channel 1</td>
<td>A ADI sw, ATT REF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PNL 03 F, L RCS OX QTY</td>
<td>F, A THC contact 3</td>
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<td></td>
</tr>
<tr>
<td>PNL 03 F, L RCS LOW QTY</td>
<td>LACS</td>
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<table>
<thead>
<tr>
<th>FF2</th>
<th>FF4</th>
<th>FA2</th>
<th>DSC OF4</th>
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<tbody>
<tr>
<td>F MANF 2 JETS</td>
<td>VERN</td>
<td>L/R MANF 3 JETS</td>
<td>VERN &amp; L MANF 1,2 RM</td>
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<tr>
<td>IMU 2</td>
<td>MOUNT</td>
<td>L OMS GMBL PRI</td>
<td>L RCS OX QTY</td>
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<tr>
<td>L OMS GMBL SEC ENA</td>
<td>A6 DAP LTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R ADI sw, ATT REF</td>
<td>R OMS GMBL SEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F, A THC contact 2</td>
<td>A RHC Roll channel 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A RHC P, Y channel 2</td>
<td>R RHC channel 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L RHC channel 2</td>
<td>GPC KU PTG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R RHC channel 1</td>
<td>KU self-test</td>
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</tr>
</tbody>
</table>

### CNTL AB1
- PLB LTS (Fwd-P, Aft-S, Bulkhead)
- L ADI ATT REF
- CCTV CONTR UNIT PRI

### CNTL BC1
- VERN
- PLB LTS (Fwd-S, Mid-P)
- R ADI ATT REF
- CCTV CONTR UNIT SEC

### CNTL BC2
- VERN
- F MANF 2 JETS
- A6 DAP ROT, TRANS pbs (PCT)
- R ADI switches, ATT REF

### CNTL BC3
- C3 DAP ROT, TRANS pbs

### CNTL CA1
- PLB LTS (Aft-P, Mid-S)
- OVHD DOCK, RMS SPOT LTS
- A ADI ATT REF

### CNTL CA2
- F MANF 3 JETS
- A6 DAP ROT, TRANS pbs (PCT)
- A ADI switches, ATT REF

### MAIN A
- FPC1: MCIU
  - FL1: F MANF 1 JETS
  - AC1B: PNL 03 RCS/OMS QTY
  - FWD EVENT TIMER
- APC4:
  - APC1: VERN
  - L OMS GMBL PRI
  - R OMS GMBL SEC
- ALC1: VERN
- O14: -Z STRK
- AFT EVENT TIMER
- O14/A8: RMS PRI PWR
- R14:
  - CCTV CAM-C, D
  - CCTV MON-1
  - CCTV CONTR UNIT PRI
- MPC1:
  - APDS RING DAMP 1, 2
  - APDS HK, RING MTR 1
  - RNS PRI PWR
  - OVHD DOCK, RMS LTS
  - PLB LTS (Fwd-P, Aft-S)
- AUX PL B: TCS

### MAIN B
- FPC2:
  - FL1: F MANF 2 JETS
  - AC2C: PNL A2 DIGITALS
- APC6:
  - APC1: VERN
  - L OMS GMBL SEC
  - R OMS GMBL SEC
  - ALC2: VERN
  - O15:
    - FWD EVENT TIMER
  - O15/A8:
    - RMS B/JU PWR
  - R14:
    - KU COMM & RR
    - CCTV CAM-A, M2
    - CCTV CONTR UNIT SEC
    - CCTV CONTR UNIT SEC
    - VPU (C/L CAM CMDS)
- MPC2:
  - KU COMM & RR
  - CCTV CAM-2
  - CCTV CONTR UNIT SEC
  - VPU (C/L CAM CMDS)
- AUX PL B: TCS

### MAIN C
- FPC3:
  - KU COMM & RR
- FLC3: VERN
- F MANF 4 JETS
- AC3A: COAS PWR
- APDC:
  - APC1: R OMS GMBL PRI
  - O16:
    - PNL 03 OMS/RCM QTY
  - R14:
    - KU SIG PROC (R OR OK)
- MPC3:
  - PLB LTS (Aft-P, Mid-S)
- CABIN PL (Flt Specific)
- CCTV C/L CAM

---

**TOP**

BACK OF ‘GPC/MDM FAILURE RESPONSE DURING RNDZ’
Note: Fabricate As Transparency

CAMERA A/D

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feet

RANGE RULER

<table>
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<tr>
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<tr>
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feet

Use Bottom/Back Of ISS Ring

Use Top/Front Of ISS Ring

CTVC FULL NO ZOOM

<table>
<thead>
<tr>
<th>T</th>
<th>RR</th>
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<tbody>
<tr>
<td>8</td>
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<tr>
<td>10</td>
<td>0.10</td>
</tr>
<tr>
<td>11</td>
<td>0.09</td>
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</table>
Note: Fabricate As Transparency

C/L CAMERA

ZOOM CALIBRATION (RING READY FOR DOCK)

CTVC AT HFOV = 40.0 DEG
FLIGHT

H-FOV

40 deg

0 5 10 15 20 25 30 35

20 deg

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

10 deg

0 1 2 3 4 5 6 7 8 9 10

SUB ANG RULER

RNDZ-13a/122/O/A
Note: Fabricate As Transparency

V10 MONITOR

CORRIDOR

CTVC 40.0 DEG HFOV - CORRIDOR
CTVC FULL ZOOM - ALIGNMENT

RNDZ-14a/122/O/A
**RCS FAILURE RESPONSE DURING PROX OPS**

**Case 1:** Do not perform LOW Z +Z (braking) pulses
- If during RPM,
  - DAP: FREE
- FLT CNTLR PWR – OFF
- MCC for further actions
- If on Vbar and RNG > 75 ft,
  - DAP: No LCW Z
  - DAP: B/VERN(PRI)
  - DAP: AUTO
  - THC: +Z (out) at 10 sec intervals as reqd to establish 0.1 fps opening
- If RNG < 75 ft,
  - DAP: No LCW Z
  - DAP: B/VERN(PRI)
  - DAP: AUTO
  - THC: +Z (out) as reqd to establish 0.1 fps opening

**Case 2:** Do not perform PCT
- NOTE: DAP disables ±Y translation
- Perform LOSS OF BOTH FxD JETS (SAME SIDE)
  (CONTINGENCY OPS), 5-39

**Case 3:** VERN
- DAP: PRI/AUTO
- Perform LOSS OF VRCS (CONTINGENCY OPS), 5-41

**Case 4:** Y
- DAP disables ±Y translation
- Perform LOSS OF FORWARD SIDE-FIRING JETS
  (CONTINGENCY OPS), 5-37

**Case 5:** +X
- Do not perform LOW Z +Z (braking) pulses
- Perform DEGRADED +X TRANSLATION (CONTINGENCY OPS), 5-35

**Case 6:** -X
- Perform DEGRADED -X TRANSLATION (CONTINGENCY OPS), 5-36

**Case 7:** 1Fx D
- Review IMMEDIATE ACTIONS for 2Fx D CASE
- Perform LOSS OF ONE FxD JET (CONTINGENCY OPS), 5-38

**FLT RULES**

<table>
<thead>
<tr>
<th>Case</th>
<th>Immediate Actions/Procedures Reference</th>
<th>RPM</th>
<th>R&lt;250</th>
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<tbody>
<tr>
<td>2Fx D</td>
<td>No-GO</td>
<td>No-GO</td>
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<td>VERN</td>
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<tr>
<td>Y</td>
<td>No-GO</td>
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<td>30</td>
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</tr>
<tr>
<td>1Fx D</td>
<td>No-GO</td>
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</table>
## RCS/DPS/EPS FAILURE IMPACTS

<table>
<thead>
<tr>
<th>DPS</th>
<th>FRCS JET GROUPS</th>
<th>EPS</th>
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</thead>
<tbody>
<tr>
<td>GPC</td>
<td>MDM</td>
<td>1</td>
</tr>
<tr>
<td>FF1</td>
<td>F1F R1</td>
<td>F1L R1</td>
</tr>
<tr>
<td>FF2</td>
<td>F2F R2</td>
<td>F2R R2</td>
</tr>
<tr>
<td>FF3</td>
<td>F3F R3</td>
<td>F3L R3</td>
</tr>
<tr>
<td>FF4</td>
<td>F4F R4</td>
<td>F4L R4</td>
</tr>
</tbody>
</table>

### Case Selection

- **1 JET**
  - 1 FxD
  - 1 FxD
  - VERN
  - VERN

- **2 JETS**
  - 2 FxD
  - 2 FxD

### ARCS JET GROUPS

<table>
<thead>
<tr>
<th>DPS</th>
<th>ARCS JET GROUPS</th>
<th>EPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPC</td>
<td>MDM</td>
<td>7</td>
</tr>
<tr>
<td>FA1</td>
<td>R1A L1</td>
<td>L1L R1</td>
</tr>
<tr>
<td>FA2</td>
<td>R3A L3A L3A L3A</td>
<td>L3R R3</td>
</tr>
<tr>
<td>FA3</td>
<td>L2L R2L R2L R2L</td>
<td>L22 R22</td>
</tr>
<tr>
<td>FA4</td>
<td>L4L R4L R4L R4L</td>
<td>L4R R4R</td>
</tr>
</tbody>
</table>

### Notes

1. For RCS failures, strike off jet(s). For DPS/EPS failures, strike all jets in same row(s) as affected GPC/MDM/jet(s).
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.