Rendezvous

STS-115

Mission Operations Directorate
Flight Design and Dynamics Division

Final
May 26, 2006
List of Implemented Change Requests (482s):

RNDZ-1210    MULTI-1762
RNDZ-1211
RNDZ-1212
RNDZ-1213
RNDZ-1214

Incorporate the following:

1. Replace v thru viii
2. Replace section 3 (12 pages)
3. Replace 4-11 thru 4-14, 4-17 thru 4-20
4. Replace 8-23 thru 8-26
5. Replace 9-1 and 9-2, CC 9-7 thru CC 9-10, CC 9-25 and 9-26
   Delete CC 9-27 and 9-28

Prepared by:  

Approved by:  

Accepted by:  

Encl: 36 pages

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

RENDZVOUS
STS-115

FINAL
May 26, 2006

PREPARED BY:

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6/06/2006
Book Manager

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6/07/2006
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ACCEPTED BY:

R. T. Gavin
6-7-06
Chief, Orbit Dynamics Branch

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

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Incorporates the following:

<table>
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<tr>
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<th>RNDZ-1173B</th>
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**AREAS OF TECHNICAL RESPONSIBILITY**

- **Book Manager**  
  DM34/J. Yencharis  
  281-483-5976

- **Rendezvous Guidance and Procedures**  
  DM34/D. Harshman  
  281-483-1965

- **Flight Dynamics**  
  DM32/D. Theis  
  281-483-1956

- **Rendezvous Design**  
  USA/T. Stuit  
  281-282-4456

- **PROX OPS Design**  
  USA/M. Schrock  
  281-282-2777

- **Flight Design**  
  USA/R. Moreno  
  282-483-8040

- **Rendezvous Training**  
  DT35/A. Fox  
  281-244-7376

- **APDS**  
  DF52/J. Dake  
  281-483-6538
NOTE
This checklist is the controlling crew document for the ISS-12A rendezvous and separation. The Rendezvous Timeline begins at T_i -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
R, RDOT  Range Rate
R, RBAR  Radius Vector (toward Earth)
RNDZ     Rendezvous
RR       Rendezvous Radar
SK       Stationkeeping
ST, STRK Star Tracker
V, VBAR  Velocity Vector (direction of orbital travel)
±X, Y, ZLV ±X, Y, or Z Local Vertical (±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)
±X, Y, ZVV ±X, Y, or Z orbiter body axis along the LVLH Velocity Vector
## RENDEZVOUS
### STS-115

**LIST OF EFFECTIVE PAGES**

<table>
<thead>
<tr>
<th>Final</th>
<th>PCN-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/26/06</td>
<td>08/04/06</td>
</tr>
</tbody>
</table>

| Sign Off | 115/FIN | 4-3 | 115/FIN |
| vii | 115/FIN | 4-9 | 115/FIN |
| viii | 115/FIN | 4-10 | 115/FIN |
| ix | 115/FIN | 4-11 | 115/FIN 1 |
| x | 115/FIN | 4-12 | 115/FIN |
| xi | 115/FIN | 4-13 | 115/FIN |
| xii | 115/FIN | 4-14 | 115/FIN 1 |
| 1-1 | 115/FIN | 4-15 | 115/FIN |
| 1-2 | 115/FIN | 4-16 | 115/FIN |
| 1-3 | 115/FIN | 4-17 | 115/FIN 1 |
| 1-4 | 115/FIN | 4-18 | 115/FIN 1 |
| 1-5 | 115/FIN | 4-19 | 115/FIN 1 |
| 1-6 | 115/FIN | 4-20 | 115/FIN 1 |
| 1-7 | 115/FIN | 4-21 | 115/FIN |
| 1-8 | 115/FIN | 4-22 | 115/FIN |
| 1-9 | 115/FIN | 5-1 | 115/FIN |
| 1-10 | 115/FIN | 5-2 | 115/FIN |
| 2-1 | 115/FIN | 5-3 | 115/FIN |
| 2-2 | 115/FIN | 5-4 | 115/FIN |
| 2-3 | 115/FIN | 5-5 | 115/FIN |
| 2-4 | 115/FIN | 5-6 | 115/FIN |
| 2-5 | 115/FIN | 5-7 | 115/FIN |
| 2-6 | 115/FIN | 5-8 | 115/FIN |
| 2-7 | 115/FIN | 5-9 | 115/FIN |
| 2-8 | 115/FIN | 5-10 | 115/FIN |
| 2-9 | 115/FIN | 5-11 | 115/FIN |
| 2-10 | 115/FIN | 5-12 | 115/FIN |
| 3-1 | 115/FIN | 5-13 | 115/FIN |
| 3-2 | 115/FIN 1 | 5-14 | 115/FIN |
| 3-3 | 115/FIN 1 | 5-15 | 115/FIN |
| 3-4 | 115/FIN 1 | 5-16 | 115/FIN |
| 3-5 | 115/FIN 1 | 5-17 | 115/FIN |
| 3-6 | 115/FIN 1 | 5-18 | 115/FIN |
| 3-7 | 115/FIN 1 | 5-19 | 115/FIN |
| 3-8 | 115/FIN 1 | 5-20 | 115/FIN |
| 3-9 | 115/FIN 1 | 5-21 | 115/FIN |
| 3-10 | 115/FIN 1 | 5-22 | 115/FIN |
| 3-11 | 115/FIN 1 | 5-23 | 115/FIN |
| 3-12 | 115/FIN 1 | 5-24 | 115/FIN |
| 4-1 | 115/FIN | 5-25 | 115/FIN |
| 4-2 | 115/FIN | 5-26 | 115/FIN |

* – Omit from flight book
<table>
<thead>
<tr>
<th>5-27</th>
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<th>7-24</th>
<th>115/FIN</th>
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<tr>
<td>5-28</td>
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<td>RNDZ-1a/115/O/A</td>
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<td>CC 9-4</td>
<td>RNDZ-1b/115/O/A</td>
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<td>RNDZ-2a/115/O/A</td>
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<td>CC 9-7</td>
<td>RNDZ-3a/115/O/B</td>
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<td>CC 9-8</td>
<td>RNDZ-3b/115/O/B</td>
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<td>APPROACH WITH RPM</td>
<td>CC 9-9</td>
<td>RNDZ-15a/115/O/B</td>
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<td>CC 9-10</td>
<td>RNDZ-15b/115/O/B</td>
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<td>CC 9-11</td>
<td>RNDZ-4a/115/O/A</td>
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<td>(Back)</td>
<td>CC 9-12</td>
<td>RNDZ-4b/115/O/A</td>
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<td>DOCKING SEQUENCE (Front)</td>
<td>CC 9-13</td>
<td>RNDZ-5a/115/O/B</td>
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<td>CC 9-14</td>
<td>RNDZ-5b/115/O/B</td>
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<td>CC 9-15</td>
<td>RNDZ-6a/115/O/A</td>
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<td>CC 9-16</td>
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<td>RNDZ-7a/115/O/A</td>
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<td>RNDZ-7b/115/O/A</td>
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<td>CC 9-19</td>
<td>RNDZ-8a/115/O/A</td>
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<td>CAMERA A/D RANGE RULER</td>
<td>CC 9-20</td>
<td>RNDZ-9a/115/O/A</td>
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<tr>
<td>C/L CAMERA ZOOM CALIBRATION (RING READY FOR DOCK)</td>
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<td>RNDZ-10a/115/O/A</td>
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<tr>
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<td>RNDZ-11a/115/O/A</td>
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<td>RNDZ-12a/115/O/A</td>
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<td>RNDZ-13a/115/O/B</td>
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<td>RNDZ-14a/115/O/A</td>
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</table>

* – Omit from flight book
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLIGHT RULES SUMMARY &amp; FLIGHT PROFILE</td>
<td>1-1</td>
</tr>
<tr>
<td>FLIGHT RULES SUMMARY</td>
<td>1-2</td>
</tr>
<tr>
<td>RNDZ/PROX OPS BREAKOUT PROCEDURES OVERVIEW</td>
<td>1-2</td>
</tr>
<tr>
<td>RNDZ BURN SOLUTION SELECTION GUIDELINES</td>
<td>1-3</td>
</tr>
<tr>
<td>ENGINE SELECTION GUIDELINES</td>
<td>1-3</td>
</tr>
<tr>
<td>FAILURE/RESPONSE SUMMARY</td>
<td>1-4</td>
</tr>
<tr>
<td>ORBT RENDEZVOUS PROFILE</td>
<td>1-5</td>
</tr>
<tr>
<td>POST Ti PROFILE</td>
<td>1-6</td>
</tr>
<tr>
<td>TERMINAL PHASE, RPM, AND TORVA</td>
<td>1-7</td>
</tr>
<tr>
<td>VBAR APPROACH</td>
<td>1-8</td>
</tr>
<tr>
<td>UNDOCKING, TORS/TORF, AND FINAL SEPARATION</td>
<td>1-9</td>
</tr>
<tr>
<td>UNDOCKING/SEPARATION TIMELINE</td>
<td>2-1</td>
</tr>
<tr>
<td>MANEUVER PADS</td>
<td>3-1</td>
</tr>
<tr>
<td>RENDEZVOUS TIMELINE</td>
<td>4-1</td>
</tr>
<tr>
<td>CONTINGENCY OPS</td>
<td>5-1</td>
</tr>
<tr>
<td>RNDZ OMS BURN</td>
<td>5-3</td>
</tr>
<tr>
<td>SENSOR FAIL</td>
<td>5-7</td>
</tr>
<tr>
<td>S TRK NAV – HIGH INITIAL RESID</td>
<td>5-8</td>
</tr>
<tr>
<td>FLTR MINUS PROP</td>
<td>5-9</td>
</tr>
<tr>
<td>COAS NAVIGATION</td>
<td>5-10</td>
</tr>
<tr>
<td>BACKOUT/BREAKOUTS</td>
<td>5-11</td>
</tr>
<tr>
<td>VBAR CORRIDOR BACKOUT</td>
<td>5-12</td>
</tr>
<tr>
<td>BREAKOUT</td>
<td>5-14</td>
</tr>
<tr>
<td>SHUTTLE NOSE IN-PLANE BREAKOUT (R &lt; 700 ft)</td>
<td>5-16</td>
</tr>
<tr>
<td>RNDZ BREAKOUT</td>
<td>5-18</td>
</tr>
<tr>
<td>EXPEDITED SEPS</td>
<td>5-19</td>
</tr>
<tr>
<td>SHUTTLE EMERGENCY SEPARATION</td>
<td>5-21</td>
</tr>
<tr>
<td>ANY ATTITUDE SEPARATION</td>
<td>5-23</td>
</tr>
<tr>
<td>Ti DELAY BURN</td>
<td>5-27</td>
</tr>
<tr>
<td>RNDZ NAV RECOVERY</td>
<td>5-29</td>
</tr>
<tr>
<td>TGT ITER</td>
<td>5-30</td>
</tr>
<tr>
<td>LOSS OF COMM</td>
<td>5-31</td>
</tr>
<tr>
<td>DEGRADED CONTROL</td>
<td>5-33</td>
</tr>
<tr>
<td>DEGRADED +X TRANSLATION</td>
<td>5-35</td>
</tr>
<tr>
<td>–X TRANSLATION</td>
<td>5-36</td>
</tr>
<tr>
<td>LOSS OF FORWARD SIDE-FIRING JETS</td>
<td>5-37</td>
</tr>
<tr>
<td>ONE FxD JET</td>
<td>5-38</td>
</tr>
<tr>
<td>BOTH FxD JETS (SAME SIDE)</td>
<td>5-39</td>
</tr>
<tr>
<td>VRCS</td>
<td>5-41</td>
</tr>
<tr>
<td>REFERENCE DATA</td>
<td>6-1</td>
</tr>
<tr>
<td>ISS RNDZ OPS DAP CONFIGURATIONS</td>
<td>6-2</td>
</tr>
<tr>
<td>POST-CONTACT THRUST (PCT) REFERENCE DATA</td>
<td>6-3</td>
</tr>
<tr>
<td>TARGETING DATA</td>
<td>6-4</td>
</tr>
<tr>
<td>POST NC</td>
<td>6-6</td>
</tr>
<tr>
<td>Ti</td>
<td>6-7</td>
</tr>
<tr>
<td>MC3</td>
<td>6-8</td>
</tr>
<tr>
<td>TCS REFLECTOR VISIBILITY DURING APPROACH</td>
<td>6-9</td>
</tr>
<tr>
<td>HHL AIMING LOCATIONS</td>
<td>6-10</td>
</tr>
<tr>
<td>SEPARATION SOLAR ARRAY CONFIGURATION</td>
<td>6-11</td>
</tr>
<tr>
<td>SHUTTLE CENTERLINE TARGET</td>
<td>6-12</td>
</tr>
<tr>
<td>ISS ATTITUDE CONTROL SYSTEM MODING INDICATORS</td>
<td>6-13</td>
</tr>
<tr>
<td>RANGING CHARTS</td>
<td>6-14</td>
</tr>
<tr>
<td>COAS SUBTENDED ANGLES (DEG) VS RANGE (FT)</td>
<td>6-15</td>
</tr>
</tbody>
</table>
RENDEZVOUS TOOLS

CCTV CONFIG FOR DOCKING/UNDOCKING

RNDZ TOOLS CHECKOUT

HAND-HELD LIDAR CHECKOUT

STOW

OPERATIONS

APDS

APDS NOMINAL

DOCKING MECHANISM INITIALIZATION

POWERUP

POWERDOWN

PREP

UNDOCKING PREP

DOCKING RING EXTENSION

RETRACTION (NOT MATED)

AIRLOCK FAN ACT AND ODS VOLUME PREP

BYPASS

PREP FOR INGRESS – BYPASS CONFIG

POST DOCKING HATCH LEAK CHECK

APDS OFF-NOMINAL

POWER FAILED OFF (STATUS LTS OFF)

DAMPING FAILED ON

CAPTURE LT FAILED ON

FIXERS FAILED ON

OFF LT FAILED ON

RING FAILS TO DRIVE

DRV CMD OFF

FINAL POSITION LT FAILED ON

FORCE RING ALIGNMENT

CLUTCH NOT ‘LOCK’

APDS CIRCUIT PROTECT OFF LT FAILED OFF.

HOOKS 1(2) OPEN LT FAILED ON

NOT CLOSED WITHIN SINGLE MTR TIME

READY TO HOOK LT FAILED ON

HOOKS 1(2) CLOSED LT FAILED ON

LATCHES OPEN LT FAILED OFF

APDS POWER FAILED OFF

DOCKING MECHANISM DEMATE/REMATE

ODS HOOKS OPEN – CONTINGENCY
PMA 2/3 HOOKS OPEN – CONTINGENCY............................................................... 8-30
APDS FAILED CAPTURE RECONFIG........................................................................ 8-33
PMA 2/3 HOOKS CLOSE ............................................................................................ 8-35
OPEN ....................................................................................................................... 8-37
CAPTURE LATCH MANUAL RELEASE ..................................................................... 8-39
REFERENCE DATA ........................................................................................................ 8-41
APDS FAILURE/IMPACT MATRIX .............................................................................. 8-42
(TLM)....................................................................................................................... 8-45
CUE CARD CONFIGURATION ....................................................................................... 9-1
FLIGHT RULES SUMMARY & FLIGHT PROFILE

FLIGHT RULES SUMMARY ........................................................................................................... 1-2
RNDZ/PROX OPS BREAKOUT PROCEDURES OVERVIEW ......................................................... 1-2
RNDZ BURN SOLUTION SELECTION GUIDELINES ................................................................. 1-3
    ENGINE SELECTION GUIDELINES .................................................................................... 1-3
    FAILURE/RESPONSE SUMMARY ....................................................................................... 1-4
ORBT RENDEZVOUS PROFILE .................................................................................................. 1-5
    POST Ti PROFILE .............................................................................................................. 1-6
TERMINAL PHASE, RPM, AND TORVA .................................................................................... 1-7
VBAR APPROACH ..................................................................................................................... 1-8
UNDOCKING, TORS/TORF, AND FINAL SEPARATION .............................................................. 1-9
## 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><strong>LONG RANGE SHUTTLE BREAKOUTS (Prior to RBAR Arrival)</strong></td>
<td></td>
</tr>
<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, 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>
<tr>
<td><strong>SHUTTLE BACKOUT</strong></td>
<td></td>
</tr>
<tr>
<td>Prior to docking</td>
<td>See VBAR CORRIDOR BACKOUT (CONTINGENCY OPS), 5-12</td>
</tr>
</tbody>
</table>
# 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>
</tbody>
</table>

Post-Ti midcourse corrections 1) Onboard solution

*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><strong>SYSTEMS:</strong>&lt;br&gt;  DPS: &lt; 2 GNC GPCs</td>
<td>2 GNC GPCs reqd for Ti and PROX OPS within 250 ft. Loss of GNC GPC redundancy inside 250 ft requires backout to 250 ft and stationkeep until reconfiguration to a 2 GNC redundant set is complete</td>
</tr>
<tr>
<td>GNC: Loss of redundant +Z Trans&lt;br&gt;  or PRCS TRANS, any axis ↓&lt;br&gt;  or PRCS ROT, any axis ↓&lt;br&gt;  or AFT THC (-Z sense),&lt;br&gt;   &gt; 1 TX contact ↓,&lt;br&gt;   all TY contacts ↓,&lt;br&gt;   all TZ contacts ↓&lt;br&gt;  or AFT RHC, all channels, any axis ↓&lt;br&gt;  or &lt; 2 IMUs</td>
<td>PROX OPS within 250 ft not permitted</td>
</tr>
<tr>
<td>Both Left Aft firing jets ↓&lt;br&gt;  or Both Right Aft firing jets ↓</td>
<td>Continue Approach, per DEGRADED +X TRANSLATION (CONTINGENCY OPS), 5-35</td>
</tr>
<tr>
<td>Two Forward firing jets ↓</td>
<td>Continue Approach, per DEGRADED –X TRANSLATION (CONTINGENCY OPS), 5-36</td>
</tr>
<tr>
<td>Both Forward Right firing jets ↓&lt;br&gt;  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), 5-37</td>
</tr>
<tr>
<td>One Forward Down firing jet ↓</td>
<td>Continue Approach per LOSS OF ONE FxD JET (CONTINGENCY OPS), 5-38</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), 5-39</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), 5-41</td>
</tr>
<tr>
<td><strong>MECH:</strong> 1 KU ANTENNA STOW MOTOR ↓</td>
<td>Normal ops</td>
</tr>
</tbody>
</table>
ORBIT RENDEZVOUS PROFILE

ISS AT CENTER OF ROTATING LVLH REFERENCE FRAME

EVENTS:
- 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

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

<table>
<thead>
<tr>
<th>MC2 ET (h:mm)</th>
<th>Range (ft) CG-CG</th>
<th>Rdot (fps)</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 0:27</td>
<td>2000</td>
<td>-3.0</td>
<td>MANUAL PHASE TAKEOVER (POST-MC4)</td>
</tr>
<tr>
<td>0:29</td>
<td>1700</td>
<td>-2.4</td>
<td></td>
</tr>
<tr>
<td>2 0:31</td>
<td>1500</td>
<td>-2.1</td>
<td></td>
</tr>
<tr>
<td>3 0:36</td>
<td>1000</td>
<td>-1.3</td>
<td>TRANSITION TO LOWZ</td>
</tr>
<tr>
<td>0:37</td>
<td>900</td>
<td>-1.1</td>
<td></td>
</tr>
<tr>
<td>4 0:37</td>
<td>800</td>
<td>-0.9</td>
<td>WHEN IN RBAR ATTITUDE: LOAD DAP A9/B9 MOD DAP A PRI/VERN ROT RATE TO 0.75 DEG/SEC AND YAW JET OPTION TO BOTH NOSE &amp; TAIL (ALL) LOAD UNIV PTG P=145 DEG</td>
</tr>
<tr>
<td></td>
<td>700</td>
<td>-0.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>650</td>
<td>-0.4</td>
<td></td>
</tr>
<tr>
<td>5 0:46</td>
<td>620</td>
<td>0.0</td>
<td>STATIONKEEP TO AVOID SHADOWING IF REQUIRED</td>
</tr>
<tr>
<td>6 1:00</td>
<td>620 600 580</td>
<td>-0.35 -0.25 -0.15</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>7 1:11</td>
<td>600 550 500</td>
<td>-0.7 -0.6 -0.4</td>
<td>RELOAD DAP A9, LOAD UNIV PTG P=179 DEG, REESTABLISH RDDT PER TORVA IC’S INITIATE TORVA: DAP A, ITEM 19 (+X PULSES AS REQ’D TO NULL TARGET MOTION IN CAMERA)</td>
</tr>
</tbody>
</table>
VBAR APPROACH

<table>
<thead>
<tr>
<th>MC2 ET (h:mm)</th>
<th>Range (ft)</th>
<th>Rdot (fps)</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1:25</td>
<td>320</td>
<td>VBAR ARRIVAL (-X PULSES AS REQ'D TO NULL TARGET MOTION IN CAMERA)</td>
</tr>
<tr>
<td></td>
<td>1:42</td>
<td>110</td>
<td>-0.15</td>
</tr>
<tr>
<td></td>
<td>1:46</td>
<td>75</td>
<td>TRANSITION TO NORMZ, LOAD DAP A10/B10, CONFIGURE FOR SINGLE -X JET (DESELECT F1/F/F2F)</td>
</tr>
<tr>
<td>9</td>
<td>1:54</td>
<td>30</td>
<td>STATIONKEEP FOR 5 MINUTES IF ANGULAR ALIGNMENT MANEUVER REQUIRED</td>
</tr>
<tr>
<td>10</td>
<td>2:05</td>
<td>0</td>
<td>DOCKING</td>
</tr>
</tbody>
</table>
## UNDOCKING, TORS/TORF, AND FINAL SEPARATION

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

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

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

MCC UPDATE
ORB SV
TGT SV
Covar Matrix

MCC UPDATE
Undocking Time

CONFIGURE FOR SEPARATION

ENABLE RENDEZVOUS NAV

On RPOP PGSCs:
Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-8, then:
Perform RPOP OPS, steps 1 thru 5 (RNDZ TOOLS), 7-9, then:
Perform TCS ACTIVATION, steps 1 thru 3 (RNDZ TOOLS), 7-18, then:
Perform TCS MANUAL ACQUISITION, step 1 (RNDZ TOOLS), 7-19
(Note: TCS will not track until after undock
Perform HHL CHECKOUT (RNDZ TOOLS), 7-6

DPS config for Undocking Ops - STRING 1233

MCC UPDATE

DAP config for Undocking Ops - STRING 1233

MCC UPDATE

CONFIGURE FOR SEPARATION

ENABLE RENDEZVOUS NAV

DAP: AUTO

RORZ: FUEL

EThermal

Set GNC TIMER counting down to Undocking Time per [4A]

DAP: LO Z
DAP: A(B)/AUTO/VERN(ALT)

R1 O2 TK3 HTR A - AUTO
A6U ADI ATT - LVLH
ERR - MED
RATE - LO
SENSE - Z
FLT CNTLR PWR - OFF

LOAD - ITEM 22 EXEC   OPS 201 PRO

LOAD - ITEM 22 EXEC
OPS 201 PRO

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

GNC 33 REL NAV

RNDZ NAV ENA - ITEM 1 EXEC (+)
SV SEL, ITEM 4 - FLTR
INH RNG, ITEM 18 - (+)
RDOT, ITEM 21 - (+)
Angles, ITEM 24 - (+)
UNDOCKING OPERATIONS

1. PREP FOR UNDOCKING
   When MCC-H and ISS issue GO for Undocking:
   - GNC 33 REL NAV
   - ORB TO TGT - ITEM 10 EXEC
   - All DDU cbs (six) – cl
   - O14, O15, O16:E
   - A6U FLT CNTLR PWR - ON

2. RECONFIGURE DAP
   - GNC 25 DAP CONFIG
   - Contig DAP A,B to A9,B9
   - X Jets ROT ENA – ITEM 7 EXEC (no *)
   - DAP: B1/FREE/ALT
   - DAP TRANS: NO LO Z
   - DAP TRANS: PULSE/PULSE/PULSE
   - SENSE: Z

3. COMMAND UNDOCKING
   - SM 167 DOCKING STATUS
   - A7L
     * If Hooks 1(2) fail to drive (HK1(2) DRV: CMD - OFF): *
     * If Hooks 1(2) appear to stop before reaching end of travel *
     * Allow for single motor drive time (~4:40) before performing *
     * POWER OFF pb - push *
     * ON pb - push *

-02:20 > UNDOCKING pb - push
   - HOOKS 1, HOOKS 2 CLOSED lo (two) - lo on [HK1,HK2 POS (two) < 92% + decr]
   - CRT
     * If Hooks 1(2) fail to drive (HK1(2) DRV CMD - OFF): *
     * OPEN Hooks pb - push *
     * If Hooks 1(2) appear to stop before reaching end of travel *
     * Allow for single motor drive time (~4:40) before performing *
     * POWER OFF pb - push *
     * ON pb - push *

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

00:00
   - HOOKS 1, HOOKS 2 OPEN lo (two) - lo on [HK1,HK2 POS (two) = 4%]
   - UNDOCK COMPLETE lo - lo on
   - √ HOOKS 1, HOOKS 2 CLOSED lo (two) - lo on [HK1,HK2 POS (two) = 92% ± 3%]
   - √ CLOSE HOOKS pb - push
   - √ HK1,HK2 POS (two) incr
   - √ POWER OFF pb - push
   - √ Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6
   - √ MCC for IFM capability
   - √ Prepare for 96 BOLT EVA TIMELINE (EVA FS, ORB CONT EVA), then,
   - √ Perform ODS HOOKS OPEN-CONTINGENCY (APDS), 8-26

4. POST UNDOCKING
   - Inform MCC-H and ISS:
     "Physical Separation"
   - When petals clear:
     - DAP: B1/LVLH/ALT
     - DAP TRANS: PULSE/PULSE/PULSE, NO LO Z
     - THC: as reqd to maintain C/L target within 8 deg corridor on C/L camera
     - Note: DAP A allowed for ±X and -Z (in) THC
   - At physical sep + 1:00
     - DAP: VERN(ALT)
     - THC: +Z(out) pulses at 10 sec intervals as reqd to establish and maintain RDOT > 0.2 fps
   - When RNG > 50 ft (DP-DF):
     - GNC 23 RCS
     - √ RCS FWD – ITEM 1 EXEC (*)
     - JET DES F1F – ITEM 31 EXEC (no *)
     - F2F – ITEM 35 EXEC (no *)

5. POWER OFF
   - POWER OFF pb - push
   - STATUS lo (eighteen) - lo off
   - GO TO SEP/FLYAROUND 8A

UNDOCKING / SEPARATION TIMELINE
UNDOCKING / SEPARATION TIMELINE

- MCC: GO FOR UNDOCKING

- UNDOCK COMPLETE

- UNDOCKING OPERATIONS (6A)

MCC UPDATE
GO for Undocking
SEP/FLYAROUND  BA

√ Flyaround terminete criteria per [4A]
* If Breakout required during flyaround
* Go to SHUTTLE NOSE IN-PLANE BREAKOUT (CONTINGENCY OPS), 5-16 >> *

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 [9A]
   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]
   DAP: A/AUTO/VERN(PRI)
   THC: Maintain ISS cg inside ± 15 degree vertical and ± 20 degrees horizontal on C/L camera

5. Prior to -Rbar crossing (Aft ADI P = 270):
   [GNC_UNIV_PTG]
   P √ -Q (-VBAR)
   TRK - ITEM 19 EXEC (CUR - *)
   When RNG > 600 ft (CG-CG):
   THC: Maintain flyaround range of 650 ± 50 ft (CG-CG)

6. Prior to -Vbar crossing (Aft ADI P = 0):
   [GNC_UNIV_PTG]
   P √ +270 (+RBAR)
   TRK - ITEM 19 EXEC (CUR - *)

---

TERMINATE SEP OPS [8C]

If KU MODE – RDR PASSIVE,
   Perform KU OPS, step 4 (Cue Card)
   [GNC_UNIV_PTG]
   CRT CNCL – ITEM 21 EXEC
   RNDZ NAV ENA - ITEM 1 EXEC (no *)
   A6L LIGHTS TRUSS FWD, AFT (two) - OFF
   Exit RPOP - [Shift]/[F10]
   Perform TCS DEACTIVATION (RNDZ TOOLS), 7-20
   Perform HHL STOW (RNDZ TOOLS), 7-6
   Go to FLIGHT PLAN

---

SEP BURNS [8B]

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

2. CONFIG FOR 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 CNTLR PWR – OFF
   Inform MCC when SEP complete
   Go to TERMINATE SEP OPS [8C]

~

SEP/BURN [8B]

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

2. CONFIG FOR 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 CNTLR PWR – OFF
   Inform MCC when SEP complete
   Go to TERMINATE SEP OPS [8C]

~

~

UNDOCKING / SEPARATION TIMELINE

2-8
UNDOCKING / SEPARATION TIMELINE

TCS Reflector Visibility During Flyaround

- 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 (th-gray)

When lock on occurs:
- CRT
- GNC 33 REL NAV
- 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 (+)

FLYAROUND RANGE REFERENCE

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

650 FT cg to cg

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<td>Progress - Aft</td>
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HHL RANGE CONVERSION

ISS NOT TO SCALE

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

Ref #5 is Out of Plane (Out of Page)
MANEUVER PADS
## Final Orbit Maneuver Pad for NC

### OMS BOTH
- **L**: 2
- **R**: 3
- **RCS SEL**: 4
- **TV ROLL**: 5

### Trim Load
- **P**: 
- **LY**: 7
- **RY**: 
- **WT**: 

### TV Roll
- **TGT PEG**: 7
- **ΔVX**: 19
- **ΔVY**: 20
- **ΔVZ**: 21

### BURN ATT
- **R**: 24
- **P**: 25
- **Y**: 26

### ΔVTOT
- **TGO**: 

### VGO
- **X**: 
- **Y**: 
- **Z**: 

### HPA
- **HA**: 
- **HP**: 

### GPC OP CL
- **ORBIT BURN MONITOR**
- **GPC FILL-INS**: __ (__) 

### Down Mode Options
- **2 OMS → 1 OMS**
- **1 OMS → RCS**

### OMS GMBL CK:
- **PRE**: 
- **POST-BURN**: 

### RCS I’CNCT:
- **L OMS → RCS**
- **R OMS → RCS**
- **NONE**

### RCS BURNS:
- **OMS HE REG TEST**
- **-X RCS BURNS**

### Burn Attitude
- **LVLH ATT**

### Notes
- **NOTES**

---

3-3

RNDZ/115/FIN 1
FINAL ORBIT MANEUVER PAD FOR NH

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

TRIM LOAD
    P
    LY 7
    RY ( )
WT
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
    L SEC
    R PRI
    R SEC
NONE

BURN ATT
    -X RCS BURNS:
    NONE

RSC 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.

NOTES

OMS HE REG TEST:
    NONE

- X RCS BURNS:
    -X

BURN ATT
    LVLH ATT
    A
    B

GPC OP CL

3-4
RNDZ/115/FIN 1
### FINAL ORBIT MANEUVER PAD FOR NH

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| BURN ATT | R 24 | |
|          | P 25 | |
|          | Y 26 | |

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<td>GPC FILL-INS __ ( __ )</td>
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<th>MAX TIG SLIP ___ MIN.</th>
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<td>UPDATE TIG AFTER ___ MIN.</td>
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# FINAL ORBIT MANEUVER PAD FOR Ti

## Notes

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

- **BURN ATT:**
  - VGO X ( )
  - VGO Y ( )
  - VGO Z ( )

- **ΔVTOT TGO:**
  - HA
  - HP

- **TRIM LOAD:**
  - P 6 ( )
  - LY 7 ( )
  - RY 8 ( )

- **WT 9**

- **TIG 10**

- **TGT PEG 7 ΔVX 19 ( )**
- **ΔVY 20 ( )**
- **ΔVZ 21 ( )**

- **TIDELEY**

- **NEW Ti (BASETIME)**

### Down Mode Options:
- 2 OMS → 1 OMS
- 1 OMS → RCS
- NONE

### TIDELEY
- **ΔVX 19 ( )**
- **ΔVY 20 ( )**
- **ΔVZ 21 ( )**

### NEW Ti (BASETIME)

### New Ti (BASETIME)

### TIDELEY

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<th>RCS SEL 4</th>
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**NOTES**

- MAX TIG SLIP ___ MIN.
- DO NOT UPDATE TIG
- UPDATE TIG AFTER ___ MIN.
**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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**TV ROLL 5**

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

**WT 9**

<table>
<thead>
<tr>
<th>TIG 10</th>
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</table>

**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**

| ( ) |

**NOTES**

**RCS I’CNCT:**

| L PRI |
| L SEC |
| R PRI |
| R SEC |

**NONE**

**OMS GMBL CK:**

| PRE |
| POST-BURN |

**RCM HE REG TEST:**

| NONE |

**-X RCS BURNS:**

| BURN ATT | LVLH ATT |
| P 15     | R       |
| Y 16     | P       |
| OM 17    | Y       |

**ORBIT BURN MONITOR**

| GPC FILL-INS ( ) |

| CRIT BURN |
| NON-CRIT BURN |

**DOWN MODE OPTIONS:**

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

**MAX TIG SLIP ___ MIN.**

**DO NOT UPDATE TIG**

**UPDATE TIG AFTER ___ MIN.**

**3-10**

**RNDZ/115/FIN 1**
### ORBIT MANEUVER PAD FOR ____________

#### OMS BOTH
- 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

#### ∆VX
- 19

#### ∆VY
- 20

#### ∆VZ
- 21

#### BURN ATT
- R 24
- P 25
- Y 26

#### ∆VTOT

#### TGO

#### VGO
- X ( )
- Y ( )
- Z ( )

#### HA
- HP

#### TGT
- ( )

#### OMS GMBL CK:
- PRE
- POST-BURN

#### RCS I’CNCT:
- L PRI
- L SEC
- R PRI
- R SEC

#### NONE

#### OMS HE REG TEST:
- GPC
- L OP
- CL
- R
- GPC
- OP
- CL

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

#### ORBIT BURN MONITOR
- GPC FILL-INS ___ ( )

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

#### MAX TIG SLIP ___ MIN.

#### DO NOT UPDATE TIG

#### UPDATE TIG AFTER ___ MIN.
RENDEZVOUS TIMELINE
This Page Intentionally Blank
**AFT FLT STATION CONFIG FOR RNDZ**

<table>
<thead>
<tr>
<th>Area</th>
<th>Settings</th>
</tr>
</thead>
</table>
| A6U  | ADI ATT  - LVLH  
ERR    - MED  
RATE   - LO  
SENSE  - minus Z |
| R13  | KU ANT    - GND |
| A1U  | PWR       - STBY  
sel     - MAN SLEW  
MODE    - RDR PASSIVE |
|      | RADAR OUTPUT - HI  
CNTL    - PNL (wait 3 seconds)  
PWR     - ON  
SIG STRENGTH sel - KU  
SLEW RATE - as reqd |
| A2   | DIGI-DIS sel - R/RDOT  
X-PNTR SCALE - X1  
**SM ANTENNA** |
| CRT  | CRT SELF TEST - ITEM 7 EXEC (*)  
**NOTE**  
SELF TEST runs about 3 min |
| A1U  | KU SCAN WARN tb - gray  
√ TRACK tb - gray  
√ SEARCH tb - gray |
| A2   | RANGE - 888.8  
DIGI-DIS sel - EL/AZ |
| CRT  | SELF TEST - ITEM 7 EXEC (no *) |
| A1U  | KU MODE - COMM  
sel - GPC  
CNTL - CMD |

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

- **03:00**
  - CDR, AFT FLT STATION CONFIG FOR RNDZ
  - PLT, RNDZ OPS INITIALIZATION

- **02:55**
  - MS, Perform 6.105 SSOR ACTIVATION, steps 1 and 2 (SODF: JOINT OPS, COMM/DATA)

- **02:50**
  - CDR,_if NH reqd:
    - If OMS BURN, Perform RNDZ OMS BURN, steps 1-4 (CONTINGENCY OPS), 5-4
    - If +X RCS burn, Perform RCS BURN, steps 1-5 (Cue Card)
    - Postburn DAP: A/LVLH/VERN(ALT)

- **02:45**

- **02:40**

- **02:35**

**MCC UPDATE**

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

**ORB SV**

**TGT SV**

**Drag K-factor**

**RNDZ OPS INITIALIZATION**

- **DPS Config for Rndz Ops - String 1233**

- **SM 2 TIME**
  - Set SM TIMER counting to Ti TIG per burn Pad, 3-6
  - Config DAP A,B to A7,B7
  - Record nominal TIGs in burn solution blocks per Execute Package:
    - NCC TIG, pg 4-11
    - MC1 TIG, pg 4-17
    - MC2 TIG, pg 4-18

- **GNC 55 GPS STATUS**
  - DES RCVR, ITEM 27 - (+)
  - INH GPS to G&C, ITEM 33 - (+)
  - NAV, ITEM 36 - (+)
RENDEZVOUS TIMELINE

PET
-02:30
A7(B7)

-02:25
TIG-5 MIN

-02:20
If reqd,
[NH_TIG]
Postburn DAP: A/LVLH/VERN(ALT)

-02:15
PLT ENABLE RENDEZVOUS NAV [7A]
MS PGSCs setup per PGSC Usage Chart (if available) or UTILITY OUTLET PLUG-IN
PLAN ORBIT CONFIGURATION (REF DATA FS, UTIL PWR)
PLT, On RPOP PGSCs:
MS Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-8, 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

MCC UPDATE
Final NC Burn Pad, 3-3

ENABLE RENDEZVOUS NAV [7A]
1. [GNC_33__REL_NAV]
   CRT RNDZ NAV ENA - ITEM 1 EXEC (*)
   √ SV SEL, ITEM 4 - PROP
   √ INH RNG, ITEM 18 - (*)
   RDOT, ITEM 21 - (*)
   Angles, ITEM 24 - (*)
   √ S TRK, ITEM 12 - (*)

2. [GNC_34__ORBIT_TGT]
   TGT NO - ITEM 1 +1 EXEC
   Set BASE TIME to Ti TIG, (Ti Burn Pad, 3-6)
   LOAD - ITEM 26 EXEC
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

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)

Load TARGET TRACK 9A

Do not INITIATE TARGET TRACK 9B until post NC

TARGET NCC BURN 11A (Preliminary), 4-11

NOTE
If NH performed, delay mnvr to NC burn attitude until NC TIG - 5 min to minimize attitude mnvr
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,
     - SV SEL, ITEM 4 - PROP
   - If previous NAV,
     - SV SEL, ITEM 4 - FLTR
   - INH Angles, ITEM 24 - (*)
   - S TRK, ITEM 12 - (*)

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

2. **INITIAL MEASUREMENT EVALUATION**

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

   **GNC 33 REL NAV**
   - Monitor RESID V and H each NAV cycle for at least four consecutive cycles (~30 sec)
   - Record init RESID V = ____________
   - 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**
   - 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 (+)
   - When SV UPDATE POS = ____________
   - If FLTR MINUS PROP changes by more than 8 kft within a S TRK pass: *
   - Perform S TRK NAV - HIGH FLTR MINUS PROP *
   - (CONTINGENCY OPS), 5-9

**END S TRK NAV**

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

   **GNC 21 IMU ALIGN**
   - CRT IMU DES - ITEM 7(8,9) EXEC (no *)
**RENDZVOUS TIMELINE**

---

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

**CRT**
- SV SEL correct
- GNC 34 ORBIT TGT
- TGT NO - ITEM 1 +9 EXEC

**MCC UPDATE**
- Ground NCC Burn Solution

---

**FINAL SOLUTION**
- T1 TIG = NCC BURN SOLUTION TIG
  - EL = +0
  - ΔT = -77.7
  - ΔX = -48.6
  - ΔY = +0.0
  - ΔZ = +1.2
- COMPUTE T1 - ITEM 28 EXEC
- Record solution in PAD

---

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

---

**MCC UPDATE**
- Nav Selected IMU

---

**FINAL SOLUTION**
- GNC 34 ORBIT TGT
- TGT NO - ITEM 1 +9 EXEC

**MCC UPDATE**
- Ground NCC Burn Solution

---

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

---

**NCC BURN SOLUTION**
- TIG

---

**NCC BURN SOLUTION**
- ΔVX
  - PRELIMINARY
    - ( )
    - ( )
  - INTERMEDIATE
    - ( )
    - ( )
  - FINAL
    - ( )
    - ( )

---

**NCC BURN SOLUTION**
- ΔVY
  - PRELIMINARY
    - ( )
    - ( )
  - INTERMEDIATE
    - ( )
    - ( )
  - FINAL
    - ( )
    - ( )

**NCC BURN SOLUTION**
- ΔVZ
  - PRELIMINARY
    - ( )
    - ( )
  - INTERMEDIATE
    - ( )
    - ( )
  - FINAL
    - ( )
    - ( )

**NCC BURN SOLUTION**
- ΔVT
  - PRELIMINARY
    - ( )
    - ( )
  - INTERMEDIATE
    - ( )
    - ( )
  - FINAL
    - ( )
    - ( )

---

**NCC BURN SOLUTION**
- FINAL - GROUND LIMITS
  - ΔVX
    - (0.6)
  - ΔVY
    - (1.5)
  - ΔVZ
    - (1.9)
  - ΔVT
    - ( )
### -Z AXIS TARGET TRACK 12A

<table>
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<th>CRT</th>
<th>TGT ID</th>
<th>BODY VECT</th>
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<td>+1 (-Z)</td>
<td>+0</td>
<td>TRK - ITEM 19 EXEC (CUR - *)</td>
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When MNVR cmplt, DAP: A/AUTO/VERN(ALT)
RENNDEZVOUS TIMELINE

When NAV converged (SV UPDATES small and stable):

PLT  TARGET Ti BURN  [13A]  (Intermediate)

RR NAVIGATION  [13B]

When:  
\[ \text{GNC 33 REL NAV} \]

NAV RNG < 150 KFT:  

MS  KU OPS, step 1 (Cue Card)

When RR RNG < 135 KFT:

PLT  Perform RR NAVIGATION  [13B]

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

MS  KU OPS, step 2 (Cue Card)

PET

-01:00
A7(B7)

-00:55
PLT  TARGET Ti BURN  [13A]  (Preliminary)

MCC UPDATE
RNDZ PRPLT PAD

If Y STRK TRACK

CDR  2 AXIS TARGET TRACK  [12A]

When:

\[ \text{GNC 33 REL NAV} \]

NAV RNG < 150 KFT:  

MS  KU OPS, step 1 (Cue Card)

TARGET Ti BURN  [13A]  (Preliminary)

CRT  \[ \sqrt{\text{SV SEL correct}} \]

\[ \text{GNC 34 ORBIT TGT} \]

TGT NO - ITEM 1 +10 EXEC

\[ \sqrt{\text{TGT Set data:}} \]

\[ T1 TIG = \text{BASE TIME} \]

\[ EL = 0 \]

\[ \Delta T = 76.9 \]

\[ \Delta X = -0.9 \]

\[ \Delta Y = 0 \]

\[ \Delta Z = 1.8 \]

COMPUTE T1 - ITEM 28 EXEC

Record solution in PAD

IF RESID RANGE > 5.0 or RDOT > 3.0

SV SEL - ITEM 4 EXEC (PROP)

Proceed with taking data and contact MCC as soon as practical

FLTR TO PROP - ITEM 8 EXEC

AUTO RNG - ITEM 17 EXEC (*)

RDOT - ITEM 20 EXEC (*)

Angles - ITEM 23 EXEC (*)

Record 1st SV UPDATE POS = 

IF SV SEL = PROP

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

SV SEL - ITEM 4 EXEC (FLTR)
RENDEZVOUS TIMELINE

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

CDR
- If Ti is +X RCS burn:
  - Perform RCS BURN (Cue Card)
- If Ti is OMS BURN:
  - Perform RNDZ OMS BURN (CONTINGENCY OPERATIONS), 5-4

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

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

TARGET Ti BURN [15A] (Final)

CRT
- OPS 202 PRO
- GNC ORBIT MNRV EXEC
  - Load Eng Sel, TVR, WT and Trims for Ti per Final Ti Burn Pad
- LOAD - ITEM 22 EXEC
- GNC 33 REL NAV
  - SV SEL correct
- GNC 34 ORBIT TGT
  - TGT NO - ITEM 1 +1 0 EXEC

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 \( \Delta V_s \)
**POST Ti NAV** 16A

<table>
<thead>
<tr>
<th>A6U</th>
<th>√DAP: A/AUTO/VERN(ALT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1U</td>
<td>√KU sel - GPC</td>
</tr>
</tbody>
</table>

**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/CAS 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**

<table>
<thead>
<tr>
<th>TGT ID</th>
<th>+1</th>
</tr>
</thead>
<tbody>
<tr>
<td>BODY VECT</td>
<td>+4</td>
</tr>
<tr>
<td>P</td>
<td>(+0)</td>
</tr>
<tr>
<td>Y</td>
<td>(+280.57)</td>
</tr>
<tr>
<td>OM</td>
<td>(+90)</td>
</tr>
</tbody>
</table>

DAP: B/AUTO/ALT  
TRK - ITEM 19 EXEC  
When MNVR cmplt:  
DAP: A/AUTO/VERN(ALT)  
Perform STAR TRACKER NAV 10A
**RENDZEVOUS TIMELINE**

**00:00**
- PLT: TARGET MC 1 BURN [17A] (Preliminary)
- TIG-3 MIN

**00:05**
- CDR: POST Ti NAV [16A]

**00:10**
- When NAV converged, (SV UPDATES small and stable):
  - PLT: TARGET MC 1 BURN [17A] (Intermediate)
  - MS: √Time of OOP null

**00:15**
- T1 TIG

**00:20**
- PLT: TARGET MC 2 BURN [17B] (Preliminary)

**00:25**
- When Y = 0:
  - PLT: MANUAL OUT-OF-PLANE NULL [19A]

**00:30**
- MC 1 TIG

---

**TARGET MC 1 BURN [17A]**

CRT: √SV SEL correct

<table>
<thead>
<tr>
<th>GNC 34 ORBIT TGT</th>
<th>TGT NO - ITEM 1 + 1 EXEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>TGT Set data:</td>
<td>T1 TIG = MC1 BURN SOLUTION TIG</td>
</tr>
<tr>
<td>EL</td>
<td>+76.9 ± 0.9</td>
</tr>
<tr>
<td>ΔT</td>
<td>+29.0, 27.0</td>
</tr>
<tr>
<td>ΔX</td>
<td>+27.0</td>
</tr>
<tr>
<td>ΔY</td>
<td>+0.0</td>
</tr>
<tr>
<td>ΔZ</td>
<td>+1.8</td>
</tr>
<tr>
<td>COMPUTE T1 - ITEM 28 EXEC</td>
<td></td>
</tr>
<tr>
<td>Record solution in PAD</td>
<td></td>
</tr>
</tbody>
</table>

**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></td>
<td>-0.1 ± (0.5)</td>
</tr>
<tr>
<td>ΔVY</td>
<td></td>
<td></td>
<td></td>
<td>+0.0 ± (0.4)</td>
</tr>
<tr>
<td>ΔVZ</td>
<td></td>
<td></td>
<td></td>
<td>+0.3 ± (1.5)</td>
</tr>
<tr>
<td>ΔVT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

CRT: √SV SEL correct

<table>
<thead>
<tr>
<th>GNC 34 ORBIT TGT</th>
<th>TGT NO - ITEM 1 + 1 EXEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>TGT Set data:</td>
<td>T1 TIG = MC2 BURN SOLUTION TIG</td>
</tr>
<tr>
<td>EL</td>
<td>+27.0 ± 0.9</td>
</tr>
<tr>
<td>ΔT</td>
<td>+27.0</td>
</tr>
<tr>
<td>ΔX</td>
<td>+0.0</td>
</tr>
<tr>
<td>ΔY</td>
<td>+1.8</td>
</tr>
<tr>
<td>ΔZ</td>
<td>+1.8</td>
</tr>
<tr>
<td>COMPUTE T1 - ITEM 28 EXEC</td>
<td></td>
</tr>
<tr>
<td>NOTE</td>
<td></td>
</tr>
<tr>
<td>If TGT EL ANG Alarm, ΔV still valid for current TIG, TIG slip limits still apply</td>
<td></td>
</tr>
<tr>
<td>Record solution in PAD</td>
<td></td>
</tr>
<tr>
<td>Target MC 2 Burn (Intermediate)</td>
<td>Target MC 2 Burn (Final)</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>CRT SV SEL correct</td>
<td>CRT SV SEL correct</td>
</tr>
<tr>
<td>[GNC 34 ORBIT TGT] TGT NO - ITEM 1 +1 2 EXEC</td>
<td>[GNC 34 ORBIT TGT] TGT NO - ITEM 1 +1 2 EXEC</td>
</tr>
<tr>
<td>COMPUTE T1 - ITEM 28 EXEC</td>
<td>√ TIG change</td>
</tr>
<tr>
<td>Record solution in PAD</td>
<td>IF TIG CHANGE &lt; -3 OR &gt; +7 MIN</td>
</tr>
<tr>
<td></td>
<td>Set BASE TIME to (Nominal MC 2 TIG -3 or +7 min as appropriate)</td>
</tr>
<tr>
<td></td>
<td>LOAD - ITEM 26 EXEC</td>
</tr>
<tr>
<td></td>
<td>TGT NO - ITEM 1 +1 2 EXEC</td>
</tr>
<tr>
<td>√ TIG change</td>
<td>TGT Set data:</td>
</tr>
<tr>
<td></td>
<td>T1 TIG = BASE TIME</td>
</tr>
<tr>
<td></td>
<td>EL +0</td>
</tr>
<tr>
<td></td>
<td>ΔT +27.0</td>
</tr>
<tr>
<td></td>
<td>ΔX -0.9</td>
</tr>
<tr>
<td></td>
<td>ΔY +0</td>
</tr>
<tr>
<td></td>
<td>ΔZ +1.8</td>
</tr>
<tr>
<td>COMPUTE T1 - ITEM 28 EXEC</td>
<td>Record solution in PAD</td>
</tr>
<tr>
<td></td>
<td>GNC 33 REL NAV</td>
</tr>
<tr>
<td>CRT FLTR TO PROP - ITEM 8 EXEC</td>
<td>END S TRK NAV [18C]</td>
</tr>
</tbody>
</table>

**MC 2 Burn Solution**

<table>
<thead>
<tr>
<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>+0.0 ± (0.4)</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>

**TIG Slip (Computed-Nom)**

<table>
<thead>
<tr>
<th>Preliminary</th>
<th>Intermediate</th>
<th>Final</th>
<th>Nominal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Nighttime Strk Ops [18E]**

1. [GNC 33 REL NAV] INH Angles - ITEM 24 EXEC (+)
   - At sunset,
   - [GNC 22 S TRK/COAS CNTL] -Z(-Y) THOLD - ITEM 14(13) +0 EXEC

2. Perform STAR TRACKER NAV [10A], steps 2 and 3

**Z Axis Target Track [18D]**

- Inh Angles - ITEM 24 EXEC (+)
  - GNC 21 IMU ALIGN
  - IMU DES - ITEM 7(8,9) EXEC (no *)
  - GNC UNIV PTG
  - CRT TGT ID
  - BODY VECT +3 (-Z)
  - OM +0
  - DAP: B/AUTO/ALT
  - TRK - ITEM 19 EXEC (CUR - *)
  - When MNVR cmplt, DAP: A/AUTO/VERN(ALT)
**RENDEZVOUS TIMELINE**

**PET**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:30</td>
<td>MS Perform 6.105 SSOR ACTIVATION, step 3 (SODF: JOINT OPS, COMM/DATA)</td>
</tr>
<tr>
<td>00:35</td>
<td>A7(B7)</td>
</tr>
</tbody>
</table>

**MC2 ET**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:40</td>
<td>On RPOP PGSC: Perform TCS ACTIVATION, steps 2-4 (RNDZ TOOLS), 7-2</td>
</tr>
<tr>
<td></td>
<td>(Set AUTO ACQ to 10,000 ft)</td>
</tr>
</tbody>
</table>

**00:45**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TIG-5 MIN</td>
</tr>
<tr>
<td></td>
<td>PLT TARGET MC 2 BURN (Final) Perform RCS BURN (Cue Card)</td>
</tr>
</tbody>
</table>

**00:50**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PLT TARGET MC 3 BURN (Preliminary)</td>
</tr>
</tbody>
</table>

**00:55**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IF INITIAL RR ACQ POST-MC2</td>
</tr>
<tr>
<td></td>
<td>CDR Perform LATE RR NAV (20E)</td>
</tr>
<tr>
<td></td>
<td>MS When RNG &lt; 10,000 ft: SSOR comm check with ISS</td>
</tr>
</tbody>
</table>

**01:00**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IF -Y S TRK TRACK</td>
</tr>
<tr>
<td></td>
<td>PLT END STAR TRACKER NAV (18C)</td>
</tr>
</tbody>
</table>

**TARGET MC 3**

<table>
<thead>
<tr>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF -Y S TRK TRACK</td>
</tr>
<tr>
<td>PLT END STAR TRACKER NAV (18C)</td>
</tr>
</tbody>
</table>

**MC 3 BURN SOLUTION**

<table>
<thead>
<tr>
<th>TIG</th>
<th>PRELIMINARY</th>
<th>FINAL</th>
<th>MEAN ± (3σ VARIATION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔX</td>
<td></td>
<td></td>
<td>+0.5 ± (1.8)</td>
</tr>
<tr>
<td>ΔY</td>
<td></td>
<td></td>
<td>+0.0 ± (0.5)</td>
</tr>
<tr>
<td>ΔZ</td>
<td></td>
<td></td>
<td>+0.6 ± (2.6)</td>
</tr>
<tr>
<td>ΔT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MANUAL OUT-OF-PLANE NULL**

<table>
<thead>
<tr>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF INITIAL RR ACQ POST-MC2</td>
</tr>
<tr>
<td>CDR Perform LATE RR NAV (20E)</td>
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<tr>
<td>MS When RNG &lt; 10,000 ft: SSOR comm check with ISS</td>
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<tbody>
<tr>
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<tr>
<td>PLT END STAR TRACKER NAV (18C)</td>
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</table>

**TARGET MC 3**

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<td>CDR Perform LATE RR NAV (20E)</td>
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<td>MS When RNG &lt; 10,000 ft: SSOR comm check with ISS</td>
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<tbody>
<tr>
<td>IF -Y S TRK TRACK</td>
</tr>
<tr>
<td>PLT END STAR TRACKER NAV (18C)</td>
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**MC 3 BURN SOLUTION**

<table>
<thead>
<tr>
<th>TIG</th>
<th>PRELIMINARY</th>
<th>FINAL</th>
<th>MEAN ± (3σ VARIATION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔX</td>
<td></td>
<td></td>
<td>+0.5 ± (1.8)</td>
</tr>
<tr>
<td>ΔY</td>
<td></td>
<td></td>
<td>+0.0 ± (0.5)</td>
</tr>
<tr>
<td>ΔZ</td>
<td></td>
<td></td>
<td>+0.6 ± (2.6)</td>
</tr>
<tr>
<td>ΔT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MANUAL OUT-OF-PLANE NULL**

<table>
<thead>
<tr>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF INITIAL RR ACQ POST-MC2</td>
</tr>
<tr>
<td>CDR Perform LATE RR NAV (20E)</td>
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<tr>
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<table>
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<tr>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF -Y S TRK TRACK</td>
</tr>
<tr>
<td>PLT END STAR TRACKER NAV (18C)</td>
</tr>
</tbody>
</table>
**MC 4 BURN SOLUTION**

<table>
<thead>
<tr>
<th>TIG</th>
<th>Preliminary</th>
<th>Final</th>
<th>Mean ± 3σ Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔVX</td>
<td>( )</td>
<td>( )</td>
<td>+0.8 ± (2.4)</td>
</tr>
<tr>
<td>ΔVY</td>
<td>( )</td>
<td>( )</td>
<td>+0.0 ± (0.5)</td>
</tr>
<tr>
<td>ΔVZ</td>
<td>( )</td>
<td>( )</td>
<td>+0.5 ± (3.6)</td>
</tr>
</tbody>
</table>

**TARGET MC 4 BURN**

- SV SEL correct
- GNC_34__ORBIT_TGT
- TGT NO - ITEM 1 + 1.4 EXEC
- T1 TIG = BASE TIME + 0:00:27:00
- EL +0
- ΔX +0
- ΔY +0
- ΔZ +0.6
- COMPUTE T1 - ITEM 28 EXEC

**ESTABLISH RBAR**

- A6U FLT CNTLR PWR - ON
- GNC UNIV PTG
- TRK - ITEM 19 EXEC (CUR - *)
- DAP: A/AUTO/VERN (PRI)
- THC: as reqd to control TGT motion in COAS

**CONFIG FOR RBAR**

- GNC UNIV PTG
- ERR TOT - ITEM 23 EXEC (*)
- Config DAP A,B to A8,B8

**LATE RADAR NAV**

- GNC_33__REL_NAV
- FLTR TO PROP - ITEM 8 EXEC
- SV SEL, ITEM 4 - PROP
- RR - ITEM 13 EXEC (*)
- AUTO RNG - ITEM 17 EXEC (*)
- RDOT - ITEM 20 EXEC (*)
- Angles - ITEM 23 EXEC (*)

- Go to RADAR FAIL PROCEDURE 20D

**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):
   - TARGET MC3 [19B] (final)
   - CDR: Perform RCS BURN (Cue Card)

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

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

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

3. At MC2 TIG + 24:00 or 2000 ft, whichever comes first:
   - GNC UNIV PTG
   - 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 WITH RPM (Cue Card)

**RENDZVOUS TIMELINE**
RENNDEZVOUS TIMELINE

01:00
A7(B7)

PET

00:10

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

01:05
A8(B8)

MC2 ET

00:15

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

01:10

MC 3 TIG

00:20

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

01:15

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

01:20

MC 4 TIG

00:25

CDR ESTABLISH RBAR [20C]

If RPM:
| Perform APPROACH WITH RPM (Cue Card)
If No RPM:
| Perform APPROACH (Cue Card)

01:25

00:30

01:30

00:40

Manual Trajectory Control

CREW REPORT
ISS tally-ho

HHL REPORT
R and Rdot

/\barb4left
[MC_3_TIG]

/\barb4left
[MC_4_TIG]
TERMINATE RNDZ OPS

1. **ORBITER CONFIG FOR MATED ATTITUDE CONTROL**

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

   **CDR**
   - A6U

   **PLT**
   - √ FLT CNTRL PWR - OFF
   - [GNC_20 DAP_CONFIG]
     - Config DAP A,B to A12,B12
     - X JET ROT ENA - ITEM 7 EXEC (+)
     - EDIT A9 - ITEM 3 + 9 EXEC
     - PRI RATE DB - ITEM 5 EXEC
     - LOAD - ITEM 5 EXEC
     - PRI RATE DB - ITEM 52 + 0.2 EXEC
     - LOAD - ITEM 5 EXEC
     - DAP: LO Z
     - If Loss of Verns:
       - [SM 167 DOCKING STATUS]
         - 12 hooks closed
       - DAP: B/ALT
       - DAP: LVLH
       - If VERN:
         - DAP: LVLH
       - If ISS attitude control required:
         - Perform 3.111 HANDOVER ATTITUDE CONTROL ORBITER TO CMG TA. (SODF: JOINT OPS, MATED OPERATIONS)

   **GNC 23 RCS**
   - CRT RCS F – ITEM 1 EXEC (+)
   -_jet des F1L – ITEM 9 EXEC (+)
   - F3L – ITEM 11 EXEC (+)
   - F2R – ITEM 13 EXEC (+)
   - F4R – ITEM 15 EXEC (+)
   - F1U – ITEM 17 EXEC (+)
   - F3U – ITEM 19 EXEC (+)
   - F2U – ITEM 21 EXEC (+)

   **GNC 20 DAP_CONFIG**
   - CRT -Z(-Y) STAR TRK - ITEM 4(3) EXEC (+)
   - -Y THOLD - ITEM 13 + 9 EXEC
   - -Z THOLD - ITEM 14 + 9 EXEC
   - [GNC 55 GPS STATUS]
   - DES RCVR - ITEM 27 (no +)
   - [GNC 33 REL NAV]
   - RNDZ NAV ENA - ITEM 1 EXEC (no +)

2. **ORBITER CONFIG FOR MATED OPS**

   **MS**
   - A6L

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

RETURN TO FLIGHT PLAN
<table>
<thead>
<tr>
<th>Contingency Ops</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>RNDZ OMS Burn</td>
<td>5-3</td>
</tr>
<tr>
<td>Sensor Fail</td>
<td>5-7</td>
</tr>
<tr>
<td>S TRK NAV – HIGH INITIAL RESID</td>
<td>5-8</td>
</tr>
<tr>
<td>FLTR MINUS PROP</td>
<td>5-9</td>
</tr>
<tr>
<td>COAS Navigation</td>
<td>5-10</td>
</tr>
<tr>
<td>Backout/Breakouts</td>
<td>5-11</td>
</tr>
<tr>
<td>VBAR Corridor Breakout</td>
<td>5-12</td>
</tr>
<tr>
<td>Breakout</td>
<td>5-14</td>
</tr>
<tr>
<td>Shuttle Nose In-Plane Breakout (R &lt; 700 ft)</td>
<td>5-16</td>
</tr>
<tr>
<td>RNDZ Breakout</td>
<td>5-18</td>
</tr>
<tr>
<td>Expedited SEPS</td>
<td>5-19</td>
</tr>
<tr>
<td>Shuttle Emergency Separation</td>
<td>5-21</td>
</tr>
<tr>
<td>Any Attitude Separation</td>
<td>5-23</td>
</tr>
<tr>
<td>Ti Delay Burn</td>
<td>5-27</td>
</tr>
<tr>
<td>RNDZ NAV Recovery</td>
<td>5-29</td>
</tr>
<tr>
<td>TGT ITER</td>
<td>5-30</td>
</tr>
<tr>
<td>Loss of Comm</td>
<td>5-31</td>
</tr>
<tr>
<td>Degraded Control</td>
<td>5-33</td>
</tr>
<tr>
<td>Degraded +X Translation</td>
<td>5-35</td>
</tr>
<tr>
<td>-X Translation</td>
<td>5-36</td>
</tr>
<tr>
<td>Loss of Forward Side-Firing Jets</td>
<td>5-37</td>
</tr>
<tr>
<td>ONE FxD JET</td>
<td>5-38</td>
</tr>
<tr>
<td>BOTH FxD JETS (SAMESIDE)</td>
<td>5-39</td>
</tr>
<tr>
<td>VRCS</td>
<td>5-41</td>
</tr>
</tbody>
</table>
1. OMS BURN PREP
   C2 Wedge
   Install OMS2/ORBIT OMS BURNS (Cue Cards) (two) and
   ORBIT BURN MONITOR (Cue Cards) (two) (F6,F8)
   1: GNC 20 DAP CONFIG
   CRT1
   √DAP config A7,B7
   GNC, OPS 202 PRO
   1: GNC ORBIT MNVR EXEC
   2: GNC SYS SUMM 2

2. LOAD TGT DATA
   If onboard computed burn:
   √Eng sel, TV ROLL, TRIM LOAD, and WT per Burn Pad
   √TIG and TGT PEG 7 ΔVs per Final ORBIT TGT solution
   √Guidance option is LAMBERT
   If ground computed burn:
   √TGT data per Burn Pad (reload WT as reqd)
   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC
   √Burn data
   C3
   DAP: A/AUTO/ALT(B/ALT as reqd)
   CRT1
   MNVR – ITEM 27 EXEC (*)
   If RR ops:
   A1U
   KU sel – AUTO TRK
   1: GNC 33 REL NAV
   CRT1
   INH Angles – ITEM 24 EXEC (*)
   1: GNC ORBIT MNVR EXEC
   When mnvr to att complete:
   √DAP: A/AUTO/ALT

3. PERFORM RNDZ OMS BURN
   CAUTION
   LAMBERT burn must be completed by
   T1 TIG + 1:30 to avoid guidance errors
   * If start of LAMBERT burn delayed: *
   * Retarget burn, then go to step 2 *
   TIG-3 F6,F8
   FLT CNTLR PWR (two) – ON
   Perform OMS2/ORBIT OMS BURNS (Cue Card)
4. **OMS POST BURN RECONFIGURATION**

- **F6,F8**: FLT CNTLR PWR (two) – OFF
- **O8**: L,R OMS He PRESS/VAP ISOL (four) – CL

- **C3**
  - DAP: B/INRTL/ALT
  - DAP TRANS: PULSE/PULSE/PULSE

- **CRT1**
  - RCS SEL – ITEM 4 EXEC (*)
  - Perform OMS TVC GMBL CK per Burn Pad

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

GNC, OPS 201 PRO

5. **MNVR TO POST BURN ATTITUDE**

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

- **C3**
  - DAP: B/AUTO/ALT

- **A1U**
  - KU sel – GPC
  - KU TRACK tb – gray

- **CRT1**
  - AUTO Angles – ITEM 23 EXEC (*)
  - 1: GNC UNIV PTG

When in attitude and rates nulled:

- **C3**
  - DAP: A/AUTO/VERN(ALT)
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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**
   
   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]

   CRT2: -Y BREAK TRK – ITEM 7 EXEC
   
   When S PRES – (*):
   
   CRT1: Monitor RESID V and H. Repeat BREAK TRK as reqd until stable lock-on
   
   Go to STAR TRACKER NAV, step 2 [10A]

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

   CRT2: Other IMU – des,sel
   
   CRT1: Record RESID V ______ and H ______

4. RESUME PASS
   
   Continue with pass per STAR TRACKER NAV, step 3 [10A], then:
   
   After S TRK pass, on MCC GO:
   
   **NOTE**
   
   SELF-TEST may false fail. \(\sqrt{\text{MCC for S TRK status}}\)

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

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

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

   When TGT centered in COAS, ATT REF pb – push
   GNC 33 REL NAV
   CRT
   If X and Y RESID magnitudes ≥ 1.0:
   | √MCC
   If X and Y RESID magnitudes < 1.0:
   FOR – ITEM 25 EXEC
   √SV UPDATE – non-zero (within 8 sec), then
   – 0.0 (after 8 sec more)

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

At sunset,

3. END COAS NAV
   A6U
   DAP: A7/AUTO/VERN(ALT)
   FLT CNTLR PWR – OFF
   GNC 22 STRK/COAS CNTL
   CRT
   COAS: DES – ITEM 25 EXEC (*)
   Resume rendezvous timeline
BACKOUT/BREAKOUTS
CAUTION

Constraints for use:
Orbiter on + Vbar in approach corridor

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

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

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

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

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

   When RNG > 50 ft:
       DAP config: A9/B9
       [GNC 23 RCS]
       RCS F – ITEM 1 EXEC (*)
       JET DES F1F – ITEM 31 EXEC (no *)
       F2F – ITEM 35 EXEC (no *)

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

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

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

   DAP: B(A)

   When opening rate established and RNG > 150:
3. PERFORM CORRIDOR BACKOUT OR BREAKOUT

   If BREAKOUT desired:
   Go To VBAR BREAKOUT, 5-14 >>
   Else:
       Maintain 8 deg corridor

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

Cont next page
4. **REAPPROACH**
   DAP: AUTO

   Go to **VBAR APPROACH** (Cue Card) from current stationkeeping range
VBAR BREAKOUT

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

   DAP: B(A)

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

     DAP TRANS: NORM/PULSE/PULSE
     THC: +X (up) for 6 sec (1.5 fps)
     DAP TRANS: PULSE/PULSE/PULSE
     FLT CNTLR PWR – OFF
     DAP: A/INRTL/VERN(ALT)

     Record Radial Burn TIG ___/___:___:

     Inform MCC when SEP complete

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

   NOTE
   Posigrade burn performed if second docking attempt desired

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

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

   Set TIG to Radial Burn +28 min:
   If Posigrade Sep:
     TGT PEG 7 ∆VX – ITEM 19 +3 EXEC
     ∆VY – ITEM 20 +0 EXEC
     ∆VZ – ITEM 21 +0 EXEC
   If Retrograde Sep:
     TGT PEG 7 ∆VX – ITEM 19 -3 EXEC
     ∆VY – ITEM 20 +0 EXEC
     ∆VZ – 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)**

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constraints for use:</td>
</tr>
<tr>
<td>Orbiter X and Z axes in-plane</td>
</tr>
<tr>
<td>Range ≤ 700 ft cg to cg*</td>
</tr>
<tr>
<td>Tgt stable on orbiter -Z axis</td>
</tr>
<tr>
<td><em>On approach use RNDZ Breakout until TORVA init (+X burns to start TORVA are complete)</em></td>
</tr>
</tbody>
</table>

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

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 CNTLR 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 ΔVX – ITEM 19 +4.3 EXEC |
| ΔVY – ITEM 20 +3.6 EXEC |
| ΔVZ – ITEM 21 +0 EXEC |

If Retrograde Sep:

| TGT PEG 7 ΔVX – ITEM 19 -4.3 EXEC |
| ΔVY – ITEM 20 +3.6 EXEC |
| ΔVZ – ITEM 21 +0 EXEC |

TV ROLL – ITEM 5 + __ EXEC

LOAD – ITEM 22 EXEC

TIMER – ITEM 23 EXEC

Config DAP A,B to A7,B7

At TIG -8 min:

DAP:  B/ALT, NO LO Z

MNVR – ITEM 27 EXEC (*)

DAP:  AUTO

At TIG -0:30:

DAP TRANS:  as reqd

DAP:  A/INRTL/PRI

F7  FLT CNTLR PWR – ON

At TIG, THC:  Trim VGOs ≤ 0.2 fps

F7  FLT CNTLR PWR – OFF

DAP TRANS:  PULSE/PULSE/PULSE

DAP:  A/INRTL/VERN(ALT)

GNC, OPS 201 PRO

On MCC call:

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

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

2. 3 FPS RETROGRADE
   CRT
   OPS 202 PRO
   [GNC ORBIT MNVR EXEC]
   \sqrt{RCS\ SEL} – ITEM 4 (*)
   Set TIG to current time
   TGT PEG 7 \Delta V_X – ITEM 19 -3 EXEC
   \Delta V_Y – ITEM 20 +0 EXEC
   \Delta V_Z – 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:
- Mated stack within 30 deg of ±Vbar attitude
- Attitude rates ≤0.12 deg/axis
- Initial separation includes APDS spring pushoff
- Nominal Undock Orbiter DAP and RCS config

1. INITIAL SEPARATION SEQUENCE
When petals clear:
   DAP: B9/LVLH/ALT
   √DAP TRANS: PULSE/PULSE/PULSE, no LO Z
   THC: as reqd to maintain target within 8 degree corridor on C/L camera or COAS
     NOTE: DAP A allowed for ±X and -Z (in) THC

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

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

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

When RNG > 75 ft (DP–DP):
   DAP: LO Z
     NOTE: DAP A allowed for ±X and ±Z THC

When RNG > 100 ft (DP–DP):
   If radar desired, perform INIT RADAR ACQ 9A, 2-9
   Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6

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

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

   Inform MCC when burn complete

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

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

**NOTE:** Final burn TIG should be NET Radial Burn TIG + 13 min and NLT Radial Burn TIG + 60 min

If performing emergency deorbit:
\[ \text{√MCC/PGSC for deorbit burn TIG/PAD} \]
TV ROLL – ITEM 5 + 180 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:
\[ \text{√MCC for} +X \text{burn TIG and direction} \]
**NOTE:** Posigrade burn should be performed if second docking attempt desired or if deorbit same day

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

If posigrade sep desired:
\[ \text{TGT PEG 7} \ \Delta VX – ITEM 19 +3 EXEC} \]
\[ \Delta VY – ITEM 20 +0 EXEC} \]
\[ \Delta VZ – ITEM 21 +0 EXEC} \]

If retrograde sep desired:
\[ \text{TGT PEG 7} \ \Delta VX – ITEM 19 –3 EXEC} \]
\[ \Delta VY – ITEM 20 +0 EXEC} \]
\[ \Delta VZ – ITEM 21 +0 EXEC} \]

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

At TIG – 0:30:
\[ \text{FLT CNTLR PWR - ON} \]
\[ \text{DAP: A/INRTL/PRI} \]

At TIG:
THC: Trim VGOs \( \leq 0.2 \) fps
\[ \text{FLT CNTLR PWR – OFF} \]
\[ \text{DAP: A/INRTL/VERN(ALT)} \]

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]
   RNDZ NAV ENA – ITEM 1 EXEC (*)
   ORB TO TGT – ITEM 10 EXEC
   Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-8, then:
   Perform RPOP OPS (RNDZ TOOLS), 7-9, steps 1 to 5, then:
   Perform TCS ACTIVATION (RNDZ TOOLS), 7-18, steps 1 to 3, then:
   Perform TCS MANUAL ACQUISITION (RNDZ TOOLS), 7-19, step 1
   (Set RANGE = 4 ft, AZIMUTH = 0, ELEVATION = 0)
   Note: TCS will not track until after undock
   Perform HHL CHECKOUT (RNDZ TOOLS), 7-6

2. CONFIGURE FOR UNDOCKING
   √ISS: FREE
   A6U
   √DAP: FREE
   √SENSE: -Z
   AFT ADI ATT – LVLH
   ERR – MED
   RATE – LO
   [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 \(-0.12 \leq ROLL, PITCH, YAW RATE \leq 0.12\)
   
   APDS CIRC PROT OFF pb – push
   
   √CIRCUIT PROTECT OFF lt – lt on
   
   OP LAT pb – push
   
   √LATCHES CLOSED lt – lt off
   
   √OPEN lt – lt on

   If APDS spring-assist expected (hard-mated)
   
   On MCC Go, and when \(-0.12 \leq ROLL, PITCH, YAW RATE \leq 0.12\)
   
   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 3**

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

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

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

   **When RNG > 100 ft (DP to DP):**
   
   If radar desired, perform INITIAL RADAR ACQ [9A], 2-9
   
   **A7L**
   
   PWR OFF pb – push

   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**

   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 \( \Delta VX \) – ITEM 19 +0 EXEC
   \( \Delta VY \) – ITEM 20 +2.5 EXEC
   \( \Delta VZ \) – ITEM 21 +0 EXEC

   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC

   If VGO Z is negative:
   TGT PEG 7 \( \Delta VY \) – ITEM 20 -2.5 EXEC
   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC
   \( \sqrt{VGO Z} \geq 0 \)

   Do not maneuver to burn attitude

   At TIG:
   - A6U FLT CNTLR PWR – OFF
   - DAP ROT: DISC/DISC/DISC
   - F6 FLT CNTLR PWR – ON
   - THC: trim VGOs ≤ 0.2 fps
   - F6 FLT CNTLR PWR – OFF

   Record Out-of-Plane Burn TIG ____ / ____ : ____ : ____

   Cont next page
8. PERFORM FINAL BURN
√MCC for final burn engine selection and breakout direction
NOTE: Posigrade burn should be performed if second docking attempt desired or if deorbit same day

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

If + X burn:
If posigrade sep desired:
 If ΔVY from Out-of-Plane burn (step 4) was positive:
   TV ROLL – ITEM 5 +2 7 0 EXEC
 If ΔVY from Out-of-Plane burn (step 4) was negative:
   TV ROLL – ITEM 5 +9 0 EXEC
   TGT PEG 7 ΔVX – ITEM 19 +7.0 EXEC
   ΔVY – ITEM 20 +0 EXEC
   ΔVZ – ITEM 21 +0 EXEC
If retrograde sep desired:
 If ΔVY from Out-of-Plane burn (step 4) was positive:
   TV ROLL – ITEM 5 +9 0 EXEC
 If ΔVY from Out-of-Plane burn (step 4) was negative:
   TV ROLL – ITEM 5 +2 7 0 EXEC
   TGT PEG 7 ΔVX – ITEM 19 -7.0 EXEC
   ΔVY – ITEM 20 +0 EXEC
   ΔVZ – ITEM 21 +0 EXEC
Set TIG to Out-of-Plane Burn TIG + 22 min

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

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

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

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

1. **OPS 202 PRO**

   **GNC ORBIT MNVR EXEC**

   Load Ti Delay $\Delta V$ from final Ti PAD, 3-7

   If no Ti Delay targets available:
   
   Add 3.0 fps to $\Delta V_x$ of 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

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

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

   **NOTE**

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

## Preliminary Intermediate

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<th>( \Delta V_X )</th>
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<th>( \Delta V_Z )</th>
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## Final Ground Final-Ground Limits

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# Ti Onboard Solutions

## Prel Filter 1st Inter Filter 2nd Inter Filter (if reqd)

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## Final Filter Prop (if reqd) Final-Ground Limits

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

1. If Recovery from OPS MODE RECALL:
   (add/delete GPC to/from redundant set)
   
   **GNC 33 REL NAV**
   
   **NOTE**
   Asterisks will not change until RNDZ NAV enabled

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

2. If Recovery from OPS TRANSITION (G8/G3 to G2):
   
   **GNC 34 ORBIT TGT**
   TGT NO – ITEM 1 +1 EXEC
   Set BASE TIME to Ti TIG (Ti Burn Pad, 3-6)
   LOAD – ITEM 26 EXEC
   GNC 33 REL NAV
   Upon MCC uplink of TGT SV,
   RNDZ NAV ENA – ITEM 1 EXEC (*)
   
   **NOTE**
   If RNDZ NAV not enabled (no *),
   **DO NOT PROCEED. √ MCC**

   Select appropriate target track attitude
   GNC UNIV PTG

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<td>+90</td>
<td>+180</td>
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   TRK – ITEM 19 (CUR-*)

3. **C3**
   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

5-29  RNDZ/115/FIN
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 400, to 170 ft” not received from MCC, do not approach inside 400 ft (CG - CG). Stationkeep on the Vbar outside of 400 ft for a maximum of 1 rev and attempt to re-establish comm. If no comm after 1 rev of stationkeeping, perform VBAR BREAKOUT (CONTINGENCY OPS), 5-14
3. If “go to proceed inside 170 ft” or “go for docking” not received from MCC do not attempt docking. Back out (if required) and stationkeep outside of 170 ft for a maximum of 1 rev and attempt to re-establish comm. If no comm after 1 rev of stationkeeping, go to VBAR BREAKOUT (CONTINGENCY OPS), 5-14
DEGRADED CONTROL
DEGRADED +X TRANSLATION

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

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

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

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

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

| DAPS A9, B9 PITCH AND YAW TO ALL [A] |
| GNC 20 DAP CONFIG |
| DAP EDIT – ITEM 3 +9 EXEC |
| PRI P OPTION – ITEM 55 EXEC – (ALL) |
| PRI Y OPTION – ITEM 56 EXEC – (ALL) |
| LOAD – ITEM 5 EXEC |

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

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

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

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

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

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

NOTE 2
DAP disables ±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

Review IMMEDIATE ACTIONS in LOSS OF BOTH FxD JETS (SAME SIDE)
(CONTINGENCY OPS), 5-39

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

  When RNG = 75 ft:
    10 second 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 Fx D JETS (SAME SIDE)

* **IMMEDIATE ACTIONS**
  * Do not perform any LO Z +Z (braking) translations
  * If during RPM:
    * DAP: FREE
    * FLT CNTLR PWR – OFF
    * 
    * MCC for further actions
  * If on Vbar and RNG > 75 ft:
    * DAP: NO LO Z
    * Use DAP: B +Z (out) pulses at 10 sec intervals as required to establish +0.1 fps opening rate
  * If on Vbar and RNG < 75 ft:
    * Use DAP: B +Z (out) pulses to establish 0.1 fps opening rate

**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.

**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-second intervals (pulses at 10 second 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, \(\sqrt{\text{MCC}}\) for breakout procedure

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

Cont next page
3. If failure occurs between TORVA initiation and Vbar arrival, continue approach:
   Perform CONFIG YAW OPTION TO ALL [B]
   Do not perform LO Z +Z (braking) translations
   If RNG < 345 cg-cg (280 dp-dp) prior to Vbar arrival, or if 8 deg corridor violated in Y-axis direction:
   Go to SHUTTLE NOSE IN-PLANE BREAKOUT (R < 500 ft), 5-16 >>
   When ready to ESTABLISH VBAR (PITCH ERR \leq 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,
   \( \sqrt{DAP} \): 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:
   \( \sqrt{DAP} \): No LO Z
   In steps 2 and 3, do not select DAP LO Z
   After step 3:
   Perform DESELECT FAILED FORWARD DOWN-FIRING JET [D]
   DAP: LO Z
   In step 4, do not trim VGO Y

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

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

   | REGAIN Y CONTROL [C] |
   | MCC for which jet to reselect |
   | GNC 23 RCS |
   | RCS FWD – ITEM 1 EXEC (*) |
   | JET DES FxD – ITEM XX EXEC (no *) |

   | NOTE: Do not perform any THC: -Z (in) commands |

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

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

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

2. COAS NAV should not be performed if VERN fail

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

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

5. Twelve hooks reqd for mated attitude control in ALT
REFERENCE DATA

ISS RNDZ OPS DAP CONFIGURATIONS ................................................................. 6-2
POST-CONTACT THRUST (PCT) REFERENCE DATA .............................................. 6-3
TARGETING DATA .................................................................................................. 6-4
POST NC .................................................................................................................. 6-6
  Ti ............................................................................................................................. 6-7
  MC3 ....................................................................................................................... 6-8
TCS REFLECTOR VISIBILITY DURING APPROACH ............................................. 6-9
HHL AIMING LOCATIONS ...................................................................................... 6-10
SEPARATION SOLAR ARRAY CONFIGURATION ................................................. 6-11
SHUTTLE CENTERLINE TARGET .......................................................................... 6-12
ISS ATTITUDE CONTROL SYSTEM MODING INDICATORS .............................. 6-13
RANGING CHARTS ................................................................................................. 6-14
COAS SUBTENDED ANGELS (DEG) VS RANGE (FT) .............................................. 6-15
## ISS RNDZ OPS DAP CONFIGURATIONS

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## POST-CONTACT THRUST (PCT) REFERENCE DATA

### PBI FUNCTION WHENEVER IN OPS 2:

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<th>When PCT is disarmed...</th>
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<th>When PCT is active...</th>
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<td>Disarms PCT</td>
<td>Disarms and Terminates PCT ¹</td>
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¹ The following actions occur when PCT terminated by either automatic timeout or manual abort via above PBIs:
- PCT firing sequence terminated
- DAP moded to A/VERN
- DAP A,B configured to A9,B9 (Prox Ops DAP)

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

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

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**Notes:**
- EL: Elapsed Time
- DT: Delta Time
- DX: Delta X
- DY: Delta Y
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HHL AIMING LOCATIONS

CL Target
Airlock
Lab - Fwd
Target - CG
Progress - Aft

Note: Array Feathering Not Shown
SEPARATION SOLAR ARRAY CONFIGURATION

Feathered FGB array (obsuring feathered SM array)

Camera A FGB Solar Arrays

Shuttle FWD Window P6 Solar Arrays
Roll indicators are to be used with the vertical and horizontal lines on the CTVC monitor overlays. All six sets of roll indicators are sized to give roll misalignments in increments of 2 degrees. At least two sets of roll indicators on opposite sides of the target backplate are required during roll misalignment determination (see roll misalignment example). The outer roll indicators (extra set on horizontal axis) may not be used with the inner roll indicator.

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

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

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<td>DIO Card Slot 4 Channel 14</td>
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Bottom View

- LED Numbers
- 4 red LEDs on each plug-type connector

Side View

- LEDs
- Orbiter overhead windows
- Location wrt Orbiter Structure: X=572, Y=0, Z=548.6
# COAS SUBTENDED ANGLES (DEG) VS RANGE (FT)
(SA DIMENSIONS TIP TO TIP)

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RENEZVOUS TOOLS

CCTV CONFIG FOR DOCKING/UNDOCKING ................................................................. 7-2
RNDZ TOOLS CHECKOUT .............................................................................................................. 7-4
TROUBLESHOOTING.................................................................................................................... 7-5
HAND-HELD LIDAR CHECKOUT ............................................................................................... 7-6
STOW...................................................................................................................................... 7-6
OPS........................................................................................................................................ 7-7
RPOP INITIALIZATION .................................................................................................................. 7-8
OPS ........................................................................................................................................ 7-9
FUNCTION KEY SUMMARY .............................................................................................................. 7-11
KEYSTROKE SUMMARY .................................................................................................................. 7-15
TRAJECTORY DATA SOURCE OPTIONS .................................................................................... 7-16
TCS ACTIVATION ............................................................................................................................ 7-18
MANUAL ACQUISITION .................................................................................................................. 7-19
DEACTIVATION ............................................................................................................................... 7-20
LIMITS ...................................................................................................................................... 7-21
TRAD FAIL RANGE AND RANGE RATE DETERMINATION .................................................... 7-21
NOMINAL OPS ................................................................................................................................. 7-21
RADAR FAIL ................................................................................................................................. 7-22
TCS FAIL .................................................................................................................................. 7-22
HHL FAIL ................................................................................................................................... 7-22
PCMMU/WINDECOM FAIL.......................................................... 7-23
PGSC FAIL (NO PROP, NO TCS) .............................................................................................. 7-23
CCTV CONFIG FOR DOCKING/UNDOCKING

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

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

2. **SET CCTV CAMERA FUNCTIONS**
   2.1 For Centerline Camera:
   ALC pb – press
   AVG pb – press
   √GAM BLK STR – ON
   √COLOR BAL – SUN

   2.2 For Cameras A,C,D:
   ALC pb – press
   AVG pb – press
   GAM BLK STR – ON
   √COLOR BAL – SUN
   SHUTTER – ON pb press as reqd

   2.3 For Camera B:
   ALC pb – press
   AVG pb – press
   LT LEVEL pb – press
   NIGHT pb – press
   GAM BLK STR – ON

3. **SET CAMERA ZOOM SETTINGS**

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<td>Centerline</td>
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<tr>
<td></td>
<td>10.1° (full zoom)</td>
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4. **MONITOR SETUP**
   MON 1,2 L-DATA – on
   C-DATA – grn
   XHAIR – grn

5. **ZERO PTU ANGLES**
   MON 2 – Camr A
   Zoom to full zoom out
   Center A on B
   Zoom to full zoom in
   MON 2 – Camr B
   Zoom to full zoom out
   Center B on A
   Zoom to full zoom in
   MON 2 – Camr A
   Recenter A on B (slow rate)
   Pan/Tilt – Reset
   MON 2 – Camr B
   Recenter B on A (slow rate)
   Pan/Tilt – Reset
   Repeat for Camrs D,C

Cont next page
6. **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 below)
   Tilt: as reqd until bottom of ODS Interface Ring touches bottom of
   screen (see figure below)

7. **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 below)
RNDZ TOOLS CHECKOUT

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

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

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

4. Perform RPOP INITIALIZATION, steps 1 thru 6, 7-8
   
   On MCC GO:
   5. Perform TCS ACTIVATION, steps 1 and 2, 7-18
   6. Perform HAND-HELD LIDAR CHECKOUT, 7-6
   7. When checkout complete, perform TCS DEACTIVATION, 7-20, then:
      Exit RPOP – [SHIFT]/[F10], then:
      HHL PWR SW – OFF, then:
      Temp stow Rndz Tools as reqd

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

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

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

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

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

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

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

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

3. Take multiple (~10) Range and Velocity measurements using top center of aft PLB bulkhead or S0 Truss Segment as TGT
   - HHL data received by RPOP (HHL trajectory source must be selected)
   - Range check:
     - √Range from aft port window to bulkhead = 60 ft
     - or
     - √Range from overhead window to S0 Truss Segment = ~23 ft
   - Velocity check:
     - Depress trigger for 5 sec
     - √Velocity = 0.0 fps
   - Report range and velocity discrepancies to MCC
   - Self-Test: Press and hold Test Mode button, √8.8.8.8. Select range

HAND-HELD LIDAR STOW

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

Power sw – ON

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

Display Intensity knob – Adjust intensity to minimum acceptable level

Select Range or Velocity decimal place by toggling RANGE/VELOCITY buttons
  Range pb – 1 ft or 0.1 ft
  Velocity pb – 0.1 fps or 0.01 fps

Center red dot on TGT

Depress trigger for each measurement
Hold trigger for velocity measurements

Velocity accuracy increases with trigger hold duration:

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<tr>
<th>Duration</th>
<th>Accuracy</th>
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<td>0.06</td>
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<tr>
<td>2.0</td>
<td>0.03</td>
</tr>
<tr>
<td>5.0</td>
<td>0.01</td>
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</table>

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

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

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

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

2. From Startup Menu, select appropriate Expansion Chassis config

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

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

5. √ PCM selected – status displayed above F6 ([CTRL]/[F6] to enable/disable)
   √ RPOP is receiving PCMMU data
   If no target state vector on board, expect flashing error msg
   If target state vector on board but rel nav not enabled, expect bad relative state

6. Update target LVLH attitude as reqd – [SHIFT]/[F6]
   [Enter Target Vehicle Attitude Info]
   Select appropriate Attitude (PYR Seq.)
   Pitch > ______  Yaw > ______  Roll > ______
   Select appropriate attitude rate
   Enter rates (as reqd)
   Click [OK] to continue
RPOP OPS

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

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

3. Update MET (as reqd):

   [CNTL]/[F10]
   RPOP Configuration

   Select [Update MET... ] button
   Update MET

   Update MET and click [OK] when finished

4. Reconfig Serial Ports (as reqd):

   [CNTL]/[F10]
   RPOP Configuration

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

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

   NOTE
   TCS source for RPOP must be set to DLL

5. Reconfig TCS No./Reflector No. Settings (as reqd):

   [CNTL]/[F10]
   RPOP Configuration

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

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

6. Config Average Rdot guidance (as reqd):

   Select Guid – [CTRL]/[F5]
   Select Guidance Type

   Select [Average Rdot] button – [A]

   Enter time until docking (countdown time)
   Min > ________
   Sec > ________

   Select [Start]. Timer starts when [Start] pressed

   Click [OK] when finished

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

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

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

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

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

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

TRAJECTORY DATA KEYS (Columns F1 → F4)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SV
STATE VECTOR
Options include:

  State Vector – Enable automatic acceptance of the Onboard Nav states
  None – Turn State Vector processing off
  Config... – Reconfigure Trajectory Data Source for this function key

RR
RENDEZVOUS RADAR
Options include:

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

HHL
HANDHELD LASER
Manually select HHL Aim Point, Angle Source, and Angle Source Aim Point
Manually enter HHL RNG and two Angle Source angles (an in-plane and out-of-plane)

Options include:

  Lock – Hold the in-plane angle constant (locked) for each HHL mark
  Lock – Hold the out-of-plane angle constant (locked) for each HHL mark
  Update Settings – Accept configuration changes to Aim Points, Angle Source, and Lock option without incorporating a trajectory mark
  HHL Nav. . . – HHL Nav activation (on/off) and configuration (display residuals, force measurements, reinitialize, length of trigger pull (short/long or long only))
  Config... – Reconfigure the Trajectory Data Source for this function key

Angle Source options include:

  Fwd CCTV, Aft CCTV, Dock Cam, COAS, Radar, TCS, Other, None

  NOTE
  Manual inputs reqd for all angle sources except Radar, TCS and None. If Radar or TCS selected, angles will be automatically snapped (if available). Other camera is optional, and may be completely specified via I-load

Aim Point options include:

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

  NOTE
  HHL Aim Pt is always available and may be completely specified via I-load. Tgt CG is always available Points of Interest 1-3 are optional, and may be completely specified via I-load. For Angle Source Radar, angle aim point is Tgt CG. For Angle Source TCS, angle aim point is current reflector no

CCTV
CLOSED CIRCUIT TELEVISION CAMERAS
Manually enter FWD and AFT CCTV tilt angles
Options include:

  Config... – Reconfigure Trajectory Data Source for this function key
TCS  TRAJECTORY CONTROL SENSOR

Options include:

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

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

   **SHUTTLE APPS**
   - TCS

2. **TCS PWRUP/INITIALIZATION**
   - L12 TCS PWR – ON (tb-gray)
     - * If tb – bp, cycle sw *
     - * If no joy, notify MCC *
   - PGCS TCS Self Test

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

   - \MSG: INITIALIZATION COMPLETE
     - * If error msg received during initialization, *
     - * \MCC *

   **TCS OPS**
   - Mode: Stby
   - Z Latch: Unlocked
   - Pulse: Avail
   - CW: Active

     - * If not in config, *
     - * \MCC *

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

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

1. ACQUIRE

   PGSC
   TCS OPS
   √Pulse: Avail
   √CW: Active

   TCS C&D
   > 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&D
     * > Commands > Acquire
     * Update Range estimate and zero AZ & EL
     * > Send

2. ENABLE RPOP TCS NAV
   Perform RPOP OPS, step 7, 7-10

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

1. SHUTDOWN TCS

PGSC

[TCS C&DI]

> Macros > SHUTDOWN

* If error msg received during SHUTDOWN, *
* MCC

[TCS OPS]

\Shutter: Closed (takes ~22 sec)

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

If Final TCS deactivation for mission:

2. SECURE Z AXIS

PGSC

[TCS C&DI]

> Commands > Lock Z Axis Latch

[TCS OPS]

\Z Latch: Locked

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

3. POWERDOWN TCS

L12

TCS PWR – OFF (tb-bp)

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

4. SHUTDOWN CADS

PGSC

[TCS C&DI]

> File > Exit TCS CAD
TCS LIMITS

<table>
<thead>
<tr>
<th>TEMPERATURE</th>
<th>LOW ALERT</th>
<th>HIGH ALERT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(degC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CW Laser</td>
<td>-40.0</td>
<td>45.0</td>
</tr>
<tr>
<td>APD</td>
<td>-40.0</td>
<td>65.0</td>
</tr>
<tr>
<td>CPU</td>
<td>-40.0</td>
<td>80.0</td>
</tr>
<tr>
<td>DC Power</td>
<td>-40.0</td>
<td>80.0</td>
</tr>
<tr>
<td>Galvos</td>
<td>-40.0</td>
<td>80.0</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>
<tbody>
<tr>
<td>1. Manual Takeover thru TCS lock-on (R &gt; 3000 ft assumed for TCS nominal lock-on*) State data: SV</td>
<td>Rdot window: HHL/Dt NOTE: Configure HHL angle source to Dock Cam and lock angles to 0</td>
<td></td>
</tr>
<tr>
<td>2. TCS lock-on thru 15 ft State data: TCS NAV</td>
<td>Rdot window: HHL/Dt NOTE: Configure HHL angle source to Dock Cam and lock angles to 0</td>
<td></td>
</tr>
<tr>
<td>3. 15 ft thru dock Raw data: TCS Raw</td>
<td>Rdot Window: Range Ruler (F12)</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Phase</th>
<th>Prime Source: Configuration</th>
<th>Backup Source: Configuration</th>
</tr>
</thead>
</table>
| 1. Manual Takeover thru TCS lock-on* | Rdot window: HHL/Dt
NOTE: Configure HHL angle source to Dock Cam and lock angles to 0 | Rdot window: Subtended angles |
|                              | State data: TCS NAV         |                              |
| 2. TCS lock-on thru 15 ft    | 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) |

*TStart 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>
</table>
| 1. Manual Takeover thru ~1200 ft | State data: SV             | Rdot window: HHL/Dt
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 | |
|                              | Rdot window: HHL/Dt
NOTE: Configure HHL angle source to Dock Cam and lock angles to 0 | |
| 2. ~1200 ft thru 15 ft       | Rdot window: Subtended angles Spec 33: FLTR, and State data: HHL can be suspect | |
|                              | Spec 33: Raw Radar*         | |
| 3. 15 ft thru dock           | Rdot Window: Range Ruler (F12) | Rdot window: HHL/Dt** |

*Start Subtended angle for Spec 33: FLTR, and State data: HHL can be suspect
**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>Rdot window: Subtended Angle</td>
<td></td>
</tr>
<tr>
<td>3. 15 ft thru dock</td>
<td>Raw data: TCS Raw</td>
<td>Rdot Window: Range Ruler (F12)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Phase</th>
<th>Prime Source: Configuration</th>
<th>Backup Source: Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOTE: Transition from phase 1 to 2 should be gradual. Start transition at ~1500 ft and complete it prior to 1000 ft braking gate</td>
<td>NOTE: RPOP state data is bad</td>
<td>NOTE: RPOP prompts user for Orb attitude after 1st HHL mark. Enter P/Y/R = (90/0/0)* and check “Do not prompt for attitude”</td>
</tr>
<tr>
<td></td>
<td>TCS CADS: Raw TCS (pulse active)</td>
<td>NOTE: Range data good, rdot can be quite noisy</td>
</tr>
<tr>
<td>NOTE: RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
<td>Rdot window: Generic</td>
<td>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>
</tbody>
</table>

2. ~1200 ft thru TCS CW lock-on (~800 ft) | Rdot window: HHL/Dt | TCS CADS: Raw TCS (pulse active) |
| NOTE: RPOP State data is bad | NOTE: RPOP State data is bad | NOTE: Range data good, rdot can be quite noisy |
| TCS CADS: Raw TCS (cw active) | Rdot window: HHL/Dt | Rdot window: Generic |

3. TCS CW lock-on (~800 ft) thru Vbar arrival | TCS CADS: Raw TCS (cw active) | Rdot window: HHL/Dt |
| NOTE: RPOP State data is bad | Rdot window: HHL/Dt | **Range Ruler Overlay**: Camera A/D |

4. Vbar arrival thru 15 ft | TCS CADS: Raw TCS (cw active) and/or | Rdot window: Range Ruler(F12) |
| State Data: TCS AUTO | Rdot window: HHL/Dt | Range Ruler Overlay: Camera A/D |
| NOTE: Check Orb Att = (90/0/0), and set TCS frequency to 30 sec[CNTRL F10] | **Subtended Angle table(6-16)**: COAS or Centerline Cam subtended angle |
| | For Rdot – **Rdot vs. ∆Rng/∆t Cue Card**: Record Raw HHL range and times on cue card |

5. 15 ft thru dock | TCS CADS: TCS Raw (cw active) | Range Ruler Overlay: Camera A/D |
| Rdot window: Range Ruler(F12) | Rdot window: Range Ruler Overlay: Camera A/D |

*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>For Rdot – <strong>Rdot vs. ∆Rng/∆t Cue Card</strong>: Record Raw HHL range and times on cue card</td>
<td>For Rdot – <strong>HHL (back of unit)</strong>: Raw HHL(long pulls)</td>
<td>For Range – <strong>Subtended Angle table(6-16)</strong>: COAS or Centerline Cam subtended angle</td>
</tr>
<tr>
<td></td>
<td>For Rdot – <strong>Rdot vs. ∆Rng/∆t Cue Card</strong>: Record subtended angle range and times on cue card</td>
<td>For Rdot – <strong>HHL (back of unit)</strong>: Raw HHL* (long trigger pulls)</td>
</tr>
</tbody>
</table>

2. ~1200 ft thru 15 ft | For Range: HHL (back of unit): Raw HHL(short pulls) | For Rdot – **HHL (back of unit)**: Raw HHL* (long trigger pulls) |
| For Rdot: **HHL (back of unit)**: Raw HHL(long pulls) | **Rdot table on Range Ruler Overlay**: Dt between 1 ft DRange | **Rdot table on Range Ruler Overlay**: Dt between 1 ft DRange |

3. 15 ft thru dock | For Range: **Range Ruler Overlay**: Camera A/D | For Rdot: **Range Ruler Overlay**: Camera A/D |
| For Rdot: **Range Ruler Overlay**: Camera A/D | **Range Ruler Overlay**: Camera A/D | **Range Ruler Overlay**: Camera A/D |

*HHL will not work if the aimpoint surface is closer than 12 feet (5 ft DP-DP)
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DOCKING MECHANISM INITIALIZATION ................................................................................ 8-4
POWERUP .................................................................................................................... 8-5
POWERDOWN ............................................................................................................. 8-6
PREP ............................................................................................................................. 8-7
UNDOCKING PREP ........................................................................................................ 8-7
DOCKING RING EXTENSION ........................................................................................ 8-8
RETRACTION (NOT MATED) .......................................................................................... 8-9
AIRLOCK FAN ACT AND ODS VOLUME PREP ............................................................. 8-10
BYPASS ....................................................................................................................... 8-10
PREP FOR INGRESS – BYPASS CONFIG ................................................................. 8-11
POST DOCKING HATCH LEAK CHECK ................................................................. 8-12
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)
   √ISOL (two) – ctr (tb-CL)
   cb ESS 1BC DEP SYS 1 VENT ISOL – op
   2CA DEP SYS 2 VENT ISOL – op
   MN A DEP SYS 1 VENT – op
   B DEP SYS 2 VENT – op
   √VEST DEP VLV SYS 1,SYS 2 VENT tb (two) – bp
   √ISOL tb (two) – bp

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

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

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

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

| A7L | 4. APDS POWER ADS,BDS,CDS (three) – ON |
| CRT | √PWR – A/B/C |

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

CRT,A7L | * If CNTL PNL PWR A(C) tlm blank, and STATUS lts nominal, * |
| CRT | * tlm failure only >> * |
| A7L | * 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 * |
SM 167 DOCKING STATUS

A7L 1. √STATUS lt (eighteen) – lt off

2. APDS POWER A_DS, B_DS, C_DS (three) – OFF
   √A_DS, B_DS, C_DS lt (three) – lt off

   CRT
   √PWR (three) – blank

A7L 3. CONTROL PANEL POWER A, B, C (three) – OFF

   CRT
   √CNTL PNL PWR A, B, C (three) – blank

A7L 4. HEATERS/DCU POWER (three) – OFF

   CRT
   √HTR/DCU PWR (three) – blank

A6L 5. PSU PWR MN A, MN B (two) – OFF

6. If post-undocking:
   VEST DEP VLV SYS 1(SYS 2) VENT – CL (hold 5 sec, tb-CL)
   ISOL – CL (hold 5 sec, tb-CL)
   cb 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
   ML86B:C
   MNB (MNA) EXT ARLK HTR VEST Z1/2/3 – op
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 – 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 It – It on
   RING ALIGNED It – It on
   HOOKS 1, HOOKS 2 OPEN It (two) – It on
   LATCHES CLOSED It – It on
   RING FINAL POSITION It – It on

CRTC
   CLUTCH – LOCK/blank

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

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

A7L
* If RING INITIAL POSITION It failed on (ring stops after 1 sec, and CLUTCH – blank/SLIP):
   FIXER OFF pb – push
   FIXERS OFF It – It on
   RING OUT pb – push

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

A7L
* If RING FORWARD POSITION It 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 It – It on
   When RING INITIAL POSITION It – It on:
   RING OUT pb – push
3:40  A7L  4.  RING INITIAL POSITION It – It on
        CRT  √ PETAL POS BASE (three): 76 ± 3%
3:50  CRT  √ CLUTCH – blank/SLIP

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

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

* If not CLUTCH – blank/SLIP:
   √ MCC

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

DOCKING RING RETRACTION (NOT MATED)

SM 167 DOCKING STATUS

A7L  1.  POWER ON pb – push
       √ ON lt – It on
       √ RING ALIGNED It – It 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
       √ 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 – It on
3:50  CRT  √ 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 diffuser cap from Airlock Fan outlet and install on middeck floor fitting

EXT A/L
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. AIRLK 2 – OFF/ON

9. TNL ADAPT 1 – OFF/ON

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

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

MO10W
12. √14.7 CAB REG INLET SYS 1, SYS 2 (two) vlv – CL

AIRLOCK FAN BYPASS

MO13Q
1. ARLK FAN A(B) – OFF

EXT A/L
2. Disconnect bypass duct from Airlock Fan outlet

MIDDK
3. Remove diffuser cap from middeck floor fitting and install on Airlock fan outlet
   Attach bypass duct to middeck floor fitting

EXT A/L
4. √Airflow at top of external airlock halo
AIRLOCK PREP FOR INGRESS – BYPASS CONFIG

Inner Hatch
1. Equal vlv caps (two) – remove

2. Equal vlv (two) – NORM

Hatch
3. √Hatch ΔP < 0.2 psid

4. Open Hatch per decal

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

MO13Q
6. TNL ADAPT 1 – ON/OFF

7. ARLK 2 – ON/OFF

8. ARLK FAN A(B) – OFF

EXT A/L
9. Disconnect bypass duct from Airlock Fan outlet

A/L
Remove diffuser cap from middeck floor and install on Airlock Fan outlet

MIDDK
Connect bypass duct to middeck floor fitting

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

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

12. √Airflow at top of external airlock halo

13. TV System

R12 (VPU)
√Green Jumper – SEC C/L
√SEC C/L Cap installed
√VPU PWR – ON (LED on)

A7
VID OUT MON 1 pb – push
IN PL2 (VPU) pb – push
CAMR CMD IRIS – CL

L12 (SSP2)
C/L CAM PWR – OFF

ODS
Remove, stow C/L Camr, Harness Assy, Bridge
Go to DEACTIVATION (Cue Card, TV) as reqd
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 1,2 (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) *

APDS OFF-NOMINAL

POWER FAILED OFF (STATUS LTS OFF) ................................................................. 8-14
DAMPING FAILED ON ......................................................................................... 8-15
CAPTURE LT FAILED ON .................................................................................... 8-15
FIXERS FAILED ON ............................................................................................. 8-16
  OFF LT FAILED ON ....................................................................................... 8-18
  OFF ........................................................................................................... 8-18
RING FAILS TO DRIVE ...................................................................................... 8-19
  DRV CMD OFF ............................................................................................ 8-19
  FINAL POSITION LT FAILED ON ................................................................. 8-20
FORCE RING ALIGNMENT ................................................................................. 8-20
CLUTCH NOT 'LOCK' ....................................................................................... 8-21
APDS CIRCUIT PROTECT OFF LT FAILED OFF .............................................. 8-21
HOOKS 1(2) OPEN LT FAILED ON ................................................................. 8-21
  NOT CLOSED WITHIN SINGLE MTR TIME .................................................. 8-22
READY TO HOOK LT FAILED ON ................................................................. 8-23
HOOKS 1(2) CLOSED LT FAILED ON .............................................................. 8-23
LATCHES OPEN LT FAILED OFF ................................................................. 8-24
APDS POWER FAILED OFF ............................................................................ 8-24
DOCKING MECHANISM DEMATE/REIMATE ............................................. 8-25
ODS HOOKS OPEN – CONTINGENCY ........................................................ 8-27
PMA 2/3 HOOKS OPEN – CONTINGENCY ................................................... 8-30
APDS FAILED CAPTURE RECONFIG ......................................................... 8-33
PMA 2/3 HOOKS CLOSE ............................................................................... 8-35
  OPEN ........................................................................................................ 8-37
CAPTURE LATCH MANUAL RELEASE ......................................................... 8-39
# POWER FAILED OFF (STATUS LTS OFF)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>CAUTION</strong></td>
<td>Pre-Contact, if all STATUS lts off, <strong>NO-GO</strong> for docking until power recovered. Initiate VBAR CORRIDOR BACKOUT (CONTINGENCY OPS) while attempting power recovery steps</td>
</tr>
</tbody>
</table>

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

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

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

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

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

SM 167 DOCKING STATUS

1. PSU PWR MN A,MN B (two) – OFF
   CRT If DAMPING – ON (TLM failure only)
   A6L PSU PWR MN A,MNB (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.

SM 167 DOCKING STATUS

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

2. POWER ON pb – push
   CRT If RING FIXERS – ON:
   APDS POWER A<sub>DS</sub> – OFF
   A7L   APDS POWER A<sub>DS</sub> – ON
         B<sub>DS</sub> – 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<sub>DS</sub> (B<sub>DS</sub>) – ON

3. APDS POWER B<sub>DS</sub> – 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<sub>DS</sub>,B<sub>DS</sub>,C<sub>DS</sub> (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<sub>DS</sub>,B<sub>DS</sub>,C<sub>DS</sub> (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:

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

A7L 2. FIXER OFF pb – push
   POWER OFF pb – push
   ON pb – push
   If FIXERS OFF lt – lt off:
   Continue in DOCKING RING EXTENSION, 8-8 >>

3. APDS CIRC PROT OFF pb – push
   \sqrt{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 >>

CRT 2. If not CLUTCH – LOCK/blank

A6L PSU PWR MN A,MN B (two) – OFF
A7L RING IN pb – push
   POWER ON pb – push
A6L 0:00 PSU PWR MN A,MN B (two) – ON
CRT 0:05 \sqrt{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
   \rightarrow ON
A6L 0:00 PSU PWR MN A,MN B (two) – ON (ring will begin to drive in this step)
CRT \sqrt{PETAL POS BASE (three) – decr}
A7L 0:05 POWER ON pb – push
CRT \sqrt{RING DRV CMD – OFF}

A6L 4. PSU PWR MN A,MN B (two) – OFF
   APDS CIRC PROT OFF pb – push
   \sqrt{CIRCUIT PROTECT OFF lt – lt on}
A7L RING OUT pb – push
   APDS POWER A_{DS},B_{DS},C_{DS} (three) – OFF
   \rightarrow ON
A6L 0:00 PSU PWR MN A,MN B (two) – ON (ring will begin to drive in this step)
CRT \sqrt{PETAL POS BASE (three) – incr}
A7L 0:05 POWER ON pb – push
CRT \sqrt{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:
   CRT    If RING DRV CMD – ON:
   CRT      If not CLUTCH – LOCK/blank:
   A7L      POWER OFF pb – push
   CRT          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
   L  Continue in DOCKING SEQUENCE (Cue Card), as reqd >>
   2. APDS POWER A\textsubscript{DS} – OFF
   RING IN pb – push
   CRT If RING DRV CMD – OFF:
   A7L    APDS POWER A\textsubscript{DS} – ON
          C\textsubscript{DS} – OFF
          RING IN pb – push
          Go to step 3
   CRT    If RING DRV CMD – OFF:
          Go to step 3
   A7L    POWER ON pb – push
   Continue in DOCKING SEQUENCE (Cue Card) through step 16 then:
   APDS POWER A\textsubscript{DS} (C\textsubscript{DS}) – ON
   OPEN LATCHES pb – push
   After 5 sec:
   \^LATCHES OPEN lt – lt on
   APDS POWER A\textsubscript{DS} (C\textsubscript{DS}) – OFF
   Go to DOCKING SEQUENCE (Cue Card) step 18 >>
   3. If free drift, comm, and power level constraints permit (\^MCC):
   Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F)
   to complete docking >>
   4. Go to FAILED CAPTURE (VBAR APPROACH, Cue Card) to undock
RING FINAL POSITION LT FAILED ON

[SM 167 DOCKING STATUS]

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

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

A7L  RING IN pb – push

In step 11, to stop ring drive

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

   0:05  √CLUTCH – LOCK/blank

   A7L  √RING INITIAL POSITION lt – lt on (√off at ~0:30)

* If RING FORWARD POSITION lt failed on (ring stops after *
* 10 sec):

   * RING OUT pb – push
   * Within 10 sec:

   * APDS POWER A_{DS},B_{DS},C_{DS} (three) – OFF
   * APDS POWER A_{DS},B_{DS},C_{DS} (three) – ON
   * CIRC PROT OFF pb – push

   * CIRCUIT PROTECT OFF lt – lt on

   CRT  * When PETAL POS BASE (any) = 92%:
   A6L  * PSU PWR MN A,MN B (two) – OFF
   CRT  * When PETAL POS BASE (three) not changing for 30 sec:

   A6L  * PSU PWR MN A,MN B (two) – ON
   CRT  * When PETAL POS BASE (three) = 98%:
   A7L  * RING OUT pb – push

   * Go to step 7

   * 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) =

10:05  √RING DRV CMD – OFF

   A7L  √FIXERS OFF lt – lt off

   √RING ALIGNED lt – lt on [PETAL POS RING (three) 50 ± 1%] and

   [PETAL POS BASE (three) within 1%]

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

**SM 167 DOCKING STATUS**

**CRT**  If no ring motion when RING DRV CMD – ON

**A7L**  1. APDS CIRC PROT OFF pb – push

   - CIRCUIT PROTECT OFF lt – lt on
   - FIXER OFF pb – push
   - FIXERS OFF lt – lt on
   - RING OUT pb – push

   After 10 sec:
   - POWER OFF pb – push
   - ON pb – push

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

**A7L**  2. RING IN pb – push

   After 10 sec:
   - POWER ON pb – push

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

3. If free drift, comm, and power level constraints permit (√MCC):

   Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F) to complete docking

**APDS CIRCUIT PROTECT OFF LT FAILED OFF**

**SM 167 DOCKING STATUS**

**CRT**  If APDS CIRC PROT – ON:

**A7L**  POWER OFF pb – push

   - ON pb – push

   APDS CIRC PROT OFF pb – push

**A7L**  If APDS CIRCUIT PROT OFF lt - lt on or

**CRT**  APDS CIRCUIT PROT – OFF:
   - Continue sequence as required >>

   Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F) for RING OUT, OPEN HOOKS, OPEN LATCHES, and UNDOCKING pb commands

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

**NOTE**

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

**A7L**  1. POWER ON pb – push

   APDS POWER A_DS – OFF

   If HOOKS 1(2) OPEN lt – lt off:
   - Go to nominal UNDOCKING OPERATIONS per nominal mission timeline with APDS POWER A_DS – OFF >>

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

**SM 167 DOCKING STATUS**

1. If no hook motion when commanded:
   - A7L
     APDS POWER A<sub>DS</sub> – OFF
     CLOSE HOOKS pb – push
   - CRT
     If no hook motion after 10 sec:
     - A7L
       APDS POWER A<sub>DS</sub> – ON
       B<sub>DS</sub> – OFF
       CLOSE HOOKS pb – push
   - CRT
     If Hook Pos increasing after 10 sec:
     Continue in DOCKING SEQUENCE (Cue Card) with the following change:
     - After step 16:
       A7L
       APDS POWER A<sub>DS</sub> (B<sub>DS</sub>) – ON >>

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
   - CRT
     \HK1,HK2 POS (two) – decr
   - A7L
     \HOOKS 1,HOOKS 2 OPEN lt (two) – lt on
   - 0:00
     RING OUT pb – push
   - CRT
     \PETAL POS BASE (three) – incr
   - 3:40
     A7L
     \RING INITIAL POSITION lt – lt on
   - Go to FAILED CAPTURE (VBAR APPROACH, Cue Card) to undock
READY TO HOOK LT FAILED ON

1. Immediately prior to step 4 in DOCKING SEQUENCE (Cue Card):
   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
     : : $\sqrt{\text{CIRCUIT PROTECT OFF lt – lt on}}$
     : : OPEN HOOKS pb – push
   : L $\sqrt{\text{HOOKS 1,HOOKS 2 OPEN lt (two) – lt on}}$
   Continue in DOCKING SEQUENCE (Cue Card), as reqd, with the
   following change:
   : After hooks begin to drive closed in step 10:
     : ⇐ APDS POWER $A_{DS}$ – 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
   $\sqrt{\text{CIRCUIT PROTECT OFF lt – lt on}}$
   OPEN HOOKS pb – push
   CRT $\sqrt{HK1(2) POS decreasing to 5\%}$
   Immediately after RING IN pb – push in step 8:
   APDS CIRC PROT OFF pb – push
   $\sqrt{\text{CIRCUIT PROTECT OFF lt – lt on}}$
   OPEN HOOKS pb – push
   CRT $\sqrt{HK1(2) POS decreasing to 5\%}$
   When PETAL POS BASE (three) $\leq$ 7%:
   APDS POWER $A_{DS}$ – OFF

HOOKS 1(2) CLOSED LT FAILED ON

A7L 1. APDS POWER $A_{DS}$ – OFF
2. If HOOKS 1(2) CLOSED lt – lt off:
   3. If Pre-Contact:
      APDS POWER $A_{DS}$ – ON
      Continue Approach
   4. Post-Capture, continue in DOCKING SEQUENCE (Cue Card). If affected
      hooks do not close in step 10:
      APDS POWER $A_{DS}$ – OFF
      CLOSE HOOKS pb – push
   5. Continue in DOCKING SEQUENCE (Cue Card) with the following
      change:
      After step 13:
      APDS POWER $A_{DS}$ – ON >>
   6. If HOOKS 1(2) CLOSED lt – lt on:
      APDS POWER $A_{DS}$ – ON
      Continue in DOCKING SEQUENCE (Cue Card). If affected hooks do not
      close in step 10:
      After DOCKING SEQUENCE (Cue Card) complete:
      Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A
      THRU F), to secure the interface with 12 hooks
LATCHES OPEN LT FAILED OFF

<table>
<thead>
<tr>
<th>CRT</th>
<th>1. If CAP LAT IND – OP/blank:</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Continue in DOCKING SEQUENCE (Cue Card) &gt;&gt;</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>A7L</th>
<th>2. √APDS POWER $A_{DS},B_{DS},C_{DS}$ (three) – ON</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\sqrt{A_{DS},B_{DS},C_{DS}}$ lt (three) – lt on</td>
</tr>
<tr>
<td></td>
<td>CIRC PROT OFF pb – push</td>
</tr>
<tr>
<td></td>
<td>$\sqrt{\text{CIRCUIT PROTECT OFF}}$ lt – lt on</td>
</tr>
<tr>
<td></td>
<td>OPEN LATCHES pb – push</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A7L, CRT</th>
<th>If LATCHES OPEN lt – lt on or CAP LAT IND – OP/blank:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Continue in DOCKING SEQUENCE (Cue Card) &gt;&gt;</td>
</tr>
</tbody>
</table>

3. Continue in DOCKING SEQUENCE (Cue Card), deleting step 18, then:
On MCC Go:
Go to CAPTURE LATCH MANUAL RELEASE, 8-39

APDS POWER FAILED OFF

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

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

---

**CAUTION**

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

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

On MCC GO:
Go to CAPTURE LATCH MANUAL RELEASE, 8-39
DOCKING MECHANISM DEMATE/REMOTE

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

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

   **SM 167 DOCKING STATUS**

   **RECAPTURE PMA PETALS**

   A7L

   2. **POWER ON pb – push**
      0:00
      CLOSE LATCHES pb – push
      √LATCHES OPEN lt – lt off
      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 It is ON or LATCHES CLOSED It is OFF. Be prepared to pick up in ANY ATTITUDE SEPARATION (CONTINGENCY OPS), step 4.

   **OPEN ODS HOOKS**

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

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

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

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

8. Interface clear of debris or other obstruction

RETRACT RING FOR SECOND MATING ATTEMPT:

0:00
9. RING IN pb – push
CRT
\[DRV CMD – ON \[PETAL POS BASE (three) - decr\]\]
\[CLUTCH – LOCK/blank\]

3:15
A7L \[READY TO HOOK lt – lt on\]
0:00 \[HOOKS 1,HOOKS 2 OPEN lt (two) – lt off\]
≤1:30 \[INTERF SEALED lt – lt on\]
2:20 \[HOOKS 1,HOOKS 2 CLOSED lt (two) – lt on\]

10. \[APDS CIRCUIT PROTECT OFF lt – lt on\]
0:00
RING OUT pb – push
CRT \[DRV CMD – ON\]
0:10 A7L \[POWER ON pb – push\]
CRT \[RING DRV CMD – OFF\]

0:00
A7L 11. OPEN LATCHES pb – push
\[LATCHES CLOSED lt – lt off\]
0:05 \[OPEN lt – lt on\]

0:00
12. RING IN pb – push
0:10 \[FINAL POSITION lt – lt on\]
0:20 CRT \[DRV CMD – OFF\]

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

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

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

16. Return to FLIGHT PLAN
ODS HOOKS OPEN – CONTINGENCY

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

To undock, the crew will start in the ANY ATTITUDE SEPARATION (AAS), 5-23 to prep for undocking, then transition to this procedure. Once in this procedure, steps 3-6 will recapture the PMA petals in preparation for firing the ODS hook pyros. Steps 7-8 re-open the ODS hooks. The capture latches maintain the connection between the two vehicles. Steps 9-11 will discharge the active hook pyros. When the active docking ring is extended in step 12, separation is expected at the interface between the fixed shuttle APDS structural ring and the fixed PMA structural ring. Vehicles maintain a physical connection via the active docking ring until the capture latches are opened after returning to the AAS procedure in step 20. If there is no separation in step 12, the passive hook pyros are discharged in steps 14-16. Interface separation is attempted again in step 17. As in step 12, the vehicles will maintain a physical connection via the active docking ring capture latches. In step 20, the crew will transition back to the AAS procedure where the capture latches will be opened and the actual vehicle separation performed.

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

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

<table>
<thead>
<tr>
<th>A7L</th>
<th>2. POWER ON pb – push</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SM 167 DOCKING STATUS</strong></td>
<td></td>
</tr>
</tbody>
</table>

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

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

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

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

     WARNING
     Vehicle separation may occur when ODS
     hooks opened or pyros discharged if RING
     FINAL POSITION lt is ON or LATCHES
     CLOSED it 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) OP lt on
          CRT  and jammed HK2(1) POS not decr:
          A7L  POWER OFF pb – push
                ON pb – push

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

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

     RECONFIGURE AND DISCHARGE PASSIVE HOOK PYROS
     A7L  13. POWER ON pb – push
     A6L  PSU PWR MN A,MN B (two) – OFF
     A7L  RING IN pb – push
          APDS POWER A_DS,B_DS,C_DS (three) – OFF
          – ON
     A6L  PSU PWR MN A,MN B (two) – ON
     CRT  When PETAL POS BASE (three) = ~6% and not decr:
     A7L  POWER ON pb – push
          Cont next page
A6L 14. PYRO PWR MN A,MN C (two) – ON
A7L PYROS $A_p,B_p,C_p$ (three) – ON
  $\sqrt{A_p,B_p,C_p}$ It (three) – It on
  PYRO CIRC PROT OFF pb – push
  $\sqrt{\text{CIRCUIT PROTECT OFF It – It on}}$

15. PAS HOOKS FIRING pb – push

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

REATTEMPT EXTENDING RING TO INITIAL POSITION FOR INTERFACE SEPARATION

A7L 17. $\sqrt{\text{APDS CIRCUIT PROTECT OFF It – It on}}$

0:00 RING OUT pb – push
  $\sqrt{\text{INTERF SEALED It – It off}}$
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. $\sqrt{\text{RING INITIAL POSITION It – It on}}$
CRT $\sqrt{\text{DRV CMD – OFF}}$
  PETAL POS BASE (three) = 76 $\pm$ 3%

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

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

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

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

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

A7L 2. POWER ON pb – push

SM 167 DOCKING STATUS

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

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

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

0:00 6. RING IN pb – push
0:10 POWER ON pb – push
   √ RING FINAL POSITION lt – lt off
   DRV CMD – OFF
   √ LATCHES CLOSED lt – lt on

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

OPEN ODS HOOKS
7. APDS CIRC PROT OFF pb – push
√CIRCUIT PROTECT OFF lt – lt on

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

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

ATTEMPT TO EXTEND RING TO INITIAL POSITION FOR INTERFACE SEPARATION

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

RECONFIGURE AND DISCHARGE PASSIVE HOOK PYROS
A7L 11. POWER ON pb – push
A6L PSU PWR MN A,MN B (two) – OFF
A7L RING IN pb – push
APDS POWER A_DS,B_DS,C_DS (three) – OFF
√ – ON
A6L PSU PWR MN A,MN B (two) – ON
CRT When PETAL POS BASE (three) = ~6% and not decr:
A7L POWER ON pb – push

A6L 12. PYRO PWR MN A,MN C (two) – ON
A7L PYROS A_P,B_P,C_P (three) – ON
√A_P,B_P,C_P lt (three) – lt on
PYRO CIRC PROT OFF pb – push
√CIRCUIT PROTECT OFF lt – lt on

13. PAS HOOKS FIRING pb – push

14. PYRO CIRC PROT ON pb – push
√CIRCUIT PROTECT OFF lt – lt off
PYROS A_P,B_P,C_P (three) – OFF
√A_P,B_P,C_P lt (three) – lt off
A6L PYRO PWR MN A,MN C (two) – OFF

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

16. POWER ON pb – push
A6L PSU PWR MN A,MN B (two) – OFF
A7L RING IN pb – push
APDS POWER Aₐₛ,Bₐₛ,Cₐₛ (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

17. PYRO PWR MN A,MN C (two) – ON
A6L PYROS Aₜ,Bₜ,Cₜ (three) – ON
√ Aₜ,Bₜ,Cₜ lt (three) – lt on
PYRO CIRC PROT OFF pb – push
√ CIRCUIT PROTECT OFF lt – lt on
A7L PYROS Aₜ,Bₜ,Cₜ (three) – OFF
√ AP,Bₜ,CP lt (three) – lt off
PYRO PWR MN A,MN C (two) – OFF

REATTEMPT EXTENDING RING TO INITIAL POSITION FOR INTERFACE SEPARATION

18. ACT HOOKS FIRING pb – push

19. PYRO CIRC PROT ON pb – push
√ CIRCUIT PROTECT OFF lt – lt off
PYROS Aₜ,Bₜ,Cₜ (three) – OFF
√ Aₜ,Bₜ,Cₜ lt (three) – lt off
A6L PYRO PWR MN A,MN C (two) – OFF

REALIGN COURSE PER DPM TIMELINE (EVA, ORB CONT EVA) >>

RECONFIGURE AND PREPARE FOR 96 BOLT EVA

20. √ APDS CIRCUIT PROTECT OFF lt – lt on
A7L 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

FINAL PREPARATION FOR VEHICLE SEPARATION

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

~3:20

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

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

Cont next page
APDS FAILED CAPTURE RECONFIG

**SM 167 DOCKING STATUS**

A7L 1. If LATCHES OPEN It – It on:
   - 0:00 CLOSE LATCHES pb – push
   - 0:05 \(\checkmark\) CLOSED It – It on

2. \(\checkmark\) APDS CIRCUIT PROTECT OFF It – It on

3. FIXER OFF pb – push
   - 0:00 RING OUT pb – push
   - CRT PETAL POS BASE (three) – incr
   - 0:05 \(\checkmark\) CLUTCH – LOCK/blank

A7L \(\checkmark\) RING INITIAL POSITION It – It on (for \~16 sec), then It off

   * If RING FORWARD POSITION It 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 PROTECT OFF It – It on
     * \(\checkmark\) RING INITIAL POSITION It – It on (for \~16 sec), then It off
     * When PETAL POS BASE (three) = 98 ± 2%:
     * RING OUT pb – push
     * After 10 sec:
       * PETAL POS BASE (three): 98 ± 2%

4. \(\checkmark\) RING FORWARD POSITION It – It on
   - ALIGNED It – It on
   - FIXERS OFF It – It off
   - CRT PETAL POS BASE (three): 98 ± 2%

0:00 A7L 5. RING IN pb – push
   - CRT CLUTCH – LOCK/blank
   - A7L \(\checkmark\) RING FORWARD POSITION It – It off
     1:15 \(\checkmark\) INITIAL POSITION It – It on (for \~16 sec), then It off

     * If RING FINAL POSITION It failed on (ring stops after 10 sec):
       * RING IN pb – push
       * \(\checkmark\) FORWARD POSITION It – It off
     1:15 \(\checkmark\) INITIAL POSITION It – It on (for \~16 sec), then It off
     4:50 CRT RING DRIVE CMD – OFF
     5:00 A7L When PETAL POS BASE (three) = 5 ± 3% and not decr:
       * POWER ON pb – push

6. \(\checkmark\) RING FINAL POSITION It – It on
   - DRV CMD – OFF

0:00 A7L 7. APDS CIRC PROT OFF pb – push
   - CRT CIRCUIT PROTECT OFF It – It on
   - RING OUT pb – push
   - CRT CLUTCH – LOCK/blank
0:10 A7L \(\checkmark\) RING FINAL POSITION It – It off

Cont next page
* If RING INITIAL POSITION lt failed on (ring stops after 1 sec, and Clutch drives to SLIP):
  * FIXER OFF pb – push
  * √FIXERS OFF lt – lt on
  * RING OUT pb – push

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

CRT
* √RING DRV CMD – OFF

A7L
* If RING FORWARD POSITION lt failed on (ring stops after 10 sec):
  * RING OUT pb – push
  * Within 10 sec:
    * APDS POWER A_DS,B_DS,C_DS (three) – OFF
    * APDS POWER A_DS,B_DS,C_DS (three) – ON
    * CIRC PROT OFF pb – push
    * √CIRCUIT PROTECT OFF lt – lt on
  * When RING INITIAL POSITION lt on:
    * RING OUT pb – push

3:40
8. √RING INITIAL POSITION lt – lt on
CRT
√PETAL POS BASE (three) – 76 ± 3%
√CLUTCH – blank/SLIP

A7L
* If CLUTCH – blank/blank:
  * √APDS CIRCUIT PROTECT OFF lt – lt on
  * RING OUT pb – push (expect 1 sec of drive),
    * wait 10 sec

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

A7L
* √RING INITIAL POSITION lt – lt on
* √FIXERS OFF lt – lt on
* APDS CIRCUIT PROTECT OFF lt – lt on
* RING OUT pb – push (expect 1 sec of drive),
  * wait 10 sec
* √RING DRV CMD – OFF

CRT
* If not CLUTCH – blank/SLIP:
  * √MCC

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

SM 167 DOCKING STATUS

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) – op
   cb PMA 2/3 GRP 1 HOOKS SYS B OP,CL (two) – op
   √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 any IND CL present, hooks will operate single motor: *
   * √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
   CRT √HK1 IND CL – 1,2
   √CMD CL – blank
   √HK CLS 1/3/5, 7/9/11 (two) – CL

A6L 6. 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 any IND CL present, hooks will operate single motor: *
   * √MCC

Cont next page
0:00 A6L 8. PMA 2/3 HOOKS SYS A,SYS B (two) – CL
   √GRP 2 tb – bp
CRT  √HK2 CMD CL – 1,2
    √IND OP – blank

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

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

WARNING
ODS to PMA 2/3 interface must remain hard mated by at least one gang of ODS hooks through entire procedure in order to provide PMA 2/3 active hook control and tlm through the interface X-connectors.

SM 167 DOCKING STATUS

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

TO OPEN HOOKS 1, PERFORM STEPS 2 THRU 5

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

   * If any IND OP present, hooks will operate single motor *

0:00 A6L 3. PMA 2/3 HOOKS SYS A, SYS B (two) – OP
   CRT
   √HK1 CMD OP – 1,2
   √IND CL – blank
   √HK CLS 1/3/5, 7/9/11 (two) – blank

2:20 A6L 4. √PMA 2/3 HOOKS GRP 1 tb – OP
   CRT
   √HK1 IND OP – 1,2
   √CMD OP – blank

   * If PMA 2/3 HOOKS fail to drive, or do not reach end-of-travel after single motor drive time (~4:40): *
   * A6L
   * PMA 2/3 HOOKS SYS A, SYS B (two) – ctr *
   * cb PMA 2/3 GRP 1 HOOKS SYS A OP, CL (two) – op *
   * cb PMA 2/3 GRP 1 HOOKS SYS B OP, CL (two) – op *
   * Perform PMA 2/3 HOOKS OPEN – CONTINGENCY, *
   * 8-30 *

5. PMA 2/3 HOOKS SYS A, SYS B (two) – ctr
   cb PMA 2/3 GRP 1 HOOKS SYS A OP, CL (two) – op
   B OP, CL (two) – op

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 any IND OP present, hooks will operate single motor *

Cont next page
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
CAPTURE LATCH MANUAL RELEASE

NOTE
This procedure assumes that the following have been completed:
  DOCKING SEQUENCE (Cue Card) excluding steps 17 and 18
  DOCKING MECHANISM POWERDOWN
  POST DOCKING HATCH LEAK CK
  ODS VOLUME PREP FOR INGRESS or AIRLOCK PREP
  FOR INGRESS - BYPASS CONFIG

1. Perform 2.104 HATCH OPENING AND SHUTTLE/ISS DUCT INSTALLATION, steps 1 to 11, at step 5 open the APAS EQUALIZATION VALVE ONLY and skip step 8 (JOINT OPS, INGRESS STATION)

2. MANUALLY RELEASE CAPTURE LATCHES
   Open (release) all three capture latch manual release levers. Gray tape each lever to the fully released position

3. Perform 4.102 SHUTTLE/ISS DUCT REMOVAL AND HATCH CLOSING, steps 11, 12, and 14.2 (JOINT OPS, EGRESS STATION)

4. RETRACT RING TO FINAL POSITION
   Perform DOCKING MECHANISM POWERUP, 8-5
   A7L POWER ON pb – push
   RING IN pb – push
   CRT √DRV CMD – ON [PETAL POS BASE (three) – decr]
   √FIXERS – ON
   A7L √FINAL POSITION It – It on
   CRT √PETAL POS BASE (three) = 5 ± 3%
   0:20 √RING DRV CMD – OFF
   A7L POWER OFF pb – push
   Perform DOCKING MECHANISM POWERDOWN, 8-6

5. MCC whether to perform 2.104 HATCH OPENING AND SHUTTLE/ISS DUCT INSTALLATION or 2.106 HATCH OPEN AND DUCT INSTALL (BYPASS CONFIG). Start in step 5 and complete the procedure as written, performing step 6 below when the ODS hatch is opened (JOINT OPS, INGRESS STATION)

6. CAPTURE LATCH MANUAL RELEASE CLEANUP
   Remove the gray tape and return each manual release lever to the fully closed (latched) position
REFERENCE DATA

APDS FAILURE/IMPACT MATRIX .................................................................................. 8-42
(TLM) .................................................................................................................. 8-45
<table>
<thead>
<tr>
<th>APDS Status lt</th>
<th>APDS FAILURE</th>
<th>IMPACT</th>
<th>OFF NOMINAL PROCEDURE (IF APPLICABLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER ON pb</td>
<td>Failed ON (m)</td>
<td>Continuous PWR ON will inhibit ring, damping, and fixer commands. Relays may overheat preventing future powerup. [Detectable only during powerup or ring drive operations]</td>
<td>RING DRV CMD OFF</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>If all STATUS lts are off, loss of all logic power to APDS. Docking system cannot be operated</td>
<td>POWER FAILED OFF (STATUS LTS OFF)</td>
</tr>
<tr>
<td>APDS CIRCUIT PROTECT OFF</td>
<td>Failed ON (m)</td>
<td>RING OUT, OPEN LATCHES, OPEN HOOKS, and UNDOCKING pb commands are enabled</td>
<td>APDS CIRCUIT PROTECT OFF LT FAILED OFF</td>
</tr>
<tr>
<td></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/REMA TE</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>INITIAL CONTACT lt disabled. Slip clutch will not drive to SLIP</td>
<td>APDS DIRECT DRIVE USING BOB required to drive slip clutch</td>
</tr>
<tr>
<td>FIXERS OFF</td>
<td>Failed ON (m)</td>
<td>IFM may be required to drive clutch to SLIP if failure occurs during ring extension. During docking, only centering springs maintain alignment during ring retraction</td>
<td>FIXERS OFF LT FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Unable to inhibit fixer operation during manual ring drive</td>
<td>FIXERS OFF LT FAILED OFF</td>
</tr>
<tr>
<td>HOOKS 1(2) OPEN</td>
<td>Failed ON (s)</td>
<td>Logic prevents hooks from driving open</td>
<td>HOOKS 1(2) OPEN LT FAILED ON [UNDOCKING]</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Hooks will not stop driving at Open position</td>
<td></td>
</tr>
<tr>
<td>LATCHES CLOSED</td>
<td>Failed ON (s)</td>
<td>If ring retraction to Final Position is attempted, ring will stall against capture latches if latches are failed closed. No impact if latches open on SPEC 167</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>No impact to nominal sequence. [May not be able to recapture, if reqd, if capture latches are not closed. Multiple failures reqd to inadvertently drive a latch motor open]</td>
<td></td>
</tr>
</tbody>
</table>
# APDS FAILURE/IMPACT MATRIX (Cont)

<table>
<thead>
<tr>
<th>APDS Status It</th>
<th>APDS FAILURE</th>
<th>IMPACT</th>
<th>OFF NOMINAL PROCEDURE (IF APPLICABLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNDOCK COMPLET</td>
<td>Failed ON (s)</td>
<td>If light comes on when APDS CIRC PROT OFF pb is pressed, hooks may be continuously commanded open.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>No impact. Indication is not used by any logic.</td>
<td></td>
</tr>
<tr>
<td>INITIAL CONTACT</td>
<td>Failed ON (s)</td>
<td>One contact cue disabled. RING ALIGNED lt, and CRT RING ALIGN and PETAL POS BASE 1,2,3 indications, may be used as contact indications.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>One contact cue disabled. (Not detectable prior to contact).</td>
<td></td>
</tr>
<tr>
<td>CAPTURE</td>
<td>Failed ON (m)</td>
<td>Auto sequence may be active (dampers, fixers, ring/hook drive). May be unable to reset dampers. Potential Shuttle/PMA 2/3 mechanism damage if no damping or damping failed on.</td>
<td></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. Starred blocks in affected procedures.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Ring will continue to drive at Forward Position until terminated by a PWR On/Off reset.</td>
<td></td>
</tr>
<tr>
<td>READY TO HOOK</td>
<td>Failed ON (s)</td>
<td>Hooks will begin driving closed with RING IN pb command.</td>
<td></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. Manual CLOSE HOOKS pb command required to drive hooks closed per starred block on DOCKING SEQUENCE (Cue Card).</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></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Hooks will not stop driving when closed position reached. HOOKS 1(2) NOT CLOSED WITHIN SINGLE MTR TIME if hooks not verified closed via CRT.</td>
<td></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></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. LATCHES OPEN LT FAILED OFF.</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></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>During Ring retraction to Final Position, ring will not stop driving at Final Position.</td>
<td></td>
</tr>
</tbody>
</table>
## APDS FAILURE/IMPACT MATRIX (Cont)

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

<table>
<thead>
<tr>
<th>APDS TLM</th>
<th>APDS FAILURE</th>
<th>IMPACT</th>
<th>OFF NOMINAL PROCEDURE (IF APPLICABLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAMPING</td>
<td>Failed ON (s)</td>
<td>Mechanism may not have compliance on contact; load capability may be exceeded. Failed-on dampers slow ring drive to about single motor drive time</td>
<td>DAMPING FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>No impact for single failure. If all dampers failed, large rates/misalignments may cause mechanism to hit hard stops, exceeding its load capability</td>
<td></td>
</tr>
<tr>
<td>RING FIXERS</td>
<td>Failed ON (s)</td>
<td>Mechanism may not have compliance on contact; load capability may be exceeded</td>
<td>FIXERS FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>No impact for single fixer failure. For multiple failure case, alignment may be lost during ring retraction. [Detectable only during ring drive operations]</td>
<td></td>
</tr>
<tr>
<td>CLUTCH – SLIP</td>
<td>Failed ON (s)</td>
<td>If slip clutch locking mechanism failed in SLIP, resistance created by dampers and/or pusher springs will load actuator sufficiently to prevent ring motion</td>
<td>APDS DIRECT DRIVE USING BOB required to drive slip clutch to LOCK</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>Must verify clutch in SLIP prior to contact</td>
<td></td>
</tr>
<tr>
<td>CLUTCH – LOCK</td>
<td>Failed ON (s)</td>
<td>Must verify clutch in SLIP prior to contact, otherwise mechanism may not have compliance on contact; load capability may be exceeded</td>
<td>APDS DIRECT DRIVE USING BOB required to drive slip clutch to SLIP</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>If slip clutch locking mechanism failed in SLIP, resistance created by dampers and/or pusher springs will load ring actuator sufficiently to prevent ring motion</td>
<td></td>
</tr>
<tr>
<td>CAP MAN REL</td>
<td>Failed OP (s)</td>
<td>If latch is released, may be unable to draw interfaces together</td>
<td></td>
</tr>
<tr>
<td>CNTL PNL PWR</td>
<td>Failed ON (s)</td>
<td>One logic bus remains powered. Still at least two failures from any inadvertent ops</td>
<td>Next failure may require APDS Direct Drive IFM to complete docking or separate, or require manual capture latch release</td>
</tr>
<tr>
<td></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></td>
</tr>
<tr>
<td>RNG DR BUS 1(2)</td>
<td>Failed OFF (s)</td>
<td>Loss of ring drive motor 1(2)</td>
<td></td>
</tr>
<tr>
<td>HKS DR BUS 1(2)</td>
<td>Failed OFF (s)</td>
<td>Loss of hook drive motor 1(2) [Affects both Hooks 1 &amp; 2]</td>
<td></td>
</tr>
<tr>
<td>DAMPER BUS 1(2)</td>
<td>Failed OFF (s)</td>
<td>BUS 1 (MN A): Dampers 1,2 failed. BUS 2 (MN B): Dampers 3 failed</td>
<td></td>
</tr>
<tr>
<td>FIXER BUS 1(2)</td>
<td>Failed OFF (s)</td>
<td>BUS 1 (MN A): Fixers 1,2 failed. BUS 2 (MN B): Fixers 3,4,5 failed</td>
<td></td>
</tr>
</tbody>
</table>
CUE CARD CONFIGURATION

RCS BURN (+X, -X, Multi-axis) (FRONT) ................................................................. CC 9-3
RENDEZVOUS PRPLT PAD (BACK) ........................................................................ CC 9-4
KU OPS (FRONT) .................................................................................................. CC 9-5
(BACK) .................................................................................................................. CC 9-6
APPROACH (FRONT) ............................................................................................ CC 9-7
VBAR APPROACH (BACK) .............................................................................. CC 9-8
C/L CAMERA TARGET ALIGNMENT (FRONT) .................................................. CC 9-9
(BACK) .................................................................................................................. CC 9-10
DOCKING SEQUENCE (FRONT) ........................................................................... CC 9-11
(BACK) .................................................................................................................. CC 9-12
STOPWATCH RDOT CONVERSION (+ VBAR) (FRONT) ....................................... CC 9-13
(BACK) .................................................................................................................. CC 9-14
GPC/MDM FAILURE RESPONSE DURING RNDZ (FRONT) .......................... CC 9-15
RNDZ REF DATA (BACK) ................................................................................... CC 9-16
C/L CAMERA CORRIDOR AND ALIGNMENT .................................................. CC 9-17
CAMERA A/D RANGE RULER ............................................................................ CC 9-18
C/L CAMERA ZOOM CALIBRATION (RING READY FOR DOCK) ....................... CC 9-19
760 PGSC DISPLAY OF C/L CAMERA CORRIDOR AND ALIGNMENT ............. CC 9-20
CAMERA A/D RANGE RULER ............................................................................ CC 9-21
SUB ANG RULER .................................................................................................... CC 9-22
V10 MONITOR CORRIDOR ................................................................................... CC 9-23
APPROACH WITH RPM ....................................................................................... CC 9-24
VBAR APPROACH POST RPM ............................................................................ CC 9-25
RCS BURN (+X, -X, Multi-axis)
1. GNC, OPS 202 PRO
   GNC ORBIT MNVR EXEC
   \text{RCS SEL, ITEM 4 – (\textasteriskcentered)}
2. If onboard computed burn:
   \text{\textasteriskcentered}\text{\textasteriskcentered} TIG and TGT PEG 7 \( \Delta \)Vs per Final solution
   Guidance option is LAMBERT
   If ground computed burn:
   \text{\textasteriskcentered}\text{\textasteriskcentered} TGT data per Burn Pad (reload WT as reqd)
   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC
3. If +X burn:
   DAP: A/AUTO/ALT(B/ALT as reqd)
   MNVR – ITEM 27 EXEC (\textasteriskcentered)
   If RR ops:
   KU – AUTO TRK
   GNC 33 REL NAV
   INH Angles – ITEM 24 EXEC (\textasteriskcentered)
   TIG-0:30
4. FLT CNTLR PWR – ON
   DAP TRANS: as reqd
   If Multi-axis:
   DAP: A/AUTO/PRI
   If +X or -X:
   DAP: A/INRTL/PRI
   \textbf{CAUTION}
   LAMBERT burn must be completed by T1 TIG +1:30 to avoid guidance errors
   * If start of LAMBERT burn delayed: *
   ** Retarget burn, then go to step 2 **
TIG
5. If VGO Z is neg, Z,X,Y seq;
   otherwise, X,Y,Z
   THC: Trim VGOS < 0.2 fps
   FLT CNTLR PWR – OFF
   DAP: ALT
   DAP TRANS: PULSE/PULSE/PULSE
   GNC, OPS 201 PRO
6. If +X burn:
   DAP: A/AUTO(B/AUTO/ALT as reqd)
   If RR ops, when ATT ERR < 30 deg:
   KU – GPC
   KU TRACK tb – gray
   GNC 33 REL NAV
   AUTO Angles – ITEM 23 EXEC (\textasteriskcentered)
7. When in attitude:
   DAP: A/AUTO/VERN(ALT)

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

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

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

When L or R RCS QTY < 7:
or when FRCS QTY < 8:
DAP: NO LO Z

When L or R RCS QTY < 9:
or when FRCS QTY < 10:
If prior to Ti:
| Do not perform Ti
If after Ti, but prior to TORVA init (+X burns to start TORVA are complete):
| Go to RNDZ BREAKOUT (CONTINGENCY OPS), 5-18
If during TORVA:
| Go to SHUTTLE NOSE IN-PLANE BREAKOUT (CONTINGENCY OPS), 5-16
If stable on +VBAR:
| Go to VBAR BREAKOUT (CONTINGENCY OPS), 5-14
KU OPS

1. CONFIGURE KU FOR RR TGT ACQ
   [GNC 33 REL NAV]
   CRT
   √ SV SEL, ITEM 4 – FLTR
   √ INH RNG, ITEM 18 – (*)
   √ RDOT, ITEM 21 – (*)
   Angles, ITEM 24 – (*)
   KU ANT ENA – ITEM 2 EXEC (*)
   GNC I/O RESET
   A2
   KU PWR – STBY
   MODE – RDR PASSIVE
   √ RDR OUTPUT – HI
   CNTL – PNL (wait 3 sec)
   PWR – ON
   KU SEL – GPC >>

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

3. RR NAVIGATION
   [GNC 33 REL NAV]
   CRT
   √ RADAR, ITEM 13 – (*)
   * If RATIO > 1.0: *
   * √ MCC *
   FLTR TO PROP – ITEM 8 EXEC (*)
   AUT RNG – ITEM 17 EXEC (*)
   RDOT – ITEM 20 EXEC (*)
   Angles – ITEM 23 EXEC (*) >>

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

   HOOK VELCRO
TOP
BACK OF 'KU OPS'

HOOK
VELCRO

HOOK
VELCRO

(reduced copy)
<table>
<thead>
<tr>
<th>CG to CG RNG (ft)</th>
<th>RDOT (ft/s)</th>
<th>MC2 ET h:mm:ss</th>
<th>DAP AUTO/VERN (PRI)</th>
<th>EVENT</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>A8/B8</td>
<td>If RDOT falls below value for next gate, THC: -Z (in) as reqd to maintain RDOT</td>
<td>1990 HHL Report</td>
<td>2015 HHL Report</td>
</tr>
<tr>
<td>1700</td>
<td>-2.6</td>
<td>0:29:00</td>
<td></td>
<td>Report to MCC: ISS solar array config</td>
<td>1690 1698</td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td>-2.3</td>
<td>0:30:00</td>
<td></td>
<td>MCC UPDATE: Go to proceed inside 400 ft to 170 ft</td>
<td>1490 1498</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>-1.5</td>
<td>0:35:00</td>
<td>LO Z</td>
<td></td>
<td>990 985</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>↓</td>
<td></td>
<td>A1U KU BD RDR OUTPUT – LOW</td>
<td></td>
<td>790 HHL Report</td>
<td>786 HHL Report</td>
</tr>
<tr>
<td>650</td>
<td></td>
<td>0:42:30</td>
<td>Report to ISS: Range 650 ft</td>
<td></td>
<td>640 636</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>-0.8</td>
<td>0:40:00</td>
<td>A9/B9</td>
<td>TORVA</td>
<td>590 586</td>
<td></td>
</tr>
<tr>
<td>550</td>
<td>-0.7</td>
<td></td>
<td></td>
<td>TRK – ITEM 19 EXEC (CUR-*)</td>
<td>540 536</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>-0.5</td>
<td></td>
<td></td>
<td>THC: + X (up) as reqd to null tgt motion in C/L camr and initiate flyaround (approx 22 DAP A pulses)</td>
<td>490 486</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>0.0 to -0.1</td>
<td></td>
<td></td>
<td>Maintain ISS within C/L camr FOV</td>
<td>390 HHL Report</td>
<td>343 HHL Report</td>
</tr>
<tr>
<td>When Pitch Error &lt; 2°</td>
<td>0:51:30</td>
<td>ESTABLISH VBAR</td>
<td>THD: - X (down) as reqd to null ISS in C/L camr, then THC: as reqd to maintain ISS in camr FOV</td>
<td>HHL RNG (to LAB)</td>
<td>TCS Refl. 1</td>
<td></td>
</tr>
<tr>
<td>415-315</td>
<td>-0.2</td>
<td>0:52:00</td>
<td>Perform CONFIGURE FOR DOCKING</td>
<td></td>
<td>357–257 HHL Report</td>
<td>355–255 HHL Report</td>
</tr>
</tbody>
</table>

* Raw TCS Range assumes ISS in docking attitude

GROUND STATION COVERAGE APPROACH

**GROUND STATION COVERAGE APPROACH**

**PRIME GROUND STATION PASS**

Approach PET 0:00 = [ ] [ ] [ ] [ ] [ ] [ ]

**BACKUP GROUND STATION PASS**

Approach PET 0:00 = [ ] [ ] [ ] [ ] [ ] [ ]

**170 ft STATIONKEEPING**

Prime Backup

**CONFIGURE FOR DOCKING**

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

*Raw TCS Range assumes ISS in docking attitude

(reduced copy)
**Interface**

<table>
<thead>
<tr>
<th>Interface</th>
<th>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 US Lab)</th>
<th>Raw TCS RNG*</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>-0.20</td>
<td>0:57:00 (-34:00)</td>
<td>√LO Z</td>
<td>MCC UPDATE: Go to proceed inside 170 ft, Go for docking</td>
<td>257</td>
<td>HHL Report</td>
<td>255</td>
</tr>
<tr>
<td>(170 ± 10)</td>
<td>170</td>
<td>(0.00)</td>
<td>-0.20 (-27:30)</td>
<td>DAP: B</td>
<td>Note: DAP A allowed for ±X and ±Z THC If reqd, THC: as reqd to null Rdot and perform VBAR stationkeeping</td>
<td>177</td>
<td>HHL Report</td>
</tr>
<tr>
<td>110</td>
<td>-0.15</td>
<td>1:08:30 (-22:30)</td>
<td>No LO Z A10,B10 √DAP: B</td>
<td>Perform CONFIGURE KU FOR COMM (Cue Card, KU OPS)</td>
<td>117</td>
<td>HHL Report</td>
<td>82</td>
</tr>
<tr>
<td>30 ± 5</td>
<td>0.0</td>
<td>1:20:00 (-11:00)</td>
<td>√A10,B10 √DAP: B</td>
<td>5° Corridor</td>
<td>32-42</td>
<td>HHL Report</td>
<td>30-40</td>
</tr>
<tr>
<td>30</td>
<td>-0.07</td>
<td>1:25:00 (-06:00)</td>
<td>√5° Corridor</td>
<td>TH: as reqd to establish RDOT = -0.07 ±0.02 fps</td>
<td>37</td>
<td>HHL Report</td>
<td>35</td>
</tr>
<tr>
<td>25</td>
<td>↑</td>
<td>1:26:00 (-05:00)</td>
<td>Maintain [GNC 23 RCS] through contact</td>
<td></td>
<td>32</td>
<td>HHL Report</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>-0.10</td>
<td>1:29:20 (-01:40)</td>
<td>No LO Z ARM PCT</td>
<td>F2(F4) SPD BK/THROT pb – AUTO</td>
<td>17</td>
<td>HHL Report</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>-0.10</td>
<td>1:30:30 (-00:30)</td>
<td>Maintain 3 inch lateral alignment cylinder</td>
<td>N/A</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTACT or ~2 in</td>
<td>-0.10</td>
<td>1:31:00 (00:00)</td>
<td>PCT (SPARE pbi)</td>
<td>CAPTURE</td>
<td>IF NO CAPTURE (bounce-off) Go to FAILED CAPTURE</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

* Raw TCS Range assumes ISS in docking attitude

**FAILED CAPTURE**

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

2. √DAP: NO LO Z
   * IF VERN FAIL: *
   * DAP: PRI *
   If petals clear:
   DAP: A(B)/LVLH

3. TH: -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

**CONTACT**

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

**A6U**

- When capture confirmed and ISS in FREE DRIFT: CNTL PWR – OFF
- Perform TCS DEACTIVATION (RNDZ TOOLS), 7-20
- Go to DOCKING SEQUENCE (CC)

**CAPTURE**

- START EVENT TIMER = 00:00:00
- Notify ISS and MCC-H: “Capture Confirmed” DISARM PCT:
- SPD BK/THROT pb – push (it off)
- √ISS in FREE DRIFT (ISS indicator lights flashing)
  - IF NO INDICATION OF ISS FREE *
  - DRIFT AT CAPTURE + 65 SEC: *
  - Go to FAILED CAPTURE *
  - When capture confirmed and ISS in FREE DRIFT: CNTL PWR – OFF
  - Perform TCS DEACTIVATION (RNDZ TOOLS), 7-20
  - Go to DOCKING SEQUENCE (CC)
## APPRAOCH WITH RPM

### CG to CG RNG (ft) | RDOT (ft/s) | MC2 ET h:mm:ss | DAP | EVENT | HHL RNG (ft) (to ISS cg) | Raw TCS RNG* (ft) (Ref1 # 2) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>-3.0</td>
<td>0:27:00</td>
<td>A8/B8 AUTO/VERN (PRI)</td>
<td>If RDOT falls below value for next gate, THC: -Z (in) as reqd to maintain RDOT</td>
<td>1990 HHL Report</td>
<td>2015</td>
</tr>
<tr>
<td>1700</td>
<td>-2.4</td>
<td>0:29:00</td>
<td>LO Z</td>
<td>Report to MCC: ISS solar array config</td>
<td>1690 1698</td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td>-2.1</td>
<td>0:31:00</td>
<td>A9/B9 A_/B9</td>
<td>MCC UPDATE: Go for RPM, Go to proceed within 400 ft to 170 ft</td>
<td>1490 1498</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>-1.3</td>
<td>0:36:00</td>
<td>Lo Z</td>
<td>Report to ISS: 10 minutes to RPM Start</td>
<td>990 985</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>-0.9</td>
<td>0:38:00</td>
<td>A10 KU RDR OUTPUT - LO, KU sel - AUTO TRK</td>
<td>When in Rbar attitude</td>
<td>790 HHL Report</td>
<td>786</td>
</tr>
<tr>
<td>700</td>
<td>-0.6</td>
<td>0:41:00</td>
<td>A9/B9 A_/B9</td>
<td>GNC 20 DAP CONFIG</td>
<td>690 686</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>-0.4</td>
<td>0:42:30</td>
<td>VERN (PRI)</td>
<td>Config DAP A,B to A9,B9</td>
<td>590 586</td>
<td>570 566</td>
</tr>
<tr>
<td>620</td>
<td>-0.4 &lt; Rdot &lt; -0.3</td>
<td>Null Xdot to 0 ± 0.1 ft/sec prior to maneuver start</td>
<td></td>
<td>RBAR PITCH MANEUVER (RPM)</td>
<td>610 606</td>
<td>590 586</td>
</tr>
<tr>
<td>580</td>
<td>-0.2 &lt; Rdot &lt; -0.1</td>
<td>If required: Stationkeep at 600-620 ft until RPM window opens</td>
<td></td>
<td></td>
<td>570 566</td>
<td></td>
</tr>
</tbody>
</table>

### AFT ADI (RPOP) P | FWD ADI P | DAP/UNIV PTG | ISS Calls / Other |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P = 90 (Rbar attitude)</td>
<td>P = 0</td>
<td>A/AUTO/PRI TRK – ITEM 19 EXEC</td>
<td>FLT CNTLR PWR – OFF Initiating RPM (with mark)</td>
</tr>
<tr>
<td>P &gt; 100</td>
<td>P &gt; 10</td>
<td>VERN (PRI)</td>
<td></td>
</tr>
<tr>
<td>P &gt; 170</td>
<td>P &gt; 145</td>
<td>FREE TRK – ITEM 19 EXEC PRI</td>
<td></td>
</tr>
<tr>
<td>P &gt; 235</td>
<td>P = 215</td>
<td>Start photos</td>
<td></td>
</tr>
<tr>
<td>P &gt; 305</td>
<td>P &gt; 280</td>
<td>End photos</td>
<td></td>
</tr>
<tr>
<td>P &gt; 500</td>
<td>P = 0</td>
<td>VERN (PRI)</td>
<td>FLT CNTLR PWR – ON</td>
</tr>
</tbody>
</table>

**RPM START WINDOW (MET) OPEN: __ / __ : __ : __**

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

**CREATE FOR DOCKING**
- Perform CONFIGURE FOR DOCKING (Cue Card)
### VBAR APPROACH POST RPM

**RNDZ-15b/115/O/B**

<table>
<thead>
<tr>
<th>Interface RNG (ft)</th>
<th>RDOT (ft/s)</th>
<th>MC2 ET: h:mm:ss (doc – PET)</th>
<th>DAP</th>
<th>EVENT</th>
<th>HHL RNG (to US Lab) (ft)</th>
<th>Raw TCS RNG* (Ref #1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>-0.20</td>
<td>1:15:00 (-34:00)</td>
<td>∨LO Z</td>
<td>MCC UPDATE: Go to proceed inside 170 ft, Go for docking Maintain ISS docking target within 8 deg Corridor</td>
<td>257</td>
<td>255</td>
</tr>
<tr>
<td>170 ± 10</td>
<td>(0.00)</td>
<td>1: 21:30 (-27:30)</td>
<td>DAP: B</td>
<td>Note: DAP A allowed for ≥X and ≥Z THC, If reqd, THC: as reqd to null Rdot and perform VBAR stationkeeping</td>
<td>177</td>
<td>175</td>
</tr>
<tr>
<td>110</td>
<td>-0.15</td>
<td>1:26:30 (-22:30)</td>
<td>No LO Z</td>
<td>Perform CONFIGURE KU FOR COMM (Cue Card, KU OPS)</td>
<td>117</td>
<td>115</td>
</tr>
<tr>
<td>75</td>
<td>-0.10</td>
<td>1:30:30 (-18:30)</td>
<td>A10, B10</td>
<td>Note: DAP A allowed for ≥X and ≥Z THC (in) GNC 23 RCS (Maintain through contact)</td>
<td>82</td>
<td>80</td>
</tr>
<tr>
<td>30 ± 5</td>
<td>0.0</td>
<td>1:38:00 (-11:00)</td>
<td>A10, B10</td>
<td>5° Corridor If Flyout Req’d: THC: +Z (out) as reqd to null RDOT Perform AUTO ANGULAR FLYOUT (Cue Card) outside 25 ft Review FAILED CAPTURE, steps 1 thru 3, CAUTION (Cue Card, DOCKING SEQUENCE)</td>
<td>32-42</td>
<td>30-40</td>
</tr>
<tr>
<td>30</td>
<td>-0.07</td>
<td>1:43:00 (-06:00)</td>
<td>∨LO Z</td>
<td>MCC UPDATE: Go to proceed inside 170 ft, Go for docking Maintain ISS docking target within 8 deg Corridor</td>
<td>37</td>
<td>35</td>
</tr>
<tr>
<td>25</td>
<td>↑</td>
<td>1:44:00 (-05:00)</td>
<td>GNC 23 RCS</td>
<td>Maintain GNC 23 RCS through contact</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>-0.10</td>
<td>1:47:20 (-01:40)</td>
<td>ARM PCT F2(F4) SPDBK/THROT pb – AUTO – ∨lt on</td>
<td>17</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-0.10</td>
<td>1:48:30 (-00:30)</td>
<td>Maintain 3 inch lateral alignment cylinder</td>
<td>N/A</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>CONTACT</td>
<td>-0.10</td>
<td>1:49:00 (00:00)</td>
<td>PCT (SPARE pbi)</td>
<td>CAPTURE IF NO CAPTURE (bounce-off) Go to FAILED CAPTURE</td>
<td>N/A</td>
<td>5</td>
</tr>
</tbody>
</table>

* Raw TCS Range assumes ISS in docking attitude

### CAPTURE

**MS** START EVENT TIMER = 00:00:00

**A7L**

- CAPTURE lt – It on
- Notify ISS and MCC-H: “Capture Confirmed”
- DISARM PCT
- F4 SPDBK/THROT pb – push (lt off)
- ∨ISS in FREE DRIFT (ISS indicator lights flashing)
  * IF NO INDICATION OF ISS FREE
  * DRIFT AT CAPTURE + 65 SEC:
  * Go to FAILED CAPTURE

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

### FAILED CAPTURE

1. APDS CIRC PROT OFF pb – push
   - ∨CIRCUIT PROTECT OFF lt – It on
   - OPEN LAT pb – push
   - ∨LATCHES CLOSED lt – It off
   - OPEN lt – It on

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

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

3. THC: +Z (out) to establish 0.1 fps opening rate
   - ∨DAP: B/LVLH
   - 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. \( \text{PITCH} = 179 - P = \_
\) (A)

5. \( \text{PITCH} = \text{PITCH} - P = \_
\) (D)

TARGET DISPLACED UP
(Cross Displaced DOWN)

\[
P = \_
\]

\[
P = \_
\]

3. \( \text{PITCH} = 179 + P = \_
\) (A)

5. \( \text{PITCH} = \text{PITCH} + P = \_
\) (D)

ROLL (R)

ITEM 16

\[
\text{Rotated CW}
\]

\[
R = \_
\]

\[
R = \_
\]

3. \( \text{YAW} = 360 - R = \_
\) (B)

5. \( \text{YAW} = \text{YAW} - R = \_
\) (E)

\[
\text{Rotated CCW}
\]

\[
R = \_
\]

\[
R = \_
\]

3. \( \text{YAW} = 0 + R = \_
\) (B)

5. \( \text{YAW} = \text{YAW} + R = \_
\) (E)

YAW (Y)

ITEM 17

TARGET DISPLACED RIGHT
(Cross Displaced LEFT)

\[
Y = \_
\]

\[
Y = \_
\]

3. \( \text{OM} = 0 + Y = \_
\) (C)

5. \( \text{OM} = \text{OM} + Y = \_
\) (F)

TARGET DISPLACED LEFT
(Cross Displaced RIGHT)

\[
Y = \_
\]

\[
Y = \_
\]

3. \( \text{OM} = 360 - Y = \_
\) (C)

5. \( \text{OM} = \text{OM} - Y = \_
\) (F)

(reduced copy)
AUTO ANGULAR FLYOUT

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

1. RECORD ANGULAR MISALIGNMENT

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

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

3. EXECUTE ALIGNMENT MNVR

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

When mnvr cplt,

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

Otherwise,

5. REPEAT ALIGNMENT
a. Calculate UNIV PTG inputs:
Use diagrams in TARGET ALIGNMENT (Cue Card) to determine UNIV PTG inputs for step 5b
b. Execute alignment MNVR

GNC UNIV PTG
√TGT ID +2
√BODY VECT +5
PITCH +(D)
YAW +(E)
OM +(F)
TRK – ITEM 19 EXEC (CUR-*)
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 tlm Failed ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPTURE lt Failed On</td>
<td>FIXERS tlm Failed On</td>
</tr>
</tbody>
</table>

**CAUTION**
If any Docking Sequence command occurs out of order or if any STATUS lt functions erroneously:
A7L POWER OFF pb – push
ON pb – push
Proceed with APDS OFF-NOMINAL procedures (APDS)

---

**Event Time**

**Contact/Capture/Damping**

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td>A7L</td>
<td>CAPTURE lt – lt on (expect RING INITIAL POSITION lt off)</td>
</tr>
<tr>
<td>0:05</td>
<td>CRT</td>
<td>DAMPING – ON</td>
</tr>
</tbody>
</table>

**Disable and Release Dampers**

1. When no relative motion [PETAL POS BASE (three) not changing for 60 sec]:
   A7L POWER ON pb – push
   CRT DAMPING – OFF

2. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   A7L FIXER OFF pb – push
   CRT FIXERS OFF lt – lt on
   RING IN pb – push

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
   RING IN pb – push

5. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   A7L POWER ON pb – push
   CRT DAMPING – OFF

6. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   A7L APDS CIRC PROT OFF pb – push
   CRT CIRCUIT PROTECT OFF lt – lt on

7. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   A7L POWER OFF pb – push
   CRT DAMPING – OFF

(reduced copy)
### Retract Ring

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

### Close Hooks

<table>
<thead>
<tr>
<th>Time</th>
<th>A7L</th>
<th>CRT</th>
<th>Action</th>
<th>Comment</th>
</tr>
</thead>
</table>
| 0:00 | A7L | CRT | HOOKS 1,HOOKS 2 OPEN lt (two) – lt off | *
|      |     |     | HK1,HK2,DRV CMD (two) – ON | *
|      |     |     | POS (two) ≥ 5% & incr | *
|      |     |     | If HK1(2) DRV CMD – OFF or HK1(2) POS not incr: | *
|      |     |     | CLOSE HOOKS pb – push | *
|      |     | A7L | If HOOKS 1(2) CLOSED lt failed ON: | *
| 0:20 | CRT |     | RING DRV CMD – OFF | *
|      |     |     | If RING DRV CMD – ON 20 sec after hooks begin | *
|      |     |     | Driving in step 10: | *
|      | A7L |     | POWER ON pb – push | *
| ≤ 1:30 | A7L | CRT | INTERF SEALED lt – lt on (expect intermittent lt initially) | *
| 2:20 | CRT |     | HOOKS 1,HOOKS 2 CLOSED lt (two) – lt on | *
|      |     |     | HK1,HK2 POS (two) = 92% | *
|      |     |     | IND (two) – blank/CL | *
|      |     |     | ODS INDIV HK CL (twelve) – CL | *

### Load Relieve Capture Latches (Extend Ring)

<table>
<thead>
<tr>
<th>Time</th>
<th>A7L</th>
<th>CRT</th>
<th>Action</th>
<th>Comment</th>
</tr>
</thead>
</table>
| 0:00 | A7L |     | APDS CIRC PROT OFF pb – push | *
|      |     |     | CIRCUIT PROTECT OFF lt – lt on | *
| 0:10 | A7L |     | POWER ON pb – push | *
| 0:10 | CRT |     | RING DRV CMD – OFF | *

### Open Capture Latches

<table>
<thead>
<tr>
<th>Time</th>
<th>A7L</th>
<th>CRT</th>
<th>Action</th>
<th>Comment</th>
</tr>
</thead>
</table>
| 0:00 | A7L |     | OPEN LATCHES pb – push | *
|      |     |     | LATCHES CLOSED lt – lt off | *
| 0:05 |     |     | OPEN lt – lt on | *

### Retract Ring to FNL POS

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

### Power Off

<table>
<thead>
<tr>
<th>Time</th>
<th>A7L</th>
<th>CRT</th>
<th>Action</th>
<th>Comment</th>
</tr>
</thead>
</table>
| 0:00 |     | CRT | STATUS lt (eighteen) – lt off | *
| 20. |     |     | Go to TERMINATE RNDZ OPS 4-22 >> | *

(reduced copy)
**STOPWATCH RDOT CONVERSION**

<table>
<thead>
<tr>
<th>TIME BETWEEN 1 FT MARKS (SEC)</th>
<th>RANGE RATE (FT/SEC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.50</td>
</tr>
<tr>
<td>3</td>
<td>0.33</td>
</tr>
<tr>
<td>4</td>
<td>0.25</td>
</tr>
<tr>
<td>5</td>
<td>0.20</td>
</tr>
<tr>
<td>5.5</td>
<td>0.18</td>
</tr>
<tr>
<td>6</td>
<td>0.17</td>
</tr>
<tr>
<td>6.5</td>
<td>0.15</td>
</tr>
<tr>
<td>7</td>
<td>0.14</td>
</tr>
<tr>
<td>7.5</td>
<td>0.13</td>
</tr>
<tr>
<td>8</td>
<td>0.125</td>
</tr>
<tr>
<td>8.5</td>
<td>0.12</td>
</tr>
<tr>
<td>9</td>
<td>0.11</td>
</tr>
<tr>
<td>10</td>
<td>0.10</td>
</tr>
<tr>
<td>11</td>
<td>0.09</td>
</tr>
<tr>
<td>12</td>
<td>0.08</td>
</tr>
<tr>
<td>13</td>
<td>0.075</td>
</tr>
<tr>
<td>14</td>
<td>0.07</td>
</tr>
<tr>
<td>15</td>
<td>0.067</td>
</tr>
<tr>
<td>16</td>
<td>0.063</td>
</tr>
<tr>
<td>18</td>
<td>0.056</td>
</tr>
<tr>
<td>20</td>
<td>0.050</td>
</tr>
</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/s)</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>
</tr>
</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>
<td>5.0</td>
<td>4.0</td>
<td>3.0</td>
<td>2.0</td>
<td>1.0</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0:55</td>
<td>10.0</td>
<td>8.3</td>
<td>6.7</td>
<td>5.0</td>
<td>4.2</td>
<td>3.3</td>
<td>2.5</td>
<td>1.7</td>
<td>0.83</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:00</td>
<td>10.0</td>
<td>8.6</td>
<td>7.1</td>
<td>5.7</td>
<td>4.3</td>
<td>3.6</td>
<td>2.9</td>
<td>2.1</td>
<td>1.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:10</td>
<td>10.0</td>
<td>8.8</td>
<td>7.5</td>
<td>6.3</td>
<td>5.0</td>
<td>3.8</td>
<td>3.1</td>
<td>2.5</td>
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### NOTE

If RPOP is available, use RPOP subtended angle function.

### TIME DELTA RANGE DELTA RANGE

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RNDZ-6b/115/O/A
### GPC/MDM FAILURE RESPONSE DURING RNDZ

**NOTES**
1. GPC assignments assume 1233 NBAT
2. Do NOT restring for Non-Universal I/O Errors. Otherwise, a restring for GPC 1,2,3 fails will recover everything (see expected restring below)
3. If any GNC GPC fails, VERNs ↓
4. If IMUs not commfaulted, THCs are normally GO
5. Loss of FF2, FF4, FA3, and FA4 do not impact Rndz (unless other failures)

<table>
<thead>
<tr>
<th>GPC</th>
<th>MDM</th>
<th>IMMEDIATE ACTION</th>
<th>MAJOR IMPACT</th>
</tr>
</thead>
</table>
| GPC1 (3232*) | FF1 | 1. If -Z ST NAV, INH ST to NAV  
2. Work appropriate ORB PKT procedure  
3. If not recovered: Use -Y ST, if reqd | 1. C3 DAP lights latched (go out with MDM pwr fail)  
2. -Z ST ↓ |
|            | FA1 | Pre-MC4: DAP: ALT/AUTO  
Post-MC4: DAP: PRI/AUTO | VERNs ↓ |
| GPC2 (1313*) | FA2 | Pre-MC4: DAP: ALT/AUTO  
Post-MC4: DAP: PRI/AUTO | VERNs ↓ |
| Man OMS Shutdown | FF3 | 1. Pre-MC4: DAP: ALT/AUTO  
Post-MC4: DAP: PRI/AUTO | 1. VERNs ↓  
2. RR → NAV/RPOP ↓  
(Post 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 Aft DAP | GPC3 (1212*) | 2. If RR NAV, INH RR to NAV  
3. If -Y ST NAV, INH ST to NAV  
4. Work appropriate ORB PKT procedure  
5. If not recovered: Work RR FAIL procedures | |
| 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**

| >> |

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RNDZ-7a/115/O/A
Note: Fabricate As Transparency

![Diagram of camera A/D range ruler with measurements and instructions for use.]

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<th>Camera A/D</th>
<th>Range Ruler</th>
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Use Bottom/Back of ISS Ring
Use Top/Front of ISS Ring

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CTVC FULL NO ZOOM

RNDZ-9a/115/O/A
C/L CAMERA

ZOOM CALIBRATION (RING READY FOR DOCK)

CTVC AT HFOV = 40.0 DEG

Note: Fabricate As Transparency
Note: Fabricate As Transparency

CTVC FULL NO ZOOM

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Use Bottom/Back Of ISS Ring
Use Top/Front Of ISS Ring

RANGE RULER

0 feet
1 feet
2 feet
3 feet
4 feet
5 feet
6 feet
7 feet

RNDZ-12a115/O/A

(reduced copy)
Note: Fabricate As Transparency

V10 MONITOR  CORRIDOR

CTVC 40.0 DEG HFOV - CORRIDOR  CTVC FULL ZOOM - ALIGNMENT