Rendezvous

STS-116

Mission Operations Directorate
Flight Design and Dynamics Division

Final
November 1, 2006
List of Implemented Change Requests (482s):

RNDZ-1229
RNDZ-1230
RNDZ-1231

Incorporate the following:

1. Replace v thru x
2. Replace 2-7 and 2-8
3. Replace 7-23 and 7-24
4. Replace 8-3 and 8-4, 8-9 thru 8-12

Prepared by: [Signature] 11/14/06
Book Manager

Approved by: [Signature] 11/14/06
Lead, Rendezvous Guidance and Procedures Group

Accepted by: [Signature] 11/14/06
Chief, Orbit Dynamics Branch

Encl: 16 pages

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

RENDZVOUS
STS-116

FINAL
November 1, 2006

PREPARED BY:

Nicholas O'Dosey
Book Manager

11/03/06

APPROVED BY:

Steve R. Walker
Lead, Rendezvous Guidance and Procedure Group

11/3/06

ACCEPTED BY:

R. T. Gavin
Chief, Orbit Dynamics Branch

11/3/06

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

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Incorporates the following:

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**AREAS OF TECHNICAL RESPONSIBILITY**

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NOTE
This checklist is the controlling crew document for the ISS-12A.1 rendezvous and separation. The Rendezvous Timeline begins at Ti -3:00 hr and continues through docking. This is a complete stand-alone document. The Separation Timeline begins 45 min prior to undock and continues through 1:15 after undock.

Timeline pages assume an FD3 rendezvous and undocking on FD10. Lighting is based on planned rendezvous altitude of 205 nm. Targeting I-Loads are based on 210 nm.
ACRONYMS

AZ, AZM  Azimuth
D/N  Day/Night
EL, ELEV  Elevation
IAH  Inertial
LOS  Line of Sight
LVLH  Local Vertical, Local Horizontal
R  Range
·  Range Rate
R, RDOT  Rendezvous Radar
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
**LIST OF EFFECTIVE PAGES**

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## FLIGHT RULES SUMMARY

### RNDZ/PROX OPS BREAKOUT PROCEDURES OVERVIEW

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<th>RANGE BREAKOUT REQD</th>
<th>BREAKOUT PROCEDURE AND SUMMARY</th>
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<tr>
<td><strong>LONG RANGE SHUTTLE BREAKOUTS (Prior to RBAR Arrival)</strong></td>
<td></td>
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<tr>
<td>Prior to Ti</td>
<td>Discontinue RNDZ burns; specific breakout only on MCC call</td>
</tr>
<tr>
<td>Ti - 5 Minutes</td>
<td>If go for Ti not received, perform Ti Delay, 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>
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<tr>
<td>Prior to docking</td>
<td>See VBAR CORRIDOR BACKOUT (CONTINGENCY OPS), 5-12</td>
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RNDZ BURN SOLUTION SELECTION GUIDELINES

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

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

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

RNDZ BURN ENGINE SELECTION GUIDELINES

<table>
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<th>DELTA V</th>
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<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>
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<tr>
<td>FAILURE</td>
<td>RESPONSE</td>
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<tr>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
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<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>
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<tr>
<td>SYSTEMS:</td>
<td>2 GNC GPCs reqd for Ti and PROX OPS within 250 ft. Loss of GNC GPC redundancy inside 250 ft requires backout to 250 ft and stationkeep until reconfiguration to a 2 GNC redundant set is complete</td>
</tr>
<tr>
<td>DPS: &lt; 2 GNC GPCs</td>
<td>PROX OPS within 250 ft not permitted</td>
</tr>
<tr>
<td>GNC: Loss of redundant +Z Trans or PRCS TRANS, any axis ↓ or PRCS ROT, any axis ↓ or AFT THC (-Z sense), &gt; 1 TX contact ↓, all TY contacts ↓, all TZ contacts ↓ or AFT RHC, all channels, any axis ↓ or &lt; 2 IMUs</td>
<td>PROX OPS within 250 ft not permitted</td>
</tr>
<tr>
<td>Both Left Aft firing jets ↓ or Both Right Aft firing jets ↓</td>
<td>Continue Approach, per DEGRADED +X TRANSLATION (CONTINGENCY OPS)</td>
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<tr>
<td>Two Forward firing jets ↓</td>
<td>Continue Approach, per DEGRADED –X TRANSLATION (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>Both Forward Right firing jets ↓ or Both Forward Left firing jets ↓</td>
<td>PROX OPS within 250 ft not permitted. Approach or Backout to 250 ft per LOSS OF FORWARD SIDE FIRING JETS (CONTINGENCY OPS)</td>
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<tr>
<td>One Forward Down firing jet ↓</td>
<td>Continue Approach per LOSS OF ONE FxD JET (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>Both Forward Down firing jets same side ↓</td>
<td>PROX OPS within 250 ft not permitted. Approach or Backout to 250 ft per LOSS OF BOTH FxD JETS (SAME SIDE) (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>Loss of VRCS</td>
<td>Use ALT in place of VERN during RNDZ, approach outside 2000 ft, and sep Use PRI in place of VERN during approach inside 2000 ft, and flyaround See LOSS OF VRCS (CONTINGENCY OPS)</td>
</tr>
<tr>
<td>MECH: 1 KU ANTENNA STOW MOTOR ↓</td>
<td>Normal ops</td>
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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
ORBIT POST Ti PROFILE

ISS AT CENTER OF ROTATING LVLH REFERENCE FRAME

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

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<th>Range (ft) CG-CG</th>
<th>Rdot (fps)</th>
<th>EVENT</th>
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<td>2000</td>
<td>-3.0</td>
<td>MANUAL PHASE TAKEOVER (POST-MC4)</td>
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<td>2 0:29</td>
<td>1700</td>
<td>-2.4</td>
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<td>3 0:31</td>
<td>1500</td>
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<tr>
<td>3 0:36</td>
<td>1000</td>
<td>-1.3</td>
<td>TRANSITION TO LOWZ</td>
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<td>-1.1</td>
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<tr>
<td>4</td>
<td></td>
<td></td>
<td>WHEN IN RBAR ATTITUDE: LOAD DAP A9/B9 MOD DAP A PRI/VERN ROT RATE TO 0.75 DEG/SEC AND YAW JET OPTION TO BOTH NOSE &amp; TAIL (ALL) LOAD UNIV PTG P=145 DEG</td>
</tr>
<tr>
<td>800</td>
<td>-0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>-0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>650</td>
<td>-0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 0:46</td>
<td>620</td>
<td>0.0</td>
<td>STATIONKEEP TO AVOID SHADOWING IF REQUIRED</td>
</tr>
<tr>
<td>6 1:00</td>
<td>620</td>
<td>-0.35</td>
<td>INITIATE RPM: DAP A/PRI, ITEM 19 WHEN -Z ADI PITCH &gt; 100 DEG: DAP A/VERN WHEN -Z ADI PITCH &gt; 170 DEG: DAP FREE, RESET UNIV PTG P=270 DEG, ITEM 19, DAP PRI DIGITAL IMAGERY TAKEN FROM ISS SM WHEN -Z ADI PITCH &gt; 10 DEG: DAP AUTO WHEN RPM COMPLETE: DAP VERN</td>
</tr>
<tr>
<td>600</td>
<td>-0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>580</td>
<td>-0.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 1:11</td>
<td>600</td>
<td>0.0</td>
<td>RELOAD DAP A9, LOAD UNIV PTG P=180 DEG, REESTABLISH RDOT PER TORVA ICs</td>
</tr>
<tr>
<td>550</td>
<td>0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>-0.6</td>
<td></td>
<td>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 1:25</td>
<td>320</td>
<td>-0.20</td>
<td>VBAR ARRIVAL (-X PULSES AS REQ'D TO NULL TARGET MOTION IN CAMERA)</td>
</tr>
<tr>
<td>1:42</td>
<td>110</td>
<td>-0.15</td>
<td>TRANSITION TO NORMZ, LOAD DAP A10/B10, CONFIGURE FOR SINGLE -X JET (DESELECT F1F/F2F)</td>
</tr>
<tr>
<td>1:46</td>
<td>75</td>
<td>-0.10</td>
<td></td>
</tr>
<tr>
<td>9 1:54</td>
<td>30</td>
<td>-0.07</td>
<td>STATIONKEEP FOR 5 MINUTES IF ANGULAR ALIGNMENT MANEUVER REQUIRED</td>
</tr>
<tr>
<td>10 2:05</td>
<td>0</td>
<td>-0.10</td>
<td>DOCKING</td>
</tr>
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</table>
# UNDOCKING, TORS/TORF, AND FINAL SEPARATION

<table>
<thead>
<tr>
<th>UNDOCK ET (h:mm)</th>
<th>RANGE (ft)</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0:03</td>
<td>0</td>
<td>UNDOCK AT MIDNIGHT-2 MIN; DAP B/ALT MODE TO LVLH; MAINTAIN CORRIDOR</td>
</tr>
<tr>
<td>1</td>
<td>0:00</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>DAP B +Z NORMZ BURNS AT 10 SEC INTERVALS TO BUILD OPENING RATE TO 0.15 FPS</td>
</tr>
<tr>
<td></td>
<td>&gt;0:03</td>
<td>&gt;30</td>
</tr>
<tr>
<td></td>
<td>&gt;00:03</td>
<td>&gt;400</td>
</tr>
<tr>
<td></td>
<td>[1:15]*</td>
<td>[1:43]*</td>
</tr>
<tr>
<td></td>
<td>&gt;2000</td>
<td>[CG-CG]</td>
</tr>
<tr>
<td>2</td>
<td>0:07</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>0:29</td>
<td>1:5 FPS +X, RADIAL BURN</td>
</tr>
<tr>
<td></td>
<td>&gt;400</td>
<td>[CG-CG]</td>
</tr>
<tr>
<td></td>
<td>[1:15]*</td>
<td>[1:43]*</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>4.0 FPS +X, NORMZ RETROGRADE BURN</td>
</tr>
<tr>
<td></td>
<td>&gt;2000</td>
<td>[CG-CG]</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

PET

-00:45
A12(B12)

√DPS config for Undocking Ops - STRING 1233

CONFIGURE FOR SEPARATION 5A

MCC UPDATE
ORB SV
TGT SV
Covar Matrix

MCC UPDATE
Undocking Time 4A

ENABLE RENDEZVOUS NAV 5B

On RPOP PGSCs:
- Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-8, then:
  - Perform RPOP OPS, steps 1 thru 5 (RNDZ TOOLS), 7-9, then:
    - Perform TCS ACTIVATION, steps 1 thru 3 (RNDZ TOOLS), 7-18, then:
      - Perform TCS MANUAL ACQUISITION, step 1 (RNDZ TOOLS), 7-19
      (Set RANGE = 4 ft, AZIMUTH = 0, ELEVATION = 0)
      - NOTE: TCS will not track until after undock
- Perform HHL CHECKOUT (RNDZ TOOLS), 7-6

-00:40

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

-00:35

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

-00:30

-00:25

-00:20

-00:15

√MCC
DAP: FREE
O14:F, RUDA 1A L2/R2 MANF DRIVER - OFF
O15:F, RUDA MANF L5/F5/R5 DRIVER - OFF
O16:F, Pri RJD LOGIC (eight) - ON

√MCC FOR GO TO POWER UP Pri DRIVERS
RUD MANF L5/F5/R5 DRIVER - ON
Wait 5 sec.
DAP: AUTO

-00:10

-00:05

-00:00

CONFIGURE FOR SEPARATION 5A

CRT
√DAP config: A12, B12

[GNC 2 TIME]
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 - LV/LH
ERR - MED
RATE - LO
SENSE - Z
√FLT CNTRL PWR - OFF

CRT

[GNC 23 RCS]
RCS F - ITEM 1 EXEC (+)
JET DES F1L - ITEM 9 EXEC (no *)
F4L - ITEM 15 EXEC (no *)
F3U - ITEM 19 EXEC (no *)

F1U - ITEM 17 EXEC (no *)
F2U - ITEM 21 EXEC (no *)

[FNC UNIV PTG]

CRT

TGT ID +2
BODY VECT +5
P +180
Y +90
OM +90
TRK - ITEM 19 EXEC (CUR - *)
ERR TOT - ITEM 23 EXEC (+)

OPS 202 PRO

[GNC ORBIT MNVR EXEC]
Enter TIG in the future and any non-zero ΔV
Update Orbiter weight per 4A
LOAD - ITEM 22 EXEC

OPS 201 PRO

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

ENABLE RENDEZVOUS NAV 5B

[GNC 33 REL NAV]

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

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

2. RECONFIGURE DAP
   (GNC UNIV PTG)
   When ATT and RATES in limits:
   "ATT ERR (Each Axis) ≤ 3.0 (VERN) ≤ 5.0 (ALT)"
   "ROLL, YAW RATE ≤ 0.05 (VERN) ≤ 0.07 (ALT)"
   "PITCH RATE -0.115 ≤ RATE ≤ -0.015 (VERN)"
   "-0.135 ≤ RATE ≤ +0.005 (ALT)"

3. COMMAND UNDOCKING
   SM 167 DOCKING STATUS
   A7L
   * If HOOKS 1(2) OPEN lt failed on: *
   * APDS POWER Aos - OFF (√Aos and failed Its off) *
   APDS CIRC PROT OFF pb - push
   √CIRCUIT PROTECT OFF lt - It on
   -02:20 > UNDOCKING pb - push
   √HOOKS 1, HOOKS 2 CLOSED lt (two) - lt off [HK1,HK2 POS (two) < 92% + decr]
   CRT
   * If Hooks 1(2) fail to drive (HK1(2) DRV CMD - OFF): *
   * OPEN HOOKS pb - push *
   * If Hooks 1(2) appear to stop before reaching end of travel *
   * [HK1(2) Pos > 4% + not decr]: *
   * Allow for single motor drive time (~4:40) before performing *
   * POWER OFF pb - push *
   * ON pb - push *

4. POST UNDOCKING
   Inform MCC-H and ISS:
   "Physical Separation"
   When petals clear:
   DAP: B/LVLH/ALT
   √DAP TRANS: PULSE/PULSE/PULSE, NO LO Z
   √DAP TRANS: PULSE/PULSE/PULSE
   √SENSE: -Z
   -03:00 > DAP: FREE
   O14:F, Pri RJD DRIVER (eight) - ON
   O15:F, O16:F
   A6U FLT CNTLR PWR - ON

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


- MCC: GO FOR UNDOCKING

- UNDOCKING OPERATIONS [6A]

- UNDOCK COMPLETE

MCC UPDATE
GO for Undocking
SEP/FLYAROUND [BA]

Flyaround terminate 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 √+0 (-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 - *)

UNDOCKING / SEPARATION TIMELINE

~

TERMINATE SEP OPS [8C]

If KU MODE – RDR PASSIVE,
Perform KU OPS; step 4 (Cue Card)

CRT [GNC UNIV PTG]
CNCL - ITEM 21 EXEC

[GNC 33 REL NAV]
RNDZ NAV ENA - ITEM 1 EXEC (no +)

A6L LIGHTS TRUSS FWD, AFT (two) - OFF
VESTIBULE PORT, STBD (two) - OFF
Exit RPOP - [Shift]/[F10]
Perform TCS DEACTIVATION (RNDZ TOOLS), 7-20
Perform HHL STOW (RNDZ TOOLS), 7-6

R1 O2 TK3 HTR A – OFF

GNC 20 DAP CONFIG
Config DAP A,B to A1,B1

Go to FLIGHT PLAN

~

SEP BURNS [8B]

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

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

3. FINAL BURN
   At final burn TIG:
   If Postigrade
   Aft THC: -X (down) 4 sec (1.0 fps)
   If Retrograde
   Aft THC: +X (up) 16 sec (4.0 fps)
   DAP TRANS: PULSE/PULSE/PULSE
   FLT CNTRL PWR – OFF
   Inform MCC when SEP complete
   Go to TERMINATE SEP OPS [8C]
INITIAL RADAR ACQ

GNC 33 REL NAV

CRT
\[ \sqrt{\text{INH RNG}} \]
- ITEM 18 - (+)

\[ \sqrt{\text{RDOT}} \]
- ITEM 21 - (+)

\[ \sqrt{\text{Angles}} \]
- ITEM 24 - (+)

KU ANT ENA - ITEM 2 EXEC (+)

GNC I/O RESET

\[ \sqrt{\text{SV SEL}} \]
- 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

\[ \sqrt{\text{sel}} \]
- 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 (lb-gray)

When lock on occurs:

GNC 33 REL NAV

CRT

AUT RNG - ITEM 17 EXEC (+)

RDOT - ITEM 20 EXEC (+)

Angles - ITEM 23 EXEC (+)

If RATIO > 1.0,

Force aff mark until RATIO < 1.0

When RESIDs small and stable,

SM ANTENNA

RDR RNG AUTO - ITEM 16 EXEC (+)

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

HHL RANGE CONVERSION

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

TCS Reflector Visibility During Flyarround

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

Ref #5 is Out of Plane (Out of Page)
MANEUVER PADS
PRELIMINARY ORBIT MANEUVER PAD FOR NC

<table>
<thead>
<tr>
<th>OMS BOTH 1</th>
<th></th>
<th></th>
</tr>
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<tbody>
<tr>
<td>L 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R 3</td>
<td>+X</td>
<td>-X</td>
</tr>
<tr>
<td>RCS SEL 4</td>
<td>MULTI-AXIS</td>
<td></td>
</tr>
<tr>
<td>TV ROLL 5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| TRIM LOAD | P 6 | ( ) |
| L Y 7     | ( ) |
| R Y 8     | ( ) |
| WT 9      |   |   |
| TIG 10    | /  |   |

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

| ΔVTOT      |   |   |
| TGO        |   |   |

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

| VGO X    |   |   |
| VGO Y    |   |   |
| VGO Z    |   |   |

| TGT       | ( ) |

<table>
<thead>
<tr>
<th>NOTES</th>
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<table>
<thead>
<tr>
<th>OMS GMBL CK:</th>
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<tbody>
<tr>
<td>L PRI</td>
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<tr>
<td>L SEC</td>
</tr>
<tr>
<td>R PRI</td>
</tr>
<tr>
<td>R SEC</td>
</tr>
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<table>
<thead>
<tr>
<th>RCS I’CNCT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>L OMS → RCS</td>
</tr>
<tr>
<td>R OMS → RCS</td>
</tr>
<tr>
<td>NONE</td>
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<table>
<thead>
<tr>
<th>DOWN MODE OPTIONS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 OMS → 1 OMS</td>
</tr>
<tr>
<td>1 OMS → RCS</td>
</tr>
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<td>NONE</td>
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<table>
<thead>
<tr>
<th>ORBIT BURN MONITOR</th>
</tr>
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<tbody>
<tr>
<td>GPC FILL-INS:</td>
</tr>
<tr>
<td>CRIT BURN</td>
</tr>
<tr>
<td>NON-CRIT BURN</td>
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</table>

<table>
<thead>
<tr>
<th>MAX TIG SLIP:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIN.</td>
</tr>
</tbody>
</table>

| DO NOT UPDATE TIG |
| UPDATE TIG AFTER: |
| MIN.              |

<table>
<thead>
<tr>
<th>GPC L OP CL</th>
</tr>
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<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
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</table>

| P 15 |
| Y 16 |
| OM 17 |

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<tr>
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<th>LVLH ATT</th>
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<td>Y</td>
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| CRIT BURN |
| NON-CRIT BURN |

| NOTES |

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<tr>
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<td>B</td>
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</tbody>
</table>

| CRIT BURN |
| NON-CRIT BURN |

| NOTES |
### Final Orbit Maneuver Pad for NC

- **Burn Attitude (BURN ATT):**
  - R: 24
  - P: 25
  - Y: 26

- **Delta V Tot (ΔVTOT):**
  - TGO: 

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

- **WT (WT):**

- **TIG (TIG):**

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

- **OMS GMBL CK (OMS GMBL CK):**
  - PRE
  - POST-BURN

- **RCS I’CNCT (RCS I’CNCT):**
  - L OMS → RCS
  - R OMS → RCS

- **Down Mode Options (DOWN MODE OPTIONS):**
  - 2 OMS → 1 OMS
  - 1 OMS → RCS

- **OMS HE REG Test (OMS HE REG TEST):**
  - NONE

- **-X RCS Burns (-X RCS BURNS):**
  - BURN ATT
  - LVLH ATT

- **Orbit Burn Monitor (ORBIT BURN MONITOR):**
  - GPC Fill-Ins: ___ (___)
  - CRIT BURN
  - NON-CRIT BURN

- **Notes (NOTES):**
  - DO NOT UPDATE TIG
  - UPDATE TIG AFTER ___ MIN.
## Preliminary Orbit Maneuver Pad for Ti

### 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
- ΔVX: 19
- ΔVY: 20
- ΔVZ: 21

### TIDelay
- TGT PEG 7
- ΔVX: 19
- ΔVY: 20
- ΔVZ: 21

### New Ti (Basetime)
- TGT PEG 7
- ΔVX: 19
- ΔVY: 20
- ΔVZ: 21

### Notes
- OMS GMBL CK:
  - PRE
  - POST-BURN
  - RCS \(\rightarrow\) CNCT:
    - L PRI
    - L SEC
    - R PRI
    - R SEC
  - NONE

### ORBIT BURN MONITOR

### OMS HE REG TEST:
- NONE

### -X RCS BURNS:

### ORBIT BURN MONITOR

### CRIT BURN

### NON-CRIT BURN

### Notes
- If Ti not started by nominal TIG + \(\text{___} \) min (G34 as reqd),
  reload original TIG and go to Ti DELAY, 5-27

### Max Ti DELAY TIG slip \(\text{___} \) min

### Do Not Update TIG

### Update TIG After \(\text{___} \) MIN.
## FINAL ORBIT MANEUVER PAD FOR Ti

### Burn Attitude

<table>
<thead>
<tr>
<th>Burn Attitude</th>
<th>B</th>
<th>C</th>
<th>D</th>
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</thead>
<tbody>
<tr>
<td>R</td>
<td>24</td>
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<tr>
<td>P</td>
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<td>26</td>
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### Delta V Total

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### VGO

<table>
<thead>
<tr>
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<th>Y</th>
<th>Z</th>
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### Target

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<th>HP</th>
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<tbody>
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### Notes

- Do not update TIG after ___ min.
- Update TIG after ___ min.

---

**TGT Peg 7**

<table>
<thead>
<tr>
<th>ΔVX</th>
<th>ΔVY</th>
<th>ΔVZ</th>
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<tbody>
<tr>
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---

**TIDELAY**

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<tbody>
<tr>
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---

**New Ti ( Basetime )**

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**TRIM LOAD**

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<tr>
<th>P</th>
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<th>RY</th>
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<td>7</td>
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<table>
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<tr>
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**TV Roll**

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**RCS Sel**

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**TV Roll**

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**OMS BOTH**

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**OMS GMBL CK**

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---

**Down Mode Options**

- 2 OMS → 1 OMS
- 1 OMS → RCS
- NONE

---

**Orbit Burn Monitor**

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<thead>
<tr>
<th>Notes</th>
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<tbody>
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# Orbit Maneuver Pad for _________

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<tr>
<td>TV ROLL</td>
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<td></td>
<td></td>
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<tr>
<td>TRIM LOAD</td>
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<td>P</td>
<td>6</td>
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<td>RY</td>
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<tr>
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</tr>
<tr>
<td>TGT PEG</td>
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<td>∆VX</td>
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<tr>
<td>∆VY</td>
<td>20</td>
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<td>∆VZ</td>
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<td>TGO</td>
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</table>

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

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<tr>
<th>HA</th>
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| TGT |
| ( ) |

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<tbody>
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<td>Don't update TIG</td>
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<tr>
<td>Update TIG after ___ min.</td>
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<th>ORBIT BURN MONITOR</th>
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<tr>
<td>NON-CRIT BURN</td>
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3-8  RNDZ/116/FIN
AFT FLT STATION CONFIG FOR RNDZ

O14,16:E √cb MNA,C DDU AFT (two) - cl

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 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 - 8888.8
DIGI-DIS sel - EL/AZ

CRT SELF TEST - ITEM 7 EXEC (no *)

A1U KU MODE - COMM
sel - GPC
CNTL - CMD

Install:
-Z COAS
RCS BURN Cue Card
KU OPS Cue Card
APPROACH Cue Card
TARGET ALIGNMENT Cue Card
DOCKING SEQUENCE Cue Card

Velcro over Aft DAP PCT pbi (SPARE pbi)
**RENDEZVOUS TIMELINE**

**PET**

**03:00**

**CDR**  AFT FLT STATION CONFIG FOR RNDZ

**02:55**

**PLT**  RNDZ OPS INITIALIZATION

**02:50**

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

**02:45**

If NH reqd:

**CDR**  If OMS BURN, Perform RNDZ OMS BURN, steps 1-4 (CONTINGENCY OPS), 5-4

If +X RCS burn, Perform RCS BURN, steps 1-5 (Cue Card)

Postburn DAP: A/LVLH/VERN(ALT)

**02:40**

**02:35**

**02:30**

**MCC UPDATE**

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

**02:55**

**ORB SV**

**TGT SV**

Drag K-factor

**SM 2 TIME**

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

Config DAP A,B to A7,B7

Record nominal TIGs in burn solution blocks per Execute Package:

- NCC TIG  pg 4-11
- MC1 TIG  pg 4-17
- MC2 TIG  pg 4-18

**GNC 55 GPS STATUS**

DES RCVR, ITEM 27 - (+)

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

NAV, ITEM 36 - (+)
RENDEZVOUS TIMELINE

PET

-02:30
A7(B7)

TIG-5 MIN

-02:25

If reqd,

[NH_TIG]
Postburn DAP: A/LVLH/VERN(ALT)

-02:20

-02:15

PLT ENABLE RENDEZVOUS NAV [7A]

MS 
PSCs setup per PGSC Usage Chart (if available) or UTILITY OUTLET PLUG-IN
PLAN ORBIT CONFIGURATION (REF DATA, 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

MCC UPDATE
Final NC Burn Pad, 3-3

-02:00

RACTS

RENDEZVOUS TIMELINE

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)

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

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
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IMU DES [10A], 4-10

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IMU DES [10A], 4-10

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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)
STAR TRACKER NAV

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)
   - CRT IMU DES - ITEM 7(8,9) EXEC (+)
   - MCC for NAV selected IMU _____
   - GNC 21 IMU ALIGN
   - GNC 33 REL NAV
     - If first NAV pass,
       - SV SEL, ITEM 4 - PROP
       - 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 8(7) EXEC (+)
   - STATUS - blank
   - SHUTTER - op

2. INITIAL MEASUREMENT EVALUATION
   - GNC 22 S TRK/COAS CNTL
     When S PRES - (+), continue
   - GNC 33 REL NAV
     Monitor RESID V and H each NAV cycle for at least four consecutive cycles (~30 sec)
   - Record init RESID
     V = _______ _______ _______ _______
     H = _______ _______ _______ _______
     If RESID V or H changes by > 0.05 each cycle:
     - GNC 22 S TRK/COAS CNTL
       - Z(-Y) BREAK TRK - ITEM 8(7) EXEC
       - Repeat Step 2
     If RESID V or H > 0.6:
       - GNC 22 S TRK/COAS CNTL
         - Z(-Y) BREAK TRK - ITEM 8(7) EXEC
         - When S PRES - (+), if RESID V or H still > 0.6 and stable:
           - Perform S TRK NAV - HIGH INITIAL RESID (CONTINGENCY OPS), 5-8

3. INCORPORATE DATA INTO NAV
   - If SV SEL = PROP:
     - AUTO Angles - ITEM 23 EXEC (+)
       - Record 1st SV UPDATE POS = _______ _______ _______ _______
       - When SV UPDATE POS < 1.0 and Angle ACPT > 9:
         - SV SEL - ITEM 4 EXEC (FLTR) >>
       - If SV = FLTR:
         - FLTR TO PROP - ITEM 8 EXEC
         - AUTO Angles - ITEM 23 EXEC (+)
         - Record 1st SV UPDATE POS = _______ _______ _______ _______
         - If FLTR MINUS PROP changes by more than 8 kft within a S TRK pass:
           - Perform S TRK NAV - HIGH FLTR MINUS PROP
           - (CONTINGENCY OPS), 5-9

END S TRK NAV
RENDEZVOUS TIMELINE

PLT  STAR TRACKER NAV [10A]

CDR  TARGET NCC BURN [11A] (Intermediate)

MCC UPDATE
Nav Selected IMU

TARGET NCC BURN [11A]

FINAND solution
OPS 202 PRO

GNC ORBIT MNR EXEC

√ Eng Sel CORRECT

CRT  √ SV SEL correct

GNC 34 ORBIT TGT

TGT NO - ITEM 1 +9 EXEC

√ TGT Set data:

T1 TIG = NCC BURN SOLUTION TIG
EL +0
AT +57.7
AX -48.6
AY +0.0
AZ +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

TIG

/  

ΔVX

( ) *

ΔVY

( ) *

ΔVZ

( ) *

ΔVT

( ) *

PRELIMINARY

INTERMEDIATE

FINAL

GROUND FINAL - GROUND LIMITS

ΔVX

( ) *

ΔVY

( ) *

ΔVZ

( ) *

ΔVT

( ) *

(0.5)

(1.5)

(1.7)

NCC BURN SOLUTION

TIG

/  

ΔVX

( ) *

ΔVY

( ) *

ΔVZ

( ) *

ΔVT

( ) *

(0.5)

(1.5)

(1.7)

•

•

•

•

•

•

•

•
-Z AXIS TARGET TRACK

[12A]

GNC UNIV PTG

TGT ID +1
BODY VECT +3 (-Z)
OM +0

C3 DAP: B/AUTO/ALT
C3 CRT TRK - ITEM 19 EXEC (CUR - *)

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

### TARGET Ti BURN (Preliminary)

- **When:** NAV RNG < 150 KFT:
  - **MS KU OPS**, step 1 (Cue Card)
  - **MCC UPDATE**
  - **RNDZ PRPLT PAD**

- **When RR RNG < 135 KFT:**
  - **PLT Perform RR NAVIGATION** (Intermediate)

### RR NAVIGATION

- **When:** NAV RNG < 150 KFT:
  - **MS KU OPS**, step 1 (Cue Card)

- **If no lock-on by 10 minutes after initial search:**
  - **MS KU OPS**, step 2 (Cue Card)

### If F Y STRK TRACK

- **PLT TARGET Ti BURN** (Preliminary)
- **CDR - 2 AXIS TARGET TRACK** (Intermediate)

### 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)**

### IF SV SEL correct

- **GNC 34 ORBIT TGT**
  - **TGT NO - ITEM 1 +1 0 EXEC**
  - **TGT Set data:**
    - **T1 TIG = BASE TIME**
    - **EL +0**
    - **ΔT +76.9**
    - **ΔX -0.9**
    - **ΔY +0**
    - **ΔZ +1.8**
  - **COMPUTE T1 - ITEM 28 EXEC**
  - **Record solution in PAD**

- **IF Y S TRK TRACK**
  - **CDR - Z AXIS TARGET TRACK**

### If RESID RANGE = ______

- **RDOT = ______**

- **SV SEL - ITEM 4 EXEC (PROP)**
### Final - Ground

<table>
<thead>
<tr>
<th>Ti Burn Solutions</th>
<th>Final Ti Burn Pad, 3-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREL FLTR</td>
<td>Final Ti Burn Pad, 3-7</td>
</tr>
<tr>
<td>INTER FLTR</td>
<td>Final Ti Burn Pad, 3-7</td>
</tr>
<tr>
<td>FINAL FLTR</td>
<td>Final Ti Burn Pad, 3-7</td>
</tr>
<tr>
<td>GND</td>
<td>Final Ti Burn Pad, 3-7</td>
</tr>
<tr>
<td>PROP (If Req)</td>
<td>Final Ti Burn Pad, 3-7</td>
</tr>
</tbody>
</table>

- ΔVX: (0.7)
- ΔVY: (1.1)
- ΔVZ: (1.6)
RENDEZVOUS TIMELINE

PET

-00:30
A7(B7)

-00:25

-00:20

-00:15

-00:10

-00:05

-00:00


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

-00:20

If GO for Ti not received by TIG - 5 or RNDZ DELAY called by MCC

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

MCC UPDATE

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

-00:15

TIG-17

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

PLT TARGET Ti BURN [15A] (Final)

MCC UPDATE

GO for Ti

-00:10

-00:05

TIG-5

If Ti is multi-axis burn:

CDR Perform RCS BURN (Cue Card)

TARGET Ti BURN [15A] (Final)

CRT OPS 202 PRO

GNC ORBIT MNVR EXEC

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

GNC 33 REL NAV

\( \sqrt{SV \text{ SEL correct}} \)

GNC 34 ORBIT TGT

TGT NO - ITEM 1 +1 EXEC

\( \sqrt{TGT \text{ Set data:}} \)

\begin{itemize}
  \item T1 TIG = BASE TIME
  \item \( \Delta T = +76.9 \)
  \item \( \Delta X = -0.9 \)
  \item \( \Delta Y = +0 \)
  \item \( \Delta Z = +1.8 \)
\end{itemize}

COMPUTE Ti - ITEM 28 EXEC

Record solution in PAD

FINAL SOLUTION

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

Burn FLTR soln

If FLTR within ground solution limits:

Burn FLTR soln

If PROP within ground solution limits:

Burn PROP soln

If none of the above:

Burn ground soln EXT \( \Delta Vs \)
POST Ti NAV [16A]

A6U
√DAP: A/AUTO/VERN(ALT)

A1U
√KU sel - GPC

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

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

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

00:00
PLT TARGET MC 1 BURN [17A] (Preliminary)

00:05
CDR POST Ti NAV [16A]

00:10
PLT TARGET MC 1 BURN [17A] (Intermediate)

00:15
MS √ Time of OOP null

00:20
MC 1 TIG

00:25
PLT TARGET MC 1 BURN [17A] (Final)
Perform RCS BURN (Cue Card)

00:30
PLT MANUAL OUT-OF-PLANE NULL [19A]

TARGET MC 1 BURN [17A]

CRT "SV SEL correct"

GNC 34 ORBIT TGT

TGT NO - ITEM 1 +1 EXEC

TGT Set data:

ΔT +56.9
ΔX +0.9
ΔY +0
ΔZ +1.8

MC UPDATE
Prox Ops Cov Matrix

COMPUTE T1 - ITEM 28 EXEC
Record solution in PAD

MC 1 BURN SOLUTION

PRELIMINARY

TIG

ΔVX

ΔVY

ΔVZ

AVT

FINAL

MEDIAN ± (3σ VARIATION)

ΔVX

ΔVY

ΔVZ

AVT

TARGET MC 2 [17B] (Preliminary)

CRT "SV SEL correct"

GNC 34 ORBIT TGT

TGT NO - ITEM 1 +2 EXEC

TGT Set data:

ΔT +29.07
ΔX +27.0
ΔY +0.9
ΔZ +1.8

MC UPDATE
Prox Ops Cov Matrix

COMPUTE T1 - ITEM 28 EXEC
Record solution in PAD

NOTE
If TGT EL ANG Alarm,
ΔV still valid for current TIG,
TIG slip limits still apply
TARGET MC 2 BURN [18A] (Intermediate)

CRT
SV SEL correct
[GNC ORBIT TGT]
TGT NO - ITEM 1 +1 2 EXEC
COMPUTE T1 - ITEM 28 EXEC
Record solution in PAD

TARGET MC 2 BURN [18B] (Final)

CRT
SV SEL correct
[GNC ORBIT TGT]
TGT NO - ITEM 1 +1 2 EXEC
√ TIG change
IF TIG CHANGE < -3 OR > +7 MIN
Set BASE TIME to (Nominal MC 2 TIG -3 or +7 min as appropriate)
LOAD - ITEM 26 EXEC
TGT NO - ITEM 1 +1 9 EXEC
√ TIG Set data:
 T1 TIG = BASE TIME
 EL +0
 ΔT +27.0
 ΔX -0.9
 ΔY +0
 ΔZ +1.8
COMPUTE T1 - ITEM 28 EXEC

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

END S TRK NAV [18C]

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

-Z AXIS TARGET TRACK [18D]

CRT
[GNC UNIV PTG]
√ TGT ID
BODY VECT +1 (Z)
OM +3
C3 DAP: B/AUTO/ALT
TRK - ITEM 19 EXEC (CUR - *)
When MNVR cmplt,
DAP: A/AUTO/VERN(ALT)

MC 2 BURN SOLUTION

PRELIMINARY

INTERMEDIATE

FINAL

MEAN ± (3σ VARIATION)

ΔVX
ΔVY
ΔVZ
ΔVT

ΔVX
ΔVY
ΔVZ
ΔVT

TIG change

TIG SLIP (COMPUTED-NOM)

PREL
INTER
FINAL
NOMINAL

NIGHTTIME STRK OPS [18E]

1. GNC REL NAV
INH Angles - ITEM 24 EXEC (*)
At sunset,
2. GNC TRK/COAS_CNTL
-Z(-Y) THOLD - ITEM 14(13) +0 EXEC
3. Perform STAR TRACKER NAV [18A] , steps 2 and 3
**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>IF S TRK NAV: At sunset-2 minutes:</td>
</tr>
<tr>
<td></td>
<td>PLT NIGHTTIME STRK OPS (Intermediate)</td>
</tr>
<tr>
<td>00:40</td>
<td>MC2 ET</td>
</tr>
<tr>
<td></td>
<td>On RPOP PGSC:</td>
</tr>
<tr>
<td></td>
<td>MS Perform TCS ACTIVATION, steps 2-4 (RNDZ TOOLS), 7-18 (Set AUTO ACQ to 10,000 ft)</td>
</tr>
<tr>
<td></td>
<td>00:10</td>
</tr>
<tr>
<td>00:45</td>
<td>PLT TARGET MC 2 BURN (Final)</td>
</tr>
<tr>
<td>00:50</td>
<td>PLT TARGET MC 3 BURN (Preliminary)</td>
</tr>
<tr>
<td>01:00</td>
<td>IF INITIAL RR ACQ POST-MC2</td>
</tr>
<tr>
<td></td>
<td>CDR Perform LATE RR NAV (20E)</td>
</tr>
<tr>
<td>00:35</td>
<td>MS Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZ TOOLS), 7-2</td>
</tr>
<tr>
<td>00:45</td>
<td>PLT TARGET MC 2 BURN (18B) (Final)</td>
</tr>
<tr>
<td></td>
<td>Perform RCS BURN ( Cue Card)</td>
</tr>
<tr>
<td>00:50</td>
<td>PLT TARGET MC 3 BURN (19B)</td>
</tr>
<tr>
<td></td>
<td>IF -Y S TRK TRACK</td>
</tr>
<tr>
<td></td>
<td>END STAR TRACKER NAV (18C)</td>
</tr>
<tr>
<td></td>
<td>-Z AXIS TARGET TRACK (18D)</td>
</tr>
<tr>
<td>01:00</td>
<td>IF S TRK NAV,</td>
</tr>
<tr>
<td></td>
<td>PLT END STAR TRACKER NAV (18C)</td>
</tr>
</tbody>
</table>

**MC2 ET**

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<td>00:35</td>
<td>IF S TRK NAV: At sunset-2 minutes:</td>
</tr>
<tr>
<td></td>
<td>PLT TARGET MC 2 BURN (18A) (Intermediate)</td>
</tr>
</tbody>
</table>

**TARGET MC 3**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:35</td>
<td>IF INITIAL RR ACQ POST-MC2</td>
</tr>
<tr>
<td></td>
<td>CDR Perform LATE RR NAV (20E)</td>
</tr>
<tr>
<td>00:40</td>
<td>MS Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZ TOOLS), 7-2</td>
</tr>
<tr>
<td>00:45</td>
<td>IF S TRK NAV: At sunset-2 minutes:</td>
</tr>
<tr>
<td></td>
<td>PLT TARGET MC 2 BURN (18A)</td>
</tr>
<tr>
<td>00:50</td>
<td>IF S TRK NAV,</td>
</tr>
<tr>
<td></td>
<td>PLT END STAR TRACKER NAV (18C)</td>
</tr>
</tbody>
</table>

**MC 3 BURN SOLUTION**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>01:00</td>
<td>IF S TRK NAV,</td>
</tr>
<tr>
<td></td>
<td>PLT END STAR TRACKER NAV (18C)</td>
</tr>
</tbody>
</table>

**MANUAL OUT-OF-PLANE NULL**

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<td>IF S TRK NAV: At sunset-2 minutes:</td>
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<td></td>
<td>PLT TARGET MC 2 BURN (18A)</td>
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<td>PLT END STAR TRACKER NAV (18C)</td>
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<td>PLT END STAR TRACKER NAV (18C)</td>
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</table>
MC 4 BURN SOLUTION

<table>
<thead>
<tr>
<th>TIG</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>PRELIMINARY</td>
<td>FINAL</td>
<td>MEAN ± 3σ VARIATION</td>
<td></td>
</tr>
<tr>
<td>ΔXY</td>
<td>-</td>
<td>(+1.2 ± 1.7)</td>
<td></td>
</tr>
<tr>
<td>ΔXZ</td>
<td>-</td>
<td>(-0.0 ± 0.5)</td>
<td></td>
</tr>
<tr>
<td>ΔYT</td>
<td>-</td>
<td>(+0.3 ± 2.4)</td>
<td></td>
</tr>
</tbody>
</table>

TARGET MC 4 BURN [20A]

CRT √ SV SEL correct

[GNC 34 ORBIT TGT]
TGT NO - ITEM 1 +1 EXEC

TGT Set data:
T1 TIG = BASE TIME + 0:00:27:00
EL +0
ΔT +13.0
ΔX +0
ΔY +0
ΔZ +0.6

COMPUTE T1 = ITEM 28 EXEC

Record solution in PAD

ESTABLISH RBAR [20C]

A6U FLT CNTLR PWR - ON

CRY GNC UNIV PTG]

CRT TRK - ITEM 19 EXEC (CUR - *)

DAP: A/AUTO/VERN(PRI)

THC: as reqd to control TGT motion in COAS

CONFIG FOR RBAR [20B]

[GNC UNIV PTG]

√ ERR TOT - ITEM 23 EXEC (*)

When ERR <2 deg each axis

[GNC 20 DAP CONFIG]

Config DAP A,B to A8,B8

=GNC UNIV PTG

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

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

RADAR FAIL PROCEDURE [20D]

Note: When TGT visible, report TGT Tally-Ho to MCC

MS If TGT outside COAS reticle, config CCTV as reqd to measure vertical position

1. At MC2 TIG+14:00 (MC3 TIG-3:00):

PLT TARGET MC2 [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]

CRT TRK - ITEM 19 EXEC (CUR - *)
A6U DAP: A/AUTO/VERN (PRI)

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

At 2000 ft:

Perform APPROACH (Cue Card)

LATE RADAR NAV [20E]

[GNC 33 REL NAV]

CRT FLTR TO PROP - ITEM 8 EXEC
SV SEL, ITEM 4 - PROP
√RR - ITEM 13 EXEC (*)

AUTO RNG - ITEM 17 EXEC (*)
RDOT - ITEM 20 EXEC (*)
Angles - ITEM 23 EXEC (*)

Go to RADAR FAIL PROCEDURE [20D]
RENDEZVOUS TIMELINE

- **PLT**: Target MC3 burn [198] (final)
  - Perform RCS burn (Cue Card)

- **MS**: Perform HHL ops ([RNDZ TOOLS], 7-7)

- **CDR**: Config for RBAR [208]

- **PET**: Target MC 4 burn [20A] (Preliminary)

- **MC 3 TIG**: TIG-3 MIN
  - PLT: Target MC 3 burn [198] (final)
  - Perform RCS burn (Cue Card)

- **MC 4 TIG**: TIG-3 MIN
  - PLT: Target MC 4 [20A] (Final)
  - Perform RCS burn (Cue Card)

- **CDR**: Establish RBAR [20C]

- **MCC Update**: GO for RPM

- **CREW Report**: ISS tally-ho

- **HHL Report**: R and Rdot

**Manual Trajectory Control**

IF NO RR INTO NAV
- CDR Go to RADAR FAIL PROCEDURES [20D]
TERMINATE RNDZ OPS

1. ORBITER CONFIG FOR MATED ATTITUDE CONTROL

**PLT**

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

**CDR**

A6U

√ FLT_CNTL PWR - OFF

**PLT**

[GNC 23 RCS]

CRT

RCS F – ITEM 1 EXEC (+)

JET DES F1L – ITEM 9 EXEC (+)

F3L – ITEM 11 EXEC (+)

F2R – ITEM 13 EXEC (+)

F4R – ITEM 15 EXEC (+)

F1U – ITEM 17 EXEC (+)

F3U – ITEM 19 EXEC (+)

F2U – ITEM 21 EXEC (+)

[GNC 20 DAP_CONFIG]

Config DAP A.B to A12.B12

X JET ROT ENA - ITEM 7 EXEC (+)

EDIT A9 - ITEM 3 + 9 EXEC

PRI RATE DB - ITEM 52 + 0.2 EXEC

LOAD - ITEM 5 EXEC

EDIT B9 - ITEM 4 + 9 EXEC

PRI RATE DB - ITEM 52 + 0.2 EXEC

LOAD - ITEM 5 EXEC

DAP: LO Z

If Loss of Verns:

[SM 167 DOCKING STATUS]

√ 12 hooks closed

DAP: B/ALT

DAP: LVLH

If VERNS:

DAP: LVLH

* If ISS attitude control required,
  * Perform 3.111 HANDOVER ATTITUDE CONTROL ORBITER TO

* CMG TA, (SODF: JOINT OPS, MATED OPERATIONS)

**MS**

Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6

A6L

LTS TRUSS FWD, AFT (two) - OFF

VEST PORT, STBD (two) - OFF

Exit RPOP - [Shift][F10]

Perform HHL STOW (RNDZ TOOLS), 7-6

-Z COAS - OFF

RETURN TO FLIGHT PLAN

2. ORBITER CONFIG FOR MATED OPS

**PLT**

[GNC 22 S TRK/COAS_CNTL]

CRT

-Z(-Y) STAR TRK - ITEM 4(3) EXEC (+)

-Y THOLD - ITEM 13 + 0 EXEC

-Z THOLD - ITEM 14 + 0 EXEC

[GNC 55 GPS_STATUS]

DES RCVR - ITEM 27 (no +)

[GNC 33 REL NAV]

RNDZ NAV ENA - ITEM 1 EXEC (no +)
CONTINGENCY OPS

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RNDZ OMS BURN

1. **OMS BURN PREP**
   - **C2** Install OMS2/ORBIT OMS BURNS (Cue Cards) (two) and ORBIT BURN MONITOR (Cue Cards) (two) (F6,F8)
   - **Wedge**
   - **CRT1**
     - DAP config A7,B7
     - GNC, OPS 202 PRO
     - 1: GNC ORBIT MNVR EXEC
     - 2: GNC SYS SUMM 2

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

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

Cont next page
4. OMS POST BURN RECONFIGURATION

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

C3     DAP: B/INRTL/ALT
       DAP TRANS: PULSE/PULSE/PULSE
CRT1   RCS SEL – ITEM 4 EXEC (*)
       Perform OMS TVC GMBL CK per Burn Pad

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

       GNC, OPS 201 PRO

5. MNVR TO POST BURN ATTITUDE

1: GNC UNIV PTG

\(\sqrt{\text{Desired UNIV PTG load active}}\)

C3     DAP: B/AUTO/ALT

If RR ops, when ATT ERR < 30 deg:

A1U    KU sel – GPC
       \(\sqrt{\text{KU TRACK tb – gray}}\)

1: GNC 33 REL NAV

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

When in attitude and rates nulled:

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

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

   On MCC GO (if no comm, continue):

2. **CHECK FOR S TRK FALSE LOCK**
   - **2: GNC 22 S TRK/COAS CNTL**
     - If -Z S TRK, perform COAS visual check:

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

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

     - If -Y S TRK, perform visual check through W1:

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

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

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

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

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

1. NAV SAFING

   1: GNC 33 REL NAV

   CRT1 INH Angles – ITEM 24 EXEC (*

On MCC GO (continue if no comm):

2. CHECK FOR S TRK FALSE LOCK

   2: GNC 22 S TRK/COAS CNTL

   If -Z S TRK, perform COAS visual check:

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

   √For debris near TGT position
   If no debris near TGT position or TGT not visible:
   | Go to step 3
   If debris near TGT position:
   SV SEL – ITEM 4 EXEC (PROP)
   PROP TO FLTR – ITEM 9 EXEC

   CRT2
   -Z BREAK TRK – ITEM 8 EXEC

   When S PRES – (*):

   CRT1 Monitor RESID V and H. Repeat BREAK TRK as reqd until stable lock-on
   Go to STAR TRACKER NAV, step 2 10A

   If -Y S TRK, perform visual check through W1:

   √For debris near TGT line-of-sight
   If no debris near TGT line-of-sight or TGT not visible:
   | Go to step 3
   If debris near TGT line-of-sight:
   SV SEL – ITEM 4 EXEC (PROP)
   PROP TO FLTR – ITEM 9 EXEC

   CRT2
   -Y BREAK TRK – ITEM 7 EXEC

   When S PRES – (*):

   CRT1 Monitor RESID V and H. Repeat BREAK TRK as reqd until stable lock-on
   Perform STAR TRACKER NAV, step 2 10A

3. RESUME PASS

   AUTO Angles – ITEM 23 EXEC (*

   Continue -Z S TRK pass

   After S TRK pass, on MCC GO:

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

   2: GNC 22 S TRK/COAS CNTL

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

   5-9 RNDZ/116/FIN
COAS NAVIGATION

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

1. COAS NAV CONFIG

A6U

\[ \sqrt{\text{SENSE: -Z}} \]
\[ \sqrt{\text{DAP: B7/AUTO/VERN(ALT)}} \]

CRT

\[ \text{COAS: SIGHT MODE – ITEM 22 EXEC (*)} \]
\[ \text{REQU ID – ITEM 21 +1 EXEC} \]
\[ \sqrt{\text{POS -Z: ITEM 27 (*)}} \]

\[ \text{GNC 22 STRK/COAS CNTL} \]
\[ \text{GNC 33 REL NAV} \]
\[ \text{INH Angles – ITEM 24 EXEC (*)} \]
\[ \sqrt{\text{SV SEL, ITEM 4 – FLTR}} \]
\[ \text{If TGT NOT in COAS FOV:} \]
\[ \sqrt{\text{MCC}} \]
\[ \text{If TGT in COAS FOV:} \]
\[ \text{FLTR TO PROP – ITEM 8 EXEC} \]
\[ \text{COAS – ITEM 14 EXEC (*)} \]

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

2. COAS MARKS

A6U

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

When TGT centered in COAS, ATT REF pb – push

\[ \text{GNC 33 REL NAV} \]
\[ \text{If X and Y RESID magnitudes \( \geq \) 1.0:} \]
\[ \sqrt{\text{MCC}} \]
\[ \text{If X and Y RESID magnitudes < 1.0:} \]
\[ \text{FOR – ITEM 25 EXEC} \]
\[ \sqrt{\text{SV UPDATE – non-zero (within 8 sec), then}} \]
\[ \text{0.0 (after 8 sec more)} \]

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

At sunset,

3. END COAS NAV

A6U

\[ \text{DAP: A7/AUTO/VERN(ALT)} \]
\[ \text{FLT CNTLR PWR – OFF} \]
\[ \text{GNC 22 STRK/COAS CNTL} \]

CRT

\[ \text{COAS: DES – ITEM 25 EXEC (*)} \]

Resume rendezvous timeline
BACKOUT/BREAKOUTS
VBAR CORRIDOR BACKOUT

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

If RNG < 75 ft:
1. **INITIATE CORRIDOR BACKOUT**
   DAP: B/LVLH/VERN(PRI), no LO Z
   
   **NOTE:** DAP A allowed for ±X and -Z (in) THC

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

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

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

   When RNG > 50 ft:
   DAP config: A9/B9
   [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

   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
\[\text{MCC for breakout direction}\]

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

GNC, OPS 202 PRO

\[\text{GNC ORBIT MNVR EXEC}\]

\[\text{RCS SEL – ITEM 4 EXEC (*)}\]

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 \(\Delta Vx\) – ITEM 19 +3 EXEC
\(\Delta Vy\) – ITEM 20 +0 EXEC
\(\Delta Vz\) – ITEM 21 +0 EXEC

If Retrograde Sep:
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

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 \(\leq\) 0.2 fps

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

Inform MCC when SEP complete

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

**CAUTION**
Constraints for use:
- Orbiter X and Z axes in-plane
- Range ≤ 700 ft cg to cg*
- Tgt stable on orbiter -Z axis

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

If RNG < 75 ft:
1. **INITIATE CORRIDOR BACKOUT**
   - DAP: B/LVLH/VERN(PRI), no LO Z
   - THC: +Z (out) to establish a +0.1 ft/sec opening rate
     Maintain 8 deg corridor

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

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

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

If Retrograde Sep:

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

TV ROLL – ITEM 5 + _ _ _ EXEC

LOAD – ITEM 22 EXEC

TIMER – ITEM 23 EXEC

Config DAP A,B to A7,B7

At TIG -8 min:

DAP: B/ALT, NO LO Z

MNVR – ITEM 27 EXEC (*)

DAP: AUTO

At TIG -0:30:

DAP TRANS: as reqd

DAP: A/INRTL/PRI

F7 FLT CNTLR PWR – ON

At TIG, THC: Trim VGOs ≤ 0.2 fps

F7 FLT CNTLR PWR – OFF

DAP TRANS: PULSE/PULSE/PULSE

DAP: A/INRTL/VERN(ALT)

GNC, OPS 201 PRO

On MCC call:

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

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

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

2. 3 FPS RETROGRADE
   CRT
   OPS 202 PRO
   [GNC ORBIT MNVR EXEC]
   \(\sqrt{\text{RCS SEL – ITEM 4 (*)}}\)
   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)
NOTE

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

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

1. INITIAL SEPARATION SEQUENCE

When petals clear:
- DAP: B9/LVLH/ALT
- DAP TRANS: PULSE/PULSE/PULSE, no LO Z
- THC: as reqd to maintain target within 8 degree corridor on C/L camera or COAS

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

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

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

When RNG > 50 ft (DP-DP):

| GNC 23 RCS |
| RCS FWD – ITEM 1 EXEC (*) |
| JET DES F1F – ITEM 31 EXEC (no *) |
| F2F – ITEM 35 EXEC (no *) |

When RNG > 75 ft (DP–DP):
- DAP: LO Z

NOTE: DAP A allowed for ±X and ±Z THC

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

2. PERFORM RADIAL BURN ON ±VBAR

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

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

Inform MCC when burn complete

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

Cont next page
3. PERFORM FINAL BURN

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

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

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

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

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

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

GNC, OPS 202 PRO

GNC ORBIT MNVR EXEC

\sqrt{RCS SEL} – ITEM 4 EXEC (*)

If posigrade sep desired:

| TGT PEG 7 ΔVX – ITEM 19 +3 EXEC |
| ΔVY – ITEM 20 +0 EXEC |
| ΔVZ – ITEM 21 +0 EXEC |

If retrograde sep desired:

| TGT PEG 7 ΔVX – ITEM 19 –3 EXEC |
| ΔVY – ITEM 20 +0 EXEC |
| ΔVZ – ITEM 21 +0 EXEC |

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

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

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

GNC, OPS 201 PRO

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

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

1. INSTALL RNDZ TOOLS
   If rendezvous tools already installed, go to step 2
   Perform C/L CAM INSTALL (PHOTO/TV, CENTERLINE (C/L) CAMR)
   Perform CCTV CONFIG FOR DOCKING/UNDOCKING (RNDZ TOOLS), 7-2
   If reqd, install –Z COAS
   If RPOP setup reqd:
     - GNC 33 REL NAV
     - RNDZ NAV ENA – ITEM 1 EXEC (*)
     - ORB TO TGT – ITEM 10 EXEC
   Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-8, then:
   Perform RPOP OPS (RNDZ TOOLS), 7-9, steps 1 to 5, then:
   Perform TCS ACTIVATION (RNDZ TOOLS), 7-18, steps 1 to 3, then:
   Perform TCS MANUAL ACQUISITION (RNDZ TOOLS), 7-19, step 1
     (Set RANGE = 4 ft, AZIMUTH = 0, ELEVATION = 0)
   Note: TCS will not track until after undock
   Perform HHL CHECKOUT (RNDZ TOOLS), 7-6

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

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

4. INITIAL SEPARATION SEQUENCE
A6U FLT CNTLR PWR – ON
When capture latches/hooks open:
If no spring-assisted separation:
DAP: B/FREE/ALT, no LO Z
THC: +Z (out) 4 pulses at 10 sec intervals
Do not attempt to maintain 8 degree corridor
If spring-assisted separation:
When petals clear:
DAP: B/LVLH/ALT, no LO Z
THC: as reqd to maintain target within 8 deg corridor on C/L camera

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

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

If reqd, perform TCS MANUAL ACQUISITION (RNDZ TOOLS), 7-19, step 3

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

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

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

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

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

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

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

√MCC for final burn engine selection and breakout direction

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

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

If + X burn:

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

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

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

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

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

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

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

1. **OPS 202 PRO**
   
   **[GNC ORBIT MNVR EXEC]**
   
   Load Ti Delay Pad, 3-7

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

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

   If RCS:
   
   Perform RCS BURN (Cue Card)

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

2. **Reload new BASETIME per final Ti PAD, 3-7**
   
   **[GNC 34 ORBIT TGT]**

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

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

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

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

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

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

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

#### TIG

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#### PRELIMINARY

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### Ti ONBOARD SOLUTIONS

#### PREL FLTR

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#### PROP (IF REQD)

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#### FINAL-GROUND LIMITS

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#### FINAL Ti PAD (MNVR PADS)

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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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   TRK – ITEM 19 (CUR-*)

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

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

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

When in Lambert Targeting and TGT ITER occurs:

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

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

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

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

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

Prox Ops
1. If “go for RPM” not received from MCC, do not perform Rbar Pitch Maneuver. Proceed directly to the TORVA and continue to the Vbar. On the Vbar, stationkeep for a maximum of 1 rev and attempt to re-establish comm. If no comm after 1 rev of stationkeeping, perform VBAR BREAKOUT (CONTINGENCY OPS), 5-14
2. If “go to proceed inside 600, to 400 ft” not received from MCC, do not approach inside 600 ft (CG - CG). Stationkeep on the Vbar outside of 600 ft for a maximum of 1 rev and attempt to re-establish comm. If no comm after 1 rev of stationkeeping, perform VBAR BREAKOUT (CONTINGENCY OPS), 5-14
3. If “go to proceed inside 400, to 170 ft” not received from MCC, do not approach inside 400 ft (CG - CG). Stationkeep on the Vbar outside of 400 ft for a maximum of 1 rev and attempt to re-establish comm. If no comm after 1 rev of stationkeeping, perform VBAR BREAKOUT (CONTINGENCY OPS), 5-14
4. If “go to proceed inside 170 ft” or “go for docking” not received from MCC do not attempt docking. Back out (if required) and stationkeep outside of 170 ft for a maximum of 1 rev and attempt to re-establish comm. If no comm after 1 rev of stationkeeping, go to VBAR BREAKOUT (CONTINGENCY OPS), 5-14
DEGRADED CONTROL
DEGRADED +X TRANSLATION

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

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

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

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

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

| 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.  
√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.
\textbackslash{}MCC for additional procedure updates

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

During approach:
If failure occurs post-Ti:
   Do not trim VGO Y on MC1-4
   If in -Z TGT TRK, do not perform MANUAL OUT-OF-PLANE NULL 19A, 4-19
Do not approach inside 250 ft (interface to interface)

If inside 250 ft, perform VBAR CORRIDOR BACKOUT \textit{(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 \textit{(CONTINGENCY OPS)}, 5-14
When RNG = 250 ft, \textbackslash{}MCC for further actions
LOSS OF ONE FxD JET

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

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

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

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

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

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. MCC for additional procedure updates

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

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

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

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

4. If failure occurs after Vbar arrival, backout to RNG > 250 ft:
   Perform VBAR CORRIDOR BACKOUT (CONTINGENCY OPS), 5-12 with following deltas:
   After establishing opening rate:
   Config DAP to A9, B9
   Perform REGAIN Y CONTROL  \[C\]
   Perform CONFIG DAP YAW OPTION TO ALL  \[B\]
   When RNG > 75 ft,
   \[\sqrt{DAP}: No LO Z\]
   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:
   \[\sqrt{MCC} for updates to UNDOCKING/SEP TIMELINE >>\]

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)

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

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

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

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

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

2. COAS NAV should not be performed if VERN fail

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

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

5. Twelve hooks reqd for mated attitude control in ALT
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# POST-CONTACT THRUST (PCT) REFERENCE DATA

## PBI FUNCTION WHENEVER IN OPS 2:

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

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

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

Expected TCS/Refl Acquisition Range
Refl #2 at TCS max range limit (5000-6000 ft)

Ref#5 is Out of Plane (Out of Page)
Ref#3 becomes less visible as Orbiter
Y-LVLH position becomes more positive

Trajectory
NOT TO SCALE
HHL AIMING LOCATIONS

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

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

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

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

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Bottom View

Side View

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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**RENADEVOUS TOOLS**

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CCTV CONFIG FOR DOCKING/UNDOCKING

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

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

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

3. **SET CAMERA ZOOM SETTINGS**

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

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

   Install CORRIDOR overlay:
   - Use green XHair to center overlay

   Install RANGE RULER overlay:
   - Place contact ring tangent line on top of ODS Contact Ring (see figure next page)
Use Top/Front Of ISS Ring

Use Bottom/Back Of ISS Ring

Contact ring tangent line

Camera FOV

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

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

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

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

4. Perform RPOP INITIALIZATION, 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
       - √ 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, \sqrt{8.8.8.8}. Select range

HAND-HELD LIDAR STOW

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

Power sw – ON

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

Display Intensity knob – Adjust intensity to minimum acceptable level

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

Center red dot on TGT

Depress trigger for each measurement
Hold trigger for velocity measurements

Velocity accuracy increases with trigger hold duration:

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

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

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

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

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

2. From Startup Menu, select appropriate Expansion Chassis config

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

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

   NOTE
   Time synchronized on [OK]

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

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

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

   Select appropriate attitude rate

   Enter rates (as reqd)

   Click [OK] to continue
RPOP ODS

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

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

3. Update MET (as reqd):
   \([\text{CNTL}]/[F10]\)
   RPOP Configuration
   Select [Update MET . . .] button
   Update MET
   Update MET and click [OK] when finished

4. Reconfig Serial Ports (as reqd):
   \([\text{CNTL}]/[F10]\)
   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):
   \([\text{CNTL}]/[F10]\)
   RPOP Configuration
   Select [TCS/Refl . . .] button
   Select TCS/Reflector Set
   Reconfig desired TCS No. and/or Reflector No. and click [OK] when finished

6. Config Average Rdot guidance (as reqd):
   Select Guid – [CTRL]/[F5]
   Select Guidance Type
   Select [Average Rdot] button – [A]
   Enter time until docking (countdown time)
   Min > __________
   Sec > __________
   Select [Start]. Timer starts when [Start] pressed
   Click [OK] when finished

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

8. Configure HHL NAV (as reqd):
   Select [Data] key for the HHL (CTRL row in columns F1 through F4)
   If there is no [Data] key for HHL, reconfigure data source for HHL
   
   Select [HHL Nav . . .] config button – [ALT]/[H]
   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 KEYSRROKE 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)

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Key Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[F1→F4] (SV, RR, HHL, CCTV or TCS)</td>
<td>PRIME KEY</td>
</tr>
<tr>
<td></td>
<td>Make this Trajectory Prime Trajectory</td>
</tr>
<tr>
<td></td>
<td>– Only one trajectory can be Prime at a time</td>
</tr>
<tr>
<td></td>
<td>– Prime Trajectory has orbiter graphics, predictors, and color-coordinated digital data</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Key Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[SHIFT]/[F1→F4] (Show/Hide)</td>
<td>SHOW/HIDE KEY</td>
</tr>
<tr>
<td></td>
<td>Show or Hide this Trajectory (toggle)</td>
</tr>
<tr>
<td></td>
<td>– Prime Trajectory cannot be hidden</td>
</tr>
<tr>
<td></td>
<td>– Background processing of trajectory continues even when hidden</td>
</tr>
<tr>
<td></td>
<td>(Exception: HHL trajectory data will not prompt for user input when hidden)</td>
</tr>
</tbody>
</table>

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

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

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

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

[CTRL]/[F5] (Guid)
GUIDANCE
Select guidance cues on demand
Available options are:
- CW Targeting - given a burn time, transfer time, and desired LVLH position, CW Targeting will provide required THC inputs
- OOP Control - provides THC recommendations for controlling out-of-plane motion
- Glideslope Control - provides THC recommendations for flying the final approach along a glideslope
- +Vbar Acquisition - provides THC recommendations for acquiring the +Vbar in preparation for final approach
- LVLH Velocity Null - provides THC recommendations for nulling LVLH velocities in each direction
- Average Rdot - information for timed approach

[F6] (Sub Ang)
SUBTENDED ANGLE
Enter subtended angle in Rdot Window to get range and range rate. Only active when SubAng source active on Rdot Window

[SHIFT]/[F6] (Tgt Att)
TARGET ATTITUDE
Update Target attitude and attitude rate

[CTRL]/[F6] (PCMMU)
PCMMU MODE
No PCM mode (displays No PCM)
Requires orbiter attitude data to be entered manually with each sensor mark
PCM MODE (displays PCM)
Orbiter attitude is automatically computed using PCMMU data

[F7] (View)
VIEW
If Tgt-Centered LVLH, cycle through views: XZ, XY, YZ
If Orb-Centered LVLH, cycle through views: XZ, XY, YZ, CAM
View identification displayed upper left-hand corner of Trajectory Display

[SHIFT]/[F7] (Ovrlay)
OVERLAY
Cycle through displays of overlays

[CTRL]/[F7] (OvrOrgn)
OVERLAY ORIGIN (Available only if Overlay is enabled)
Toggle anchor point of corridor overlay between Target vehicle attach point and orbiter attach point

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

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

[CTRL]/[F8] (POR)
POINT OF REFERENCE
Cycle through preselected orbiter Point-Of-Reference to Target Point-Of-Reference sets (e.g., CG to CG, Dock Port to Dock Port)
### GENERAL FUNCTION KEYS (Columns F5 → F12) (Cont)

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Function Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>[F9]</strong> THC CLEAR</td>
<td>Clear THC “What if” inputs from the Prime Trajectory</td>
</tr>
<tr>
<td>(THC Clr)</td>
<td></td>
</tr>
<tr>
<td><strong>[SHIFT]/[F9]</strong> TRAJECTORY CLEAR</td>
<td>Clear Prime Trajectory history of all but 2 most recent data inputs</td>
</tr>
<tr>
<td>(TrajClr)</td>
<td></td>
</tr>
<tr>
<td><strong>[CTRL]/[F9]</strong> BACK 1</td>
<td>Delete last data input from the Prime Trajectory</td>
</tr>
<tr>
<td>(Back 1)</td>
<td></td>
</tr>
<tr>
<td><strong>[F10]</strong> HELP</td>
<td>Access on-line help information</td>
</tr>
<tr>
<td>(Help)</td>
<td></td>
</tr>
<tr>
<td><strong>[SHIFT]/[F10]</strong> EXIT</td>
<td>Save output files and exit RPOP program</td>
</tr>
<tr>
<td>(Exit)</td>
<td></td>
</tr>
<tr>
<td><strong>[CTRL]/[F10]</strong> RPOP CONFIGURATION</td>
<td>Configure following RPOP options:</td>
</tr>
<tr>
<td>(Config)</td>
<td></td>
</tr>
<tr>
<td>Debug</td>
<td>Enable serial port I/O debug text to be displayed. Displays Debug</td>
</tr>
<tr>
<td>Data Freq...</td>
<td>Change frequency of automatic acceptance (plotting) of PCM data (SV or RR Auto) or TCS data (TCS Auto)</td>
</tr>
<tr>
<td>Predictors...</td>
<td>Change number and/or time increment of displayed predictors</td>
</tr>
<tr>
<td>Update MET...</td>
<td>Change the mission elapsed time</td>
</tr>
<tr>
<td>Altitude...</td>
<td>Change altitude of target vehicle</td>
</tr>
<tr>
<td>Comm Ports...</td>
<td>Reconfigure serial ports and/or the DLL</td>
</tr>
<tr>
<td>TCS/Refi...</td>
<td>Select TCS ID number (1-2) and reflector ID number (1-6)</td>
</tr>
<tr>
<td>Views...</td>
<td>Enable/disable Tgt- and Orb-Centered views</td>
</tr>
</tbody>
</table>

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Options include:

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

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

   SHUTTLE APPS
   > TCS

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

   PGCS
   TCS Self Test

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

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

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

   * If not in config, *
   * \MCC

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

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

1. **ACQUIRE**

   **PGSC**
   - **TCS OPS**
   - √Pulse: Avail
   - √CW: Active
   - **TCS C&DI**
   - > Macros > ACQUISITION

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

   √95% RANGE GATE – (no X)
   > SEND

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

   √Data – Good (and active tracking data)
   - * If TCS not tracking and no RPOP or Auto Seed
   - * Update disabled,
   - * **TCS C&DI**
   - * > Commands > Acquire
   - * Update Range estimate and zero AZ & EL
   - * > Send

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

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

1. **SHUTDOWN TCS**

   **PGSC**
   
   TCS C&DI
   > Macros > SHUTDOWN
   
   * If error msg received during SHUTDOWN, *
   * \MCC

   **TCS OPS**
   
   √Shutter: Closed (takes ~22 sec)
   
   * If shutter fails to close: *
   * > Commands > Close shutter *

   If Final TCS deactivation for mission:
   
   2. **SECURE Z AXIS**

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

   **TCS OPS**
   
   √Z Latch: Locked
   
   * If Z Latch fails to lock: *
   * If Z Latch: Transit *
   * 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>CW Laser</td>
<td>-40.0</td>
<td>45.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50.0</td>
</tr>
<tr>
<td>APD</td>
<td>-40.0</td>
<td>65.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70.0</td>
</tr>
<tr>
<td>CPU</td>
<td>-40.0</td>
<td>80.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>85.0</td>
</tr>
<tr>
<td>DC Power</td>
<td>-40.0</td>
<td>80.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>85.0</td>
</tr>
<tr>
<td>Galvos</td>
<td>-40.0</td>
<td>80.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>85.0</td>
</tr>
</tbody>
</table>

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

TRAD FAIL RANGE AND RANGE RATE DETERMINATION

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

NOMINAL OPS

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

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

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

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

### TCS FAIL

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

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

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

### HHL FAIL

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

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

<table>
<thead>
<tr>
<th>Phase</th>
<th>Prime Source:</th>
<th>Backup Source:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Manual Takeover thru ~1200 ft</strong>&lt;br&gt;Note: Transition from phase 1 to 2 should be gradual. Start transition at ~1500 ft and complete it prior to 1000 ft braking gate&lt;br&gt;Note: RPOP state data is bad</td>
<td>Spec 33: FLTR</td>
<td>Rdot window: HHL/Dt&lt;br&gt;Note: RPOP prompts user for Orb attitude after 1st HHL mark. Enter P/Y/R = (90/0/0)* and check “Do not prompt for attitude”&lt;br&gt;TCS CADS: Raw TCS (pulse active)&lt;br&gt;Note: Range data good, rdot can be quite noisy&lt;br&gt;Note: Resize and reposition the RPOP window so that the TCS mode (pulse/CW) is visible</td>
</tr>
<tr>
<td>2. ~1200 ft thru TCS CW lock-on (~800 ft)&lt;br&gt;Note: RPOP State data is bad</td>
<td>Rdot window: HHL/Dt&lt;br&gt;Note: RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
<td>TCS CADS: Raw TCS (pulse active)&lt;br&gt;Note: Range data good, rdot can be quite noisy&lt;br&gt;Rdot window: Generic&lt;br&gt;Note: Manually enter raw TCS range marks. RPOP uses the last two marks with Dt &gt; 30 sec to calculate the Rdot estimate</td>
</tr>
<tr>
<td>3. TCS CW lock-on (~800 ft) thru Vbar arrival&lt;br&gt;Note: RPOP State data is bad</td>
<td>TCS CADS: Raw TCS (cw active)</td>
<td>Rdot window: HHL/Dt</td>
</tr>
<tr>
<td>4. Vbar arrival thru 15 ft&lt;br&gt;Note: Range: HHL (back of unit): Raw HHL range and times on cue card&lt;br&gt;Note: Rdot: HHL (back of unit): Raw HHL* (long trigger pulls)&lt;br&gt;Rdot table on Range Ruler Overlay: Dt between 1 ft DRange</td>
<td>TCS CADS: Raw TCS (cw active) and/or&lt;br&gt;Note: State Data: TCS AUTO&lt;br&gt;Note: Check Orb Att = (90/0/0), and set TCS frequency to 30 sec [CNTRL F10]</td>
<td>Rdot window: HHL/Dt</td>
</tr>
<tr>
<td>5. 15 ft thru dock</td>
<td>TCS CADS: TCS Raw (cw active)</td>
<td>Rdot window: Range Ruler(F12)</td>
</tr>
</tbody>
</table>

*Orbiter attitude displayed on RPOP will not be correct until maneuver to Vbar attitude is complete. Until Vbar arrival, do not use the RPOP trajectory data other than the data in the Rdot Window

---

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

<table>
<thead>
<tr>
<th>Phase</th>
<th>Prime Source:</th>
<th>Backup Source:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Manual Takeover thru ~1200 ft</strong> (noisy RR angles)</td>
<td>Spec 33: SV, Raw RR</td>
<td>For range – HHL (back of unit): Raw HHL&lt;br&gt;For Rdot – Rdot vs. ∆Rng/∆t Cue Card: Record Raw HHL range and times on cue card</td>
</tr>
<tr>
<td>2. ~1200 ft thru 15 ft</td>
<td>For Range: HHL (back of unit): Raw HHL(short pulls)&lt;br&gt;For Rdot: HHL (back of unit): Raw HHL(long pulls)</td>
<td>For range – Subtended Angle table (6-14): COAS or Centerline Cam subtended angle&lt;br&gt;For Rdot – Rdot vs. ∆Rng/∆t Cue Card: Record subtended angle range and times on cue card</td>
</tr>
<tr>
<td>3. 15 ft thru dock</td>
<td>For Range: HHL Overlay: Camera A/D&lt;br&gt;HHL (back of unit): Raw HHL* (long trigger pulls)&lt;br&gt;Rdot table on Range Ruler Overlay: Dt between 1 ft DRange</td>
<td>For Range – HHL (back of unit): Raw HHL&lt;br&gt;For Rdot – Rdot vs. ∆Rng/∆t Cue Card: Record Raw HHL range and times on cue card</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
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<td>AIRLOCK FAN ACT AND ODS VOLUME PREP</td>
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<td>PREP FOR INGRESS – BYPASS Config</td>
<td>8-11</td>
</tr>
<tr>
<td>POST DOCKING HATCH LEAK CHECK</td>
<td>8-12</td>
</tr>
</tbody>
</table>
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 MNB EXT ARLK HTR VEST Z1/2/3 – cl
DOCKING MECHANISM POWERUP

SM 167 DOCKING STATUS

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

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

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

A7L 4. APDS POWER A_DS, B_DS, C_DS (three) – ON
   √A_DS, B_DS, C_DS lt (three) – lt on

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

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

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

**SM 167 DOCKING STATUS**

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

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

CRT
    √CLUTCH – blank/SLIP

UNDOCKING PREP

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

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

**SM 167 DOCKING STATUS**

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

CRT
   - CLUTCH – LOCK/blank

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

0:00

3. RING OUT pb – push

0:10
- FINAL POSITION lt – lt off

CRT
- DRV CMD – ON
- FIXERS – ON
- PETAL POS BASE (three) – incr

A7L
- If RING INITIAL POSITION lt failed on (ring stops after 1 sec,*)
  - and CLUTCH – blank/SLIP): *

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

A7L
- POWER OFF pb – push *
- 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 *

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

A7L
- RING OUT pb – push *
- Within 10 sec: *
  - APDS POWER A_{DS},B_{DS},C_{DS} (three) – OFF *
  - APDS POWER A_{DS},B_{DS},C_{DS} (three) – ON *
  - CIRC PROT OFF pb – push *
  - CIRCUIT PROTECT OFF lt – lt on *
  - When RING INITIAL POSITION lt – lt on: *
  - RING OUT pb – push *

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

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

* If CLUTCH – LOCK/blank:
  * A7L  * √RING INITIAL POSITION lt – lt on
  *       * √FIXERS OFF lt – lt off
  *       * √APDS CIRCUIT PROTECT OFF lt – lt on
  *       * RING OUT pb – push (expect 1 sec of drive), wait
  *       * 10 sec
CRT  * √RING DRV CMD – OFF

* If not CLUTCH – blank/SLIP:
  * A7L  √MCC

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

DOCKING RING RETRACTION (NOT MATED)

[SM 167 DOCKING STATUS]

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

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

A7L  * If RING FINAL POSITION lt failed on (ring stops after 10 sec):
    * RING IN pb – push
3:40  CRT  * When PETAL POS BASE = 5 ± 3% and not decr:
    * Wait 10 sec, then:
A7L  * POWER OFF pb – push
    * √STATUS lt (eighteen) – lt off >>

3:40  A7L  3. √RING FINAL POSITION lt – lt on
3:50  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 cap from Airlock Fan outlet and temp stow. Unstow, install diffuser on middeck floor fitting.

TNL EXT  2. Attach bypass duct to Airlock Fan outlet.

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

MO13Q  4. ARLK FAN A(B) – ON

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

If in Approach CC perform the following:

6. Unstrap centerline camera diffuser flex duct from EXT A/L wall
   Attach flex duct to camera bracket to direct air flow to window
   If required, tape diffuser open

AW18A  7. LTG FLOOD 1(3,4) – OFF

MO13Q  8. ARLK 2 – OFF/ON

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

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

MO10W  11. 14.7 CAB REG INLET SYS 1, SYS 2 (two) vlv – CL
AIRLOCK PREP FOR INGRESS – BYPASS CONFIG

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

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

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

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

11. \( \sqrt{\text{Airflow at top of external airlock halo}} \)

R12
12. Go to P/TV02 DOCK, DEACTIVATION, step 3 (PHOTO/TV, SCENES)
POST DOCKING HATCH LEAK CHECK

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

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

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

[SM 177 EXTERNAL AIRLOCK]

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

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

5. Notify MCC and ISS: "Initial hatch leak checks complete. Ready for vestibule pressurization"
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
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HOOKS 1(2) CLOSED LT FAILED ON .......................................................................... 8-23
LATCHES OPEN LT FAILED OFF .................................................................................. 8-24
APDS POWER FAILED OFF .......................................................................................... 8-24
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APDS FAILED CAPTURE RECONFIG ........................................................................... 8-33
PMA 2/3 HOOKS CLOSE .............................................................................................. 8-35
   OPEN ....................................................................................................................... 8-37
POWER FAILED OFF (STATUS LTS OFF)

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

A7L

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

2. CONTROL PANEL POWER A – ON
   APDS POWER A,OFF – 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,OFF – ON
   B,OFF – 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,OFF – OFF
      A,OFF,B,OFF (two) – ON
   POWER ON pb – push
   If STATUS lt (eighteen) – lt off:
      APDS POWER B,OFF – OFF
      C,OFF – ON
   POWER ON pb – push
   APDS CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on
   Go to **DOCKING SEQUENCE** (Cue Card), step 17
### DAMPING FAILED ON

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

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

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

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

### CAPTURE LT FAILED ON

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

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

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

---

**SM 167 DOCKING STATUS**

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

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

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

**DISABLE DAMPING**

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

Cont next page
COMMAND CLUTCH TO LOCK

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

RETRACT RING

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

EXTEND RING

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

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


FIXERS OFF LT FAILED ON

SM 167 DOCKING STATUS

If performing DOCKING RING EXTENSION, 8-8:

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

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

3. APDS CIRC PROT OFF pb – push
   √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 √CLUTCH – LOCK/blank
A6L 3. PSU PWR MN A,MN B (two) – OFF
A7L RING IN pb – push
   APDS POWER A_{DS},B_{DS},C_{DS} (three) – OFF
   – ON
A6L 0:00 PSU PWR MN A,MN B (two) – ON (ring will begin to drive in this step)
CRT √PETAL POS BASE (three) – decr
A7L 0:05 POWER ON pb – push
CRT √RING DRV CMD – OFF
A6L 4. PSU PWR MN A,MN B (two) – OFF
A7L RING OUT pb – push
   APDS POWER A_{DS},B_{DS},C_{DS} (three) – OFF
   – ON
A6L 0:00 PSU PWR MN A,MN B (two) – ON (ring will begin to drive in this step)
CRT √PETAL POS BASE (three) – incr
A7L 0:05 POWER ON pb – push
CRT √RING DRV CMD – OFF

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

A7L 1. POWER ON pb – push
    APDS CIRC PROT OFF pb – push
    √CIRCUIT PROTECT OFF lt – lt on
    FIXER OFF pb – push
    √FIXERS OFF lt – lt on

2. RING OUT pb – push

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

CRT 3. If PETAL POS BASE (three) not incr:
    If RING DRV CMD – ON:
    If not CLUTCH – LOCK/blank:
    A7L POWER OFF pb – push
        ON pb – push
        Go to CLUTCH NOT ‘LOCK’ >>

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

RING DRV CMD OFF

A7L 1. POWER OFF pb – push
    ON pb – push
    If STATUS lt (eighteen) – lt off:
    CONTROL PANEL POWER A – OFF
    POWER ON pb – push
    If STATUS lt (eighteen) – lt off:
    Go to step 3
    Continue in DOCKING SEQUENCE (Cue Card), as reqd >>

2. APDS POWER A_DS – OFF
    RING IN pb – push
    CRT If RING DRV CMD – OFF:
    A7L APDS POWER A_DS – ON
    C_DS – OFF
    RING IN pb – push
    CRT If RING DRV CMD – OFF:
    Go to step 3
    A7L POWER ON pb – push
    Continue in DOCKING SEQUENCE (Cue Card) through step 16 then:
    APDS POWER A_DS (C_DS) – ON
    OPEN LATCHES pb – push
    After 5 sec:
    √LATCHES OPEN lt – lt on
    APDS POWER A_DS (C_DS) – OFF
    Go to DOCKING SEQUENCE (Cue Card) step 18 >>

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

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

**SM 167 DOCKING STATUS**

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

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

**A7L**

RING IN pb – push

In step 11, to stop ring drive

POWER ON pb – push

**CRT**

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

**A7L**

POWER OFF pb – push

**FORCE RING ALIGNMENT**

**A7L**

1. APDS CIRC PROT OFF pb – push

   √CIRCUIT PROTECT OFF lt – lt on

2. FIXER OFF pb – push

   √FIXERS OFF lt – lt on

0:00

3. RING OUT pb – push

**CRT**

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

FIXERS – OFF

0:05

® CLUTCH – LOCK/blank

**A7L**

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

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

* RING OUT pb – push

* Within 10 sec: *

* APDS POWER A_{DS},B_{DS},C_{DS} (three) – OFF *

* APDS POWER A_{DS},B_{DS},C_{DS} (three) – ON *

* CIRC PROT OFF pb – push *

* √CIRCUIT PROTECT OFF lt – lt on *

**CRT**

* When PETAL POS BASE (any) = 92%:

**A6L**

* PSU PWR MN A,MN B (two) – OFF

**CRT**

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

**A6L**

* PSU PWR MN A,MN B (two) – ON

**CRT**

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

**A7L**

* RING OUT pb – push

* Go to step 7

**CRT**

4. When PETAL POS BASE (any) = 92%:

**A7L**

POWER ON pb – push

**CRT**

5. When PETAL POS BASE (three) not changing for 30 sec:

**A7L**

RING OUT pb – push

0:00

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

0:10

**CRT**

7. RING DRV CMD – OFF

**A7L**

FIXERS OFF lt – lt off

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

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

<table>
<thead>
<tr>
<th>SM 167 DOCKING STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRT If no ring motion when RING DRV CMD – ON</td>
</tr>
</tbody>
</table>

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

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>CRT If APDS CIRC PROT – ON:</td>
</tr>
</tbody>
</table>

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

A7L If APDS CIRCUIT PROTECT OFF lt – lt on or

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

HOOKS 1(2) OPEN LT FAILED ON

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

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

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

SM 167 DOCKING STATUS

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

2. APDS POWER A_{DS} (B_{DS}) – ON
   POWER OFF pb – push
   ON pb – push

3. If other hook gang closed:
   Continue in DOCKING SEQUENCE (Cue Card), as reqd
   After DOCKING SEQUENCE (Cue Card) complete, go to PMA 2/3
   HOOKS CLOSE, 8-35, to secure interface with 12 hooks

4. If neither hook gang closed:
   MCC for IFM capability
   Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A
   THRU F) and PMA 2/3 HOOKS CLOSE, 8-35, as reqd, to secure
   interface with 12 hooks

5. If no IFM capability or time does not permit IFM:
   APDS CIRC PROT OFF pb – push
   CIRCUIT PROTECT OFF lt – lt on
   OPEN HOOKS pb – push

   CRT
   A7L
   HK1,HK2 POS (two) – decr
   HOOKS 1,HOOKS 2 OPEN lt (two) – lt on

   0:00
   RING OUT pb – push

   3:40
   A7L
   PETAL POS BASE (three) – incr
   RING INITIAL POSITION lt – lt on
   Go to FAILED CAPTURE (VBAR APPROACH, Cue Card) to undock
READY TO HOOK LT FAILED ON

1. Immediately prior to step 4 in DOCKING SEQUENCE (Cue Card):
   A7L  
   APDS POWER A<sub>DS</sub> – OFF
   If READY TO HOOK lt – lt off:
   : If HOOKS 1(2) OPEN lt – lt off:
   : : APDS CIRC PROT OFF pb – push
   : : √CIRCUIT PROTECT OFF lt – lt on
   : : OPEN HOOKS pb – push
   : L √HOOKS 1,HOOKS 2 OPEN lt (two) – lt on
   : Continue in DOCKING SEQUENCE (Cue Card), as reqd, with the
   : following change:
   : After hooks begin to drive closed in step 10:
   L
   APDS POWER A<sub>DS</sub> – ON >>

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

HOOKS 1(2) CLOSED LT FAILED ON

A7L 1. APDS POWER A<sub>DS</sub> – OFF

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

6. If HOOKS 1(2) CLOSED lt – lt on:
   APDS POWER A<sub>DS</sub> – 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

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

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

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

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

APDS POWER FAILED OFF

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

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

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

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

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 lt is ON or LATCHES CLOSED lt is OFF. Be prepared to pick up in ANY ATTITUDE SEPARATION (CONTINGENCY OPS), step 4.

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

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

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

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

8. Interface clear of debris or other obstruction

RETRACT RING FOR SECOND MATING ATTEMPT:

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

3:15
READY TO HOOK lt – lt on

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
POWER ON pb – push
   CRT RING DRV CMD – OFF

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

0:05
OPEN lt – lt on

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

13. POWER OFF pb – push
   A7L 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

A7L 2. POWER ON pb – push

SM 167 DOCKING STATUS

RECAPTURE PMA PETALS
3. CLOSE LATCHES pb – push
   √LATCHES OPEN It – It 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
0:10  POWER ON pb – push
√RING FINAL POSITION lt – lt off
CRT  √DRV CMD – OFF
A7L  √LATCHES CLOSED lt – lt on

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

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

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

DISCHARGE ACTIVE HOOK PYROS
A6L  9. PYRO PWR MN A,MN C (two) – ON
A7L  PYROS Aₚ,Bₚ,Cₚ (three) – ON
     √Aₚ,Bₚ,Cₚ 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 Aₚ,Bₚ,Cₚ (three) – OFF
     √Aₚ,Bₚ,Cₚ 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
     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 A₃₅,B₃₅,C₃₅ (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

8-28  RNDZ/116/FIN
A6L 14. 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

15. PAS HOOKS FIRING pb – push

16. 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 17. √APDS CIRCUIT PROTECT OFF lt – lt on

0:00
RING OUT pb – push
√INTERF SEALED lt – lt off
CRT If interface separates [PETAL POS BASE (three) incr after 20 sec]:
Go to step 19

RECONFIGURE AND PREPARE FOR 96 BOLT EVA

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

FINAL PREPARATION FOR VEHICLE SEPARATION

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

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

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

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

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

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

A7L 2. POWER ON pb – push

SM 167 DOCKING STATUS

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

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

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

0:00 6. RING IN pb – push
0:10 POWER ON pb – push
   √ RING FINAL POSITION lt – lt off
   CRT √ DRV CMD – OFF
A7L  √ LATCHES CLOSED lt – lt on

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

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

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

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

RECONFIGURE AND DISCHARGE PASSIVE HOOK PYROS
A7L 11. POWER ON pb – push
A6L PSU PWR MN A,MN B (two) – OFF
A7L RING IN pb – push
   APDS POWER A_DS,B_DS,C_DS (three) – OFF
   √ – ON
A6L PSU PWR MN A,MN B (two) – ON
CRT When PETAL POS BASE (three) = ~6% and not decr:
A7L POWER ON pb – push
A6L 12. PYRO PWR MN A,MN C (two) – ON
A7L PYROS A_p,B_p,C_p (three) – ON
   √A_p,B_p,C_p lt (three) – lt on
   PYRO CIRC PROT OFF pb – push
   √CIRCUIT PROTECT OFF lt – lt on
13. PAS HOOKS FIRING pb – push
14. PYRO CIRC PROT ON pb – push
   √CIRCUIT PROTECT OFF lt – lt off
   PYROS A_p,B_p,C_p (three) – OFF
   √A_p,B_p,C_p lt (three) – lt off
A6L PYRO PWR MN A,MN C (two) – OFF

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

Cont next page
RECONFIGURE AND DISCHARGE ACTIVE HOOK PYROS

A7L 16. POWER ON pb – push
A6L PSU PWR MN A,MN B (two) – OFF
A7L RING IN pb – push
APDS POWER A_DS,B_DS,C_DS (three) – OFF
– ON
A6L PSU PWR MN A,MN B (two) – ON
CRT When PETAL POS BASE (three) = ~6% and not decre:
A7L POWER ON pb – push

A6L 17. PYRO PWR MN A,MN C (two) – ON
A7L PYROS A_p,B_p,C_p (three) – ON
\sqrt{A_p,B_p,C_p} lt (three) – It on
PYRO CIRC PROT OFF pb – push
\sqrt{CIRCUIT PROTECT OFF} It – It on

18. ACT HOOKS FIRING pb – push

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

REATTEMPT EXTENDING RING TO INITIAL POSITION FOR INTERFACE SEPARATION

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

RECONFIGURE AND PREPARE FOR 96 BOLT EVA

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

FINAL PREPARATION FOR VEHICLE SEPARATION

~3:20 A7L 22. \sqrt{RING INITIAL POSITION} It – It on
CRT \sqrt{DRV CMD} – OFF
\sqrt{PETAL POS BASE (three)} = 76 ± 3%

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

SM 167 DOCKING STATUS

A7L

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

2. \APDS CIRCUIT PROTECT OFF lt – lt on

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

4. \RING FORWARD POSITION lt – lt on
   \ALIGNED lt – lt on
   \FIXERS OFF lt – lt off
   CRT \PETAL POS BASE (three): 98 ± 2%
   0:00 A7L \RING IN pb – push
   CRT \CLUTCH – Lock/blank
   A7L \RING FORWARD POSITION lt – lt off
   1:15   \INITIAL POSITION lt – lt on (for ~16 sec), then lt off
   * If RING 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
   * \CIRCUIT PROT OFF pb – push
   * \CIRCUIT PROTECT OFF lt – lt on
   * \RING INITIAL POSITION lt – lt on (for ~16 sec),
   * then lt off
   CRT * When PETAL POS BASE (three) = 98 ± 2%:
   A7L * RING OUT pb – push
   * After 10 sec:
   CRT * \RING DRV CMD – OFF

5. \RING FINAL POSITION lt – lt on
   5:00  \DRV CMD – OFF

6. \RING FINAL POSITION lt – lt on
   5:00  \DRV CMD – OFF

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

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 off
    * APDS CIRC PROT OFF pb – push
    * √CIRCUIT PROTECT OFF lt – lt on
    * RING OUT pb – push
    * After 1 sec:
    * CRT
  * √RING DRV CMD – OFF
  * A7L
  * If RING FORWARD POSITION lt failed on (ring stops after 10 sec):
    * RING OUT pb – push
    * Within 10 sec:
      * APDS POWER A\textsubscript{3S},B\textsubscript{3S},C\textsubscript{3S} (three) – OFF
      * APDS POWER A\textsubscript{3S},B\textsubscript{3S},C\textsubscript{3S} (three) – ON
      * CIRC PROT OFF pb – push
      * √CIRCUIT PROTECT OFF lt – lt on
    * When RING INITIAL POSITION lt on:
    * RING OUT pb – push

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

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

   * If CLUTCH – LOCK/blank:
   * A7L
     * √RING INITIAL POSITION lt – lt on
     * √FIXERS OFF lt – lt off
     * √APDS CIRCUIT PROTECT OFF lt – lt on
     * RING OUT pb – push (expect 1 sec of drive), wait 10 sec
     * √RING DRV CMD – OFF
   * CRT
     * If not CLUTCH – blank/SLIP:
       * √MCC

9. POWER OFF pb – push
   √STATUS lt (eighteen) – lt off
**PMA 2/3 HOOKS CLOSE**

**CAUTION**
Procedure assumes one ODS Hook Gang has failed and one PMA 2/3 Hook Gang can be used to recover a total of 12 hooks. ODS to PMA 2/3 interface must be hard mated, as verified by the ODS X3/X4 connector mate indications, in order to provide PMA 2/3 active hook control and tlm through the interface X-connectors.

**NOTE**
PMA2/3 Active Hooks 1(2) engage ODS Passive Hooks 2(1). Therefore, if ODS Active Hooks 1(2) is failed, it is preferred to close PMA Active Hooks 2(1).

**SM 167 DOCKING STATUS**

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

TO CLOSE HOOKS 1, PERFORM STEPS 3 THRU 6

| CRT | 3. cb PMA 2/3 GRP 1 HOOKS SYS A OP,CL (two) – cl |
|     | √ cb PMA 2/3 GRP 1 HOOKS SYS B OP,CL (two) – cl |
|     | √ PMA 2/3 HOOKS GRP 1 tb – OP |
|     | √ HK1 IND OP – 1,2 |
|     | √ IND CL – blank |
|     | √ HK CLS 1/3/5, 7/9/11 (two) – blank |
|     | * If either IND CL present, hooks may operate single motor. If both IND CL present, hooks may not drive: |
|     | * 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. PMA 2/3 HOOKS SYS A,SYS B (two) – ctr |
|     | cb PMA 2/3 GRP 1 HOOKS SYS A OP,CL (two) – op |
|     | B OP,CL (two) – op |
TO CLOSE HOOKS 2, PERFORM STEPS 7 THRU 10

7. cb PMA 2/3 GRP 2 HOOKS SYS A OP, CL (two) – cl
   B OP, CL (two) – cl
   √PMA 2/3 HOOKS GRP 2 tb – OP
   CRT
   √HK2 IND OP – 1, 2
   √CL – blank
   √HK CLS 2/4/6, 8/10/12 (two) – blank
   * If either IND CL present, hooks may operate single motor.
   * If both IND CL present, hooks may not drive:
   * √MCC

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

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

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

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

---

**SM 167 DOCKING STATUS**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td>A6L</td>
</tr>
<tr>
<td></td>
<td>cb PMA 2/3 GRP 1,2 HOOKS (eight) – op</td>
</tr>
<tr>
<td></td>
<td>√ PMA 2/3 HOOKS SYS A, SYS B (two) – ctr (tb-bp)</td>
</tr>
<tr>
<td></td>
<td>√ GRP 1 tb – bp</td>
</tr>
<tr>
<td></td>
<td>√ GRP 2 tb – bp</td>
</tr>
<tr>
<td>2:20</td>
<td>A6L</td>
</tr>
<tr>
<td></td>
<td>√ PMA 2/3 HOOKS GRP 1 tb – CL</td>
</tr>
<tr>
<td></td>
<td>CRT</td>
</tr>
<tr>
<td></td>
<td>√ HK1 IND CL – 1,2</td>
</tr>
<tr>
<td></td>
<td>√ OP – blank</td>
</tr>
<tr>
<td></td>
<td>√ HK CLS 1/3/5, 7/9/11 (two) – CL</td>
</tr>
</tbody>
</table>

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

---

**TO OPEN HOOKS**

1. PERFORM STEPS 2 THRU 5

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

   √ PMA 2/3 HOOKS GRP 1 tb – CL

   CRT
   √ HK1 CMD OP – 1,2
   √ IND CL – blank
   √ HK CLS 1/3/5, 7/9/11 (two) – blank

* If PMA 2/3 HOOKS fail to drive, or do not reach end-of-travel after single motor drive time (~4:40): *

---

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:20</td>
<td>A6L</td>
</tr>
<tr>
<td></td>
<td>√ PMA 2/3 HOOKS GRP 1 tb – OP</td>
</tr>
<tr>
<td></td>
<td>CRT</td>
</tr>
<tr>
<td></td>
<td>√ HK1 IND OP – 1,2</td>
</tr>
<tr>
<td></td>
<td>√ CMD OP – blank</td>
</tr>
</tbody>
</table>

* If PMA 2/3 HOOKS fail to drive, or do not reach end-of-travel after single motor drive time (~4:40): *

---

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

   CRT
   √ HK1 CMD OP – 1,2
   √ IND CL – blank
   √ HK CLS 1/3/5, 7/9/11 (two) – blank

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

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

Cont next page
TO OPEN HOOKS 2, PERFORM STEPS 6 THRU 9

6. cb PMA 2/3 GRP 2 HOOKS SYS A OP, CL (two) – cl
   B OP, CL (two) – cl
   √PMA 2/3 HOOKS GRP 2 tb – CL
   CRT
   √HK2 IND CL – 1,2
   √IND OP – blank
   √HK CLS 2/4/6, 8/10/12 (two) – CL

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

0:00 A6L 7. PMA 2/3 HOOKS SYS A, SYS B (two) – OP
   √GRP 2 tb – bp
   CRT
   √HK2 CMD OP – 1,2
   √IND CL – blank
   √HK CLS 2/4/6, 8/10/12 (two) – blank

2:20 A6L 8. PMA 2/3 HOOKS GRP 2 tb – OP
   CRT
   √HK2 IND OP – 1,2
   √CMD OP – blank

   * If PMA 2/3 HOOKS fail to drive, or do not reach end-of-travel after single motor drive time (~4:40):

   A6L
   * cb PMA 2/3 GRP 2 HOOKS SYS A OP, CL (two) – op
   * cb PMA 2/3 GRP 2 HOOKS SYS B OP, CL (two) – op
   * Perform PMA 2/3 HOOKS OPEN – CONTINGENCY
   * 8-30

9. PMA 2/3 HOOKS SYS A, SYS B (two) – ctr
   cb PMA 2/3 GRP 2 HOOKS SYS A OP, CL (two) – op
   B OP, CL (two) – op
<table>
<thead>
<tr>
<th>REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>APDS FAILURE/IMPACT MATRIX ................................................................. 8-40</td>
</tr>
<tr>
<td>(TLM) ......................................................... 8-43</td>
</tr>
</tbody>
</table>
# APDS FAILURE/IMPACT MATRIX

<table>
<thead>
<tr>
<th>APDS Status It</th>
<th>APDS FAILURE</th>
<th>IMPACT</th>
<th>OFF NOMINAL PROCEDURE (IF APPLICABLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>s = potential single failure</td>
<td>m = multiple failures reqd</td>
<td></td>
</tr>
<tr>
<td><strong>POWER ON pb</strong></td>
<td>Failed ON (m)</td>
<td>Continuous PWR ON will inhibit ring, damping, and fixer commands. Relays may overheat preventing future powerup. [Detectable only during powerup or ring drive operations]</td>
<td>RING DRV CMD OFF</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>If all STATUS lts are off, loss of all logic power to APDS. Docking system cannot be operated</td>
<td>POWER FAILED OFF (STATUS LTS OFF)</td>
</tr>
<tr>
<td><strong>APDS CIRCUIT PROTECT OFF</strong></td>
<td>Failed ON (m)</td>
<td>RING OUT, OPEN LATCHES, OPEN HOOKS, and UNDOCKING pb commands are enabled</td>
<td>APDS CIRCUIT PROTECT OFF LT FAILED OFF</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>No RING OUT, OPEN LATCHES, OPEN HOOKS, or UNDOCKING pb capability</td>
<td></td>
</tr>
<tr>
<td><strong>RING ALIGNED</strong></td>
<td>Failed ON (m)</td>
<td>Prime alignment cue lost. Use CRT RING ALIGN and PETAL POS BASE 1,2,3 indications as backup. Erroneous ind possible with significant pitch motion (sensors rotated 360°)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (s)</td>
<td>Prime alignment cue lost. Use CRT RING ALIGN and PETAL POS BASE 1,2,3 indications as backup</td>
<td></td>
</tr>
<tr>
<td><strong>RING INITIAL POSITION</strong></td>
<td>Failed ON (s)</td>
<td>Ring will only drive for 1 sec with RING OUT pb commands. Slip clutch will drive alternately between the SLIP and LOCK positions</td>
<td>Starred blocks in the DOCKING RING EXTENSION and DOCKING MECHANISM DEMATE/REIMATE</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>INITIAL CONTACT lt disabled. Slip clutch will not drive to SLIP</td>
<td>APDS DIRECT DRIVE USING BOB required to drive slip clutch</td>
</tr>
<tr>
<td><strong>FIXERS OFF</strong></td>
<td>Failed ON (m)</td>
<td>IFM may be required to drive clutch to SLIP if failure occurs during ring extension. During docking, only centering springs maintain alignment during ring retraction</td>
<td>FIXERS OFF LT FAILED ON</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Unable to inhibit fixer operation during manual ring drive</td>
<td>FIXERS OFF LT FAILED OFF</td>
</tr>
<tr>
<td><strong>HOOKS 1(2) OPEN</strong></td>
<td>Failed ON (s)</td>
<td>Logic prevents hooks from driving open</td>
<td>HOOKS 1(2) OPEN LT FAILED ON [UNDOCKING]</td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Hooks will not stop driving at Open position</td>
<td></td>
</tr>
<tr>
<td><strong>LATCHES CLOSED</strong></td>
<td>Failed ON (s)</td>
<td>If ring retraction to Final Position is attempted, ring will stall against capture latches if latches are failed closed. No impact if latches open on SPEC 167</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>No impact to nominal sequence. [May not be able to recapture, if reqd, if capture latches are not closed. Multiple failures reqd to inadvertently drive a latch motor open]</td>
<td></td>
</tr>
<tr>
<td>APDS Status It</td>
<td>APDS FAILURE</td>
<td>IMPACT</td>
<td>OFF NOMINAL PROCEDURE (IF APPLICABLE)</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------</td>
<td>--------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>UNDOCK COMPLET</td>
<td>Failed On (s)</td>
<td>If light comes on when APDS CIRC PROT OFF pb is pressed, hooks may be continuously commanded open.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed Off (m)</td>
<td>No impact. Indication is not used by any logic</td>
<td></td>
</tr>
<tr>
<td>INITIAL CONTACT</td>
<td>Failed On (s)</td>
<td>One contact cue disabled. RING ALIGNED lt, and CRT RING ALIGN and PETAL POS BASE 1,2,3 indications, may be used as contact indications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed Off (m)</td>
<td>One contact cue disabled. [Not detectable prior to contact]</td>
<td></td>
</tr>
<tr>
<td>CAPTURE</td>
<td>Failed On (m)</td>
<td>Auto sequence may be active (dampers, fixers, ring/hook drive). May be unable to reset dampers. Potential Shuttle/PMA 2/3 mechanism damage if no damping or damping failed on</td>
<td></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 RING FINAL POSITION LT FAILED ON</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>&lt;br&gt;$A_D$, $B_D$, $C_D$</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>&lt;br&gt;$A(B)$ $t_b$</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>&lt;br&gt;$A_p$, $B_p$, $C_p$</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>&lt;br&gt;PROTECT OFF</td>
<td>Failed ON (m)</td>
<td>Possible loss of Pyro charge/fire inhibits</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed OFF (m)</td>
<td>Loss of capability to arm/fire Pyros</td>
<td></td>
</tr>
</tbody>
</table>
# APDS FAILURE/IMPACT MATRIX (TLM)

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

RCS BURN (+X, -X, Multi-axis) (Front) ................................................................. CC 9-3
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(Back) ................................................................................................................ CC 9-6
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A31P PGSC CAMERA A/D RANGE RULER ....................................................... CC 9-25
RCS BURN (+X, -X, Multi-axis)

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

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

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

TIG-0:30

4. FLT CNTLR PWR – ON
   DAP TRANS: as reqd
   If Multi-axis:
     DAP: A/AUTO/PRI
   If +X or -X:
     DAP: A/INRTL/PRI
   CAUTION
   LAMBERT burn must be completed by
   T1 TIG +1:30 to avoid guidance errors
   * If start of LAMBERT burn delayed: *
   * Retarget burn, then go to step 2 *

TIG

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

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

7. When in attitude:
   DAP: A/AUTO/VERN(ALT)

(reduced copy)
**RENNDEZVOUS PRPLT PAD**

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

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

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

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

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

<table>
<thead>
<tr>
<th>CRT</th>
<th>GNC 33 REL NAV</th>
</tr>
</thead>
<tbody>
<tr>
<td>SV SEL, ITEM 4</td>
<td>FLTR</td>
</tr>
<tr>
<td>INH RNG, ITEM 18</td>
<td>(*)</td>
</tr>
<tr>
<td>RDOT, ITEM 21</td>
<td>(*)</td>
</tr>
<tr>
<td>Angles, ITEM 24</td>
<td>(*)</td>
</tr>
<tr>
<td>KU ANT ENA</td>
<td>ITEM 2 EXEC (*)</td>
</tr>
</tbody>
</table>

GNC I/O RESET

<table>
<thead>
<tr>
<th>A2</th>
<th>DIGI-DIS sel</th>
<th>R/RDOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1U</td>
<td>KU PWR</td>
<td>STBY</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>KU MODE</th>
<th>RDR PASSIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDR OUTPUT</td>
<td>HI</td>
</tr>
<tr>
<td>CNTL</td>
<td>PNL (wait 3 sec)</td>
</tr>
<tr>
<td>PWR</td>
<td>ON</td>
</tr>
</tbody>
</table>

| KU SEL | GPC |

2. AUTO TRK ACQ

<table>
<thead>
<tr>
<th>KU SEL</th>
<th>AUTO TRK</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLEW</td>
<td>as reqd (as seen in COAS)</td>
</tr>
<tr>
<td>EL, AZ angles &lt; 30 deg</td>
<td></td>
</tr>
<tr>
<td>KU SEARCH</td>
<td>SEARCH (tb–gray)</td>
</tr>
<tr>
<td>Repeat slew and search as reqd</td>
<td></td>
</tr>
</tbody>
</table>
| If acquisition not successful, MCC >>

3. RR NAVIGATION

<table>
<thead>
<tr>
<th>CRT</th>
<th>GNC 33 REL NAV</th>
</tr>
</thead>
<tbody>
<tr>
<td>RADAR, ITEM 13</td>
<td>(*)</td>
</tr>
</tbody>
</table>

| * 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

<table>
<thead>
<tr>
<th>CRT</th>
<th>GNC 33 REL NAV</th>
</tr>
</thead>
<tbody>
<tr>
<td>INH RNG</td>
<td>ITEM 18 (*)</td>
</tr>
<tr>
<td>RDOT</td>
<td>ITEM 21 (*)</td>
</tr>
<tr>
<td>Angles</td>
<td>ITEM 24 (*)</td>
</tr>
<tr>
<td>KU ANT ENA</td>
<td>ITEM 2 (no *)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A1U</th>
<th>KU PWR</th>
<th>STBY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODE</td>
<td>COMM</td>
<td></td>
</tr>
<tr>
<td>sel</td>
<td>GPC</td>
<td></td>
</tr>
<tr>
<td>CNTL</td>
<td>CMD</td>
<td></td>
</tr>
</tbody>
</table>

| A2 | DIGI-DIS sel | EL/AZ |

(reduced copy)
TOP
BACK OF ‘KU OPS’

HOOK
VELCRO

HOOK
VELCRO

(reduced copy)

CC 9-6

RNDZ-2b/116/O/A

RNDZ/116/FIN
<table>
<thead>
<tr>
<th>CG to CG RNG (ft)</th>
<th>RPM &amp; CONT</th>
<th>TORVA RDOT (ft/s)</th>
<th>DAP UPTG</th>
<th>EVENT</th>
<th>NO- RPM RDOT (ft/s) w/ RPM</th>
<th>HHL RNG (ft) (to ISS cg)</th>
<th>Raw TCS RNG (ft) (Ref #2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>–3.0</td>
<td>0:27:00</td>
<td>A/B/A</td>
<td>If ROOT falls below value for next gate, TH: Z (in) as reqd to maintain ROOT</td>
<td>–3.0</td>
<td>1990</td>
<td>2015</td>
</tr>
<tr>
<td>1700</td>
<td>–2.4</td>
<td>0:29:00</td>
<td>A/B/A</td>
<td>If ROOT falls below value for next gate, TH: Z (in) as reqd to maintain ROOT</td>
<td>–2.6</td>
<td>1690</td>
<td>1698</td>
</tr>
<tr>
<td>1500</td>
<td>–2.1</td>
<td>0:31:00</td>
<td>A/B/A</td>
<td>If ROOT falls below value for next gate, TH: Z (in) as reqd to maintain ROOT</td>
<td>–2.3</td>
<td>1490</td>
<td>1498</td>
</tr>
<tr>
<td>1000</td>
<td>–1.3</td>
<td>0:36:00</td>
<td>LO Z</td>
<td>If Request to MCC: ISS solar array config MCC UPDATE: Go within 600 ft, Go within 400 ft to 170 ft if no-go to proceed inside 600 ft, perform CONTINGENCY 600 FT TORVA</td>
<td>–1.5</td>
<td>990</td>
<td>985</td>
</tr>
<tr>
<td>900</td>
<td>–1.1</td>
<td>0:37:00</td>
<td>A/B/B</td>
<td>If Go for RPM, report to ISS: 10 min to RPM start</td>
<td>–1.3</td>
<td>890</td>
<td>885</td>
</tr>
<tr>
<td>800</td>
<td>–0.9</td>
<td>0:38:00</td>
<td>A/B/A</td>
<td>Null ISS rates in CL camr</td>
<td>∏</td>
<td>790</td>
<td>786</td>
</tr>
<tr>
<td>700</td>
<td>–0.6</td>
<td>0:41:00</td>
<td>A/B/B</td>
<td>Null ISS rates in CL camr</td>
<td>∏</td>
<td>690</td>
<td>686</td>
</tr>
<tr>
<td>650</td>
<td>–0.4</td>
<td>0:42:30</td>
<td>A/B/B</td>
<td>Null ISS rates in CL camr</td>
<td>∏</td>
<td>590</td>
<td>586</td>
</tr>
<tr>
<td>620</td>
<td>–0.4 &lt; Rdot &lt; –0.3</td>
<td>610</td>
<td>590</td>
<td>570</td>
<td>566</td>
<td>5</td>
<td>Perform RBAR PITCH MNVR</td>
</tr>
<tr>
<td>600</td>
<td>–0.4 &lt; Rdot &lt; –0.2</td>
<td>630</td>
<td>610</td>
<td>590</td>
<td>570</td>
<td>5</td>
<td>Perform RBAR PITCH MNVR</td>
</tr>
<tr>
<td>580</td>
<td>–0.2 &lt; Rdot &lt; –0.1</td>
<td>660</td>
<td>640</td>
<td>620</td>
<td>600</td>
<td>580</td>
<td>Perform RBAR PITCH MNVR</td>
</tr>
</tbody>
</table>

* Raw TCS Range assumes ISS in docking attitude
# VBAR APPROACH

<table>
<thead>
<tr>
<th>Interface Range (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>(\sqrt{L0Z})</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) 170</td>
<td>(0.00)</td>
<td>(-0.20 ±0.05)</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>-0.16</td>
<td>1:26:30 (-22:30)</td>
<td>No LO Z A10, B10 (\sqrt{DAP: B})</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>(\sqrt{A10, B10}) (\sqrt{DAP: B})</td>
<td>Note: DAP A allowed for ±X and ±Z THC (in) GNC 23 RCS (Maintain through contact) RCS FWD = ITEM 1 EXEC (<em>) JET DES F1F – ITEM 31 EXEC (</em>) F2F – ITEM 35 EXEC (*)</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>(\sqrt{A10, B10}) (\sqrt{DAP: B})</td>
<td>5th 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) (\sqrt{A7L}) Panel Config Set EVENT TIMER for CAPTURE (counting up from 00:00)</td>
<td>32-42</td>
<td>30-40</td>
</tr>
<tr>
<td>30</td>
<td>0.07</td>
<td>1:43:00 (-06:00)</td>
<td>(\sqrt{5th}) Corridor</td>
<td>TH: as reqd to establish RDOT = -0.07 ± 0.02 fps Report to MCC and ISS: Initiating final approach</td>
<td>37</td>
<td>35</td>
</tr>
<tr>
<td>25</td>
<td>↑ 1</td>
<td>1:44:00 (-25:00)</td>
<td>No LO Z ARM PCT F2(F4) SPDBK/THROT pb – AUTO (\sqrt{vlt on})</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)</td>
<td>Maintain 3 inch lateral alignment cylinder</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>-0.10</td>
<td>1:48:30 (-00:30)</td>
<td>No LO Z A96</td>
<td>Maintain 3 inch lateral alignment cylinder</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>CONTACT or ~2 in</td>
<td>-0.10</td>
<td>1:49:00 (00:00)</td>
<td>PCT (SPARE pb)</td>
<td>CAPTURE</td>
<td>N/A</td>
<td>5</td>
</tr>
</tbody>
</table>

* Raw TCS Range assumes ISS in docking attitude

## CAPTURE

<table>
<thead>
<tr>
<th>MS</th>
<th>START EVENT TIMER = 00:00:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7L</td>
<td>(\sqrt{\text{CAPTURE it, It on}})</td>
</tr>
<tr>
<td>F4</td>
<td>(\sqrt{\text{DISARM PCT, SPDBK/THROT pb – push It off}})</td>
</tr>
</tbody>
</table>

\(\sqrt{\text{ISS in FREE DRIFT (ISS indicator lights flashing)}}\)

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

<table>
<thead>
<tr>
<th>A6U</th>
<th>(\sqrt{\text{CAPTURE it, It on}})</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLT CNTLR PWR OFF</td>
<td></td>
</tr>
<tr>
<td>Perform TCS DeACTIVATION (KNDZ TOOLS), 7-20</td>
<td></td>
</tr>
<tr>
<td>Go to DOCKING SEQUENCE (CC)</td>
<td></td>
</tr>
</tbody>
</table>

## FAILED CAPTURE

1. APDS CIRC PROT OFF pb – push
\(\sqrt{\text{CIRCUIT PROTECT OFF It – It on}}\)
OPEN LATCHES pb – push
LATCHES CLOSED IT – It off
OPEN IT – It on

2. DAP: NO LO Z

- IF VERN FAIL:
- DAP: PRI

- If petals clean:
DAP: A(B) \(\sqrt{\text{dilv}}\)

3. TH: +Z (out) to establish 0.1 fps opening rate
DAP: AVR

- If ISS in FREE DRIFT:
  - Use ISS CG as corridor reference
Maintain 8 degree corridor
Inform MCC-H and ISS: Failed Capture
Maintain opening rate of at least 0.1 fps

4. Go to VBAR CORRIDOR BACKOUT, CONTINGENCY OPS, 5-12
C/L CAMERA TARGET ALIGNMENT (+VBAR)

**PITCH (P)**

**ITEM 15**

Target Displaced DOWN  
(Cross Displaced UP)

3. $\text{PITCH} = 180 - P =_____(A)$
5. $\text{PITCH} = \text{PITCH} - P =_____(D)$

Target Displaced UP  
(Cross Displaced DOWN)

3. $\text{PITCH} = 180 + P =_____(A)$
5. $\text{PITCH} = \text{PITCH} + P =_____(D)$

**ROLL (R)**

**ITEM 16**

Rotated CW

3. $\text{YAW} = 360 - R =_____(B)$
5. $\text{YAW} = \text{YAW} - R =_____(E)$

Rotated CCW

3. $\text{YAW} = 0 + R =_____(B)$
5. $\text{YAW} = \text{YAW} + R =_____(E)$

**YAW (Y)**

**ITEM 17**

Target Displaced RIGHT  
(Cross Displaced LEFT)

3. $\text{OM} = 0 + Y =_____(C)$
5. $\text{OM} = \text{OM} + Y =_____(F)$

Target Displaced LEFT  
(Cross Displaced RIGHT)

3. $\text{OM} = 360 - Y =_____(C)$
5. $\text{OM} = \text{OM} - Y =_____(F)$

(reduced copy)
AUTO ANGULAR FLYOUT

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

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

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

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

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

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

**CAUTION**

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

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

**Disable and Release Dampers**

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

4. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   - A7L √FIXER OFF pb – push
   - CRT √FIXERS tlm – tlm on
   - 0:00 √RING IN pb – push
   - CRT √DRV CMD – ON [PETAL POS BASE (three) – decr]
   - √CLUTCH – LOCK/blank

5. When no relative motion pb – push
   - CRT √RING DRV CMD – OFF

6. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
   - A7L APDS CIRC PROT OFF pb – push
   - √CIRCUIT PROTECT OFF lt – lt on
   - 0:00 RING OUT pb – push
   - CRT √DRV CMD – ON [PETAL POS BASE (three) – incr]

7. When no relative motion pb – push
   - A7L √FIXERS OFF lt – lt off
   - CRT √RING DRV CMD – OFF

(reduced copy)
## Retract Ring

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

## Close Hooks

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
<th>Conditions</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td>A7L</td>
<td>√HOOKS 1,HOOKS 2 OPEN lt (two) – lt off</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CRT</td>
<td>√HK1,HK2 DRV CMD (two) – ON</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>√POS (two) ≥ 5% &amp; incr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A7L</td>
<td>* If HK1(2) DRV CMD – OFF or HK1(2) POS not incr: *</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* CLOSE HOOKS pb – push</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* If HOOKS 1(2) CLOSED lt failed ON:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Perform HOOKS 1(2) CLOSED lt FAILED ON, 8-23</td>
<td></td>
</tr>
<tr>
<td>0:20</td>
<td>CRT</td>
<td>√RING DRV CMD – OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A7L</td>
<td>* If RING DRV CMD – ON 20 sec after hooks begin:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* driving in step 10:</td>
<td></td>
</tr>
<tr>
<td>≤ 1:30</td>
<td>A7L</td>
<td>* POWER ON pb – push</td>
<td></td>
</tr>
<tr>
<td>2:20</td>
<td>CRT</td>
<td>√INTERF SEALED lt – lt on (expect intermittent lt initially)</td>
<td></td>
</tr>
</tbody>
</table>

## Load Relieve Capture Latches (Extend Ring)

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
<th>Conditions</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td>A7L</td>
<td>APDS CIRC PROT OFF pb – push</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CRT</td>
<td>√CIRCUIT PROTECT OFF lt – lt on</td>
<td></td>
</tr>
<tr>
<td>0:10</td>
<td>A7L</td>
<td>POWER ON pb – push</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CRT</td>
<td>√RING DRV CMD – OFF</td>
<td></td>
</tr>
</tbody>
</table>

## Open Capture Latches

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
<th>Conditions</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td>A7L</td>
<td>OPEN LATCHES pb – push</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>√LATCHES CLOSED lt – lt off</td>
<td></td>
</tr>
<tr>
<td>0:05</td>
<td></td>
<td>√OPEN lt – lt on</td>
<td></td>
</tr>
</tbody>
</table>

## Retract Ring to FNL POS

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

## Power Off

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
<th>Conditions</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
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<td>A7L</td>
<td>POWER OFF pb – push</td>
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<td></td>
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<td>√STATUS lt (eighteen) – lt off</td>
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<td>20.</td>
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<td>Go to TERMINATE RNDZ OPS 22A 4-22 &gt;&gt;</td>
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STOPWATCH RDOT CONVERSION

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**NOTE**

HHL SPECS state that the HHL will not work if the aimpoint surface is closer than 12 ft from the HHL unit; therefore, no HHL use should be expected at an HHL range less than 12 ft (5 ft interface-to-interface).
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<th>400</th>
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</tbody>
</table>

**NOTE:**
If RPOP is available, use RPOP subtended angle function.
# 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>
<tbody>
<tr>
<td>GPC1</td>
<td>FF1</td>
<td>1. If -Z ST NAV, INH ST to NAV</td>
<td>1. C3 DAP lights latched (go out with MDM pwr fail)</td>
</tr>
<tr>
<td>(3232*)</td>
<td></td>
<td>2. Work appropriate ORB PKT procedure</td>
<td>2. -Z ST ↓</td>
</tr>
<tr>
<td>FA1</td>
<td></td>
<td>3. If not recovered: Use -Y ST, if reqd</td>
<td>VERNs ↓</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pre-MC4: DAP: ALT/AUTO</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-MC4: DAP: PRI/AUTO</td>
<td></td>
</tr>
<tr>
<td>GPC2</td>
<td>FA2</td>
<td>Pre-MC4: DAP: ALT/AUTO</td>
<td>VERNs ↓</td>
</tr>
<tr>
<td>(1313*)</td>
<td></td>
<td>Post-MC4: DAP: PRI/AUTO</td>
<td></td>
</tr>
<tr>
<td>Man OMS Shutdown</td>
<td>FF3</td>
<td>1. Pre-MC4: DAP: ALT/AUTO</td>
<td>1. VERNs ↓</td>
</tr>
<tr>
<td>GPC3</td>
<td></td>
<td>Post-MC4: DAP: PRI/AUTO</td>
<td>2. RR → NAV/RPOP ↓</td>
</tr>
<tr>
<td>(1212*)</td>
<td></td>
<td>2. If RR NAV, INH RR to NAV</td>
<td>(Panel A2 OK)</td>
</tr>
<tr>
<td>Loss of Aft DAP</td>
<td></td>
<td>3. If -Y ST NAV, INH ST to NAV</td>
<td>3. A6 DAP lights latched (go out with MDM pwr fail)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Work appropriate ORB PKT procedure</td>
<td>4. -Y ST ↓</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. If not recovered: Work RR FAIL procedures</td>
<td>5. Also for loss of GPC3: R OMS GMBL PRI/SEC ↓</td>
</tr>
<tr>
<td>GPC4</td>
<td>PL</td>
<td>If Ku breaks lock: Ku sel – AUTO TRK</td>
<td>1. GPC Ku ptg ↓, slew in AUTO TRK if Ku breaks lock</td>
</tr>
<tr>
<td>(1212*)</td>
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<td>2. No Ku self-test</td>
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* Expect this NBAT if GPC fail

<table>
<thead>
<tr>
<th>MALFUNCTION</th>
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RNDZ-7a/116/O/A
## RNDZ REF DATA

### FF1
- **F MANF 1 JETS**
- C3 DAP LTS
- IMU 1
- -Z STRK
- L OMS GMBL PRI ENA
- L ADI sw, ATT REF
- F,A THC contact 1
- L RHC channel 1
- PNL 03 F,L,R RCS OX QTY
- PNL 03 F,L RCS LOW QTY

### FF2
- **F MANF 2 JETS**
- IMU 2
- L OMS GMBL SEC ENA
- R ADI sw, ATT REF
- F,A THC contact 2
- A RHC P,Y channel 2
- L RHC channel 2
- R RHC channel 1

### FF3
- **VERNS**
- **F MANF 4 JETS**
- A6 DAP LTS
- IMU 3
- RR → NAV/RPOP
- -Y STRK
- R OMS GMBL SEC ENA
- F,A THC contact 3
- L RHC channel 3
- PNL 03 R RCS LOW QTY
- PNL 03 F,L,R RCS FU QTY

### FA1
- **VERNS**
- L R MANF 1 JETS
- L OMS GMBL PRI

### FA2
- **VERNS**
- L R MANF 3 JETS
- L OMS GMBL SEC

### FA3
- **VERNS**
- L R MANF 2 JETS
- R OMS GMBL SEC

### FA4
- **VERNS**
- L R MANF 4 JETS
- R OMS GMBL PRI

### MDM OA1(OA2)
- **L(R) OMS DEORB ONLY**

### DSC OF2
- **VERNS & F MANF 3,4 RM**
- F RCS OX, FU QTY

### DSC OF4
- **VERNS & L MANF 1,2 RM**
- R OMS DEORB ONLY
- L RCS OX QTY

### DSC OL2
- **LMANF 3,4 RM**
- L RCS FU QTY

### DSC OR2
- **VERNS & R MANF 1,2 RM**
- R OMS DEORB ONLY
- R RCS OX QTY

### DSC OA2
- **VERNS**

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

### CNTL AB2
- F MANF 1 JETS
- L ADI switches, ATT REF

### CNTL AB3
- C3 DAP ROT,TRANS pbs

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

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

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

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

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

### MAIN A
- **FPC1:** MCIU
- **FLC1:** F MANF 1 JETS
- **AC1B:** PNL 03 RCS/OMS QTY
- **FWD EVENT TIMER**
- **APC4:**
- **APC2:**
- **APC1:**
- **L OMS GMBL PRI**
- **R OMS GMBL SEC**
- **ALC1:** VERSN
- **O15:** FWD EVENT TIMER
- **R14:** KU COMM & RR
- **CCTV CAM-A,D**
- **CABIN TV UTIL PORT**
- **MDM OA1:**
- **VERNS RM**

### MAIN B
- **FPC2:**
- **FLC2:** F MANF 2 JETS
- **AC2C:** PNL A2 DIGITALS
- **APC6:**
- **APC2:**
- **APC1:**
- **VERNS**
- **L OMS GMBL SEC**
- **VERNS**
- **Y STRK**
- **FWD EVENT TIMER**
- **O15/A8:** RMS B/JU PWR
- **R14:** KU COMM & RR
- **CCTV CAM-A, A-M**
- **CABIN TV UTIL PORT**
- **MDPC2:**
- **KU COMM & RR**
- **APDS RING DAMP 3**
- **APDS HK, RING MTR 2**
- **RMS B/JU PWR**
- **PLB LTS (Fwd-S, Mid-P, Bulkhead)**

### MAIN C
- **FPC3:** KU COMM & RR
- **FLC3:** VERSN
- **F MANF 4 JETS**
- **AC3A:** COAS PWR
- **APC6:**
- **APC2:**
- **APC1:** R OMS GMBL PRI
- **O15:** PNL 03 OMS/RC OX QTY
- **R14:** KU SIG PROC (RR OK)
- **CCTV CAM-B**
- **CABIN PL (Flt Specific)**
- **CCTV C/L CAM**

### ESS 2CA
- **TCS**

### CAPN PL (Flt Specific)
- **CCTV C/L CAM**

---

**TOP**

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

C/L CAMERA

CORRIDOR AND ALIGNMENT

CTVC 40.0 DEG HFOV - CORRIDOR
CTVC FULL ZOOM - ALIGNMENT

RNDZ-8a/116/O/A
Note: Fabricate As Transparency

CAMERA A/D

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<tr>
<td>11</td>
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<td>15</td>
<td>0.07</td>
</tr>
</tbody>
</table>

RANGE RULER

Use Bottom/Back Of ISS Ring

Use Top/Front Of ISS Ring

CTVC FULL NO ZOOM
Note: Fabricate As Transparency

C/L CAMERA

ZOOM CALIBRATION (RING READY FOR DOCK)

CTVC AT HFOV = 40.0 DEG
FLIGHT

H-FOV

40 deg

0  5  10  15  20  25  30  35

20 deg

0  1  2  3  4  5  6  7  8  9  10

10 deg

0  1  2  3  4  5  6  7  8  9  10

Note: Fabricate as Transparency
Note: Fabricate As Transparency
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RENEDEZVOUS

STS

116