Space Shuttle Program
FLIGHT DATA FILE

JSC–48072–113

Rendezvous

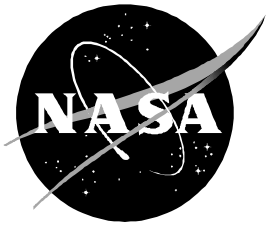
STS–113

Mission Operations Directorate
Flight Design & Dynamics Division

Final
June 17, 2002

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas



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MISSION OPERATIONS DIRECTORATE

RENDEZVOUS
STS–113

FINAL
June 17, 2002

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	RNDZ–1040A	RNDZ–1047	RNDZ–1054	
	RNDZ–1041	RNDZ–1048	RNDZ–1055	
	RNDZ–1042	RNDZ–1050	RNDZ–1056	

AREAS OF TECHNICAL RESPONSIBILITY

Book Manager	DM34/R. Bigonesse	281–483–7613
Rendezvous Guidance and Procedures	DM34/S. Walker	281–483–1665
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Rendezvous Design	USA/K. Pettinger	281–282–4573
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APDS	DF52/M. Friant	281–483–0682

NOTE

This checklist is the controlling crew document for the ISS–11A rendezvous and separation. The Rendezvous Timeline begins at Ti –3:00 hr and continues through docking. This is a complete stand–alone document. The Separation Timeline begins 45 min prior to undock and continues through 1:15 after undock.

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

ACRONYMS

AZ, AZM	Azimuth
D/N	Day/Night
EL, ELEV	Elevation
IAH	Inertial
LOS	Line of Sight
LVLH	Local Vertical, Local Horizontal
R	Range
$\dot{R}$, RDOT	Range Rate
$\bar{R}$, RBAR	Radius Vector (toward Earth)
RNDZ	Rendezvous
RR	Rendezvous Radar
SK	Stationkeeping
ST, STRK	Star Tracker
$\bar{V}$, 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

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RENDEZVOUS CUE CARDS

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RENDEZVOUS PRPLT PAD (Back)	CC 9–4	RNDZ–1b/113/O/A
KU OPS (Front)	CC 9–5	RNDZ–2a/113/O/A
(Back)	CC 9–6	RNDZ–2b/113/O/A
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VBAR APPROACH (Back)	CC 9–8	RNDZ–3b/113/O/B
C/L CAMERA TARGET ALIGNMENT (Front)	CC 9–9	RNDZ–4a/113/O/B
(Back)	CC 9–10	RNDZ–4b/113/O/B
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C/L CAMERA CORRIDOR AND ALIGNMENT	CC 9–17	RNDZ–8a/113/O/A
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C/L CAMERA ZOOM CALIBRATION (RING READY FOR DOCK)	CC 9–19	RNDZ–10a/113/O/A
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RNDZ/PROX OPS BREAKOUT PROCEDURES OVERVIEW

RANGE BREAKOUT REQD	BREAKOUT PROCEDURE AND SUMMARY
LONG RANGE SHUTTLE BREAKOUTS (Prior to RBAR Arrival)	
Prior to Ti	Discontinue RNDZ burns; specific breakout only on MCC call
Between Ti and TORVA init	RNDZ BREAKOUT (CONTINGENCY OPS), 5–18 3 fps retrograde
Between TORVA init and Vbar arrival	SHUTTLE NOSE IN–PLANE BREAKOUT (CONTINGENCY OPS), 5–16 1.5 fps ±X burn, followed in 30 min by 3.5/3.0 fps retrograde/out–of–plane burn (posigrade if second approach is desired)
Between Vbar arrival and contact OR Between undock and flyaround start	VBAR BREAKOUT (CONTINGENCY OPS), 5–14 If RNG < 75 ft, back out to 75 ft. When RNG > 75 ft, perform 1.5 fps radial up burn in LO Z, followed in 28 min by 3.0 fps posigrade/retrograde burn
During flyaround	SHUTTLE NOSE IN–PLANE BREAKOUT (CONTINGENCY OPS), 5–16 1.5 fps ±X burn, followed in 30 min by 3.5/3.0 fps retrograde/out–of–plane burn (posigrade if second approach is desired)
Otherwise:	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
SHUTTLE BACKOUT	
Prior to docking	See VBAR CORRIDOR BACKOUT (CONTINGENCY OPS), 5–12

RNDZ BURN SOLUTION SELECTION GUIDELINES

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

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

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

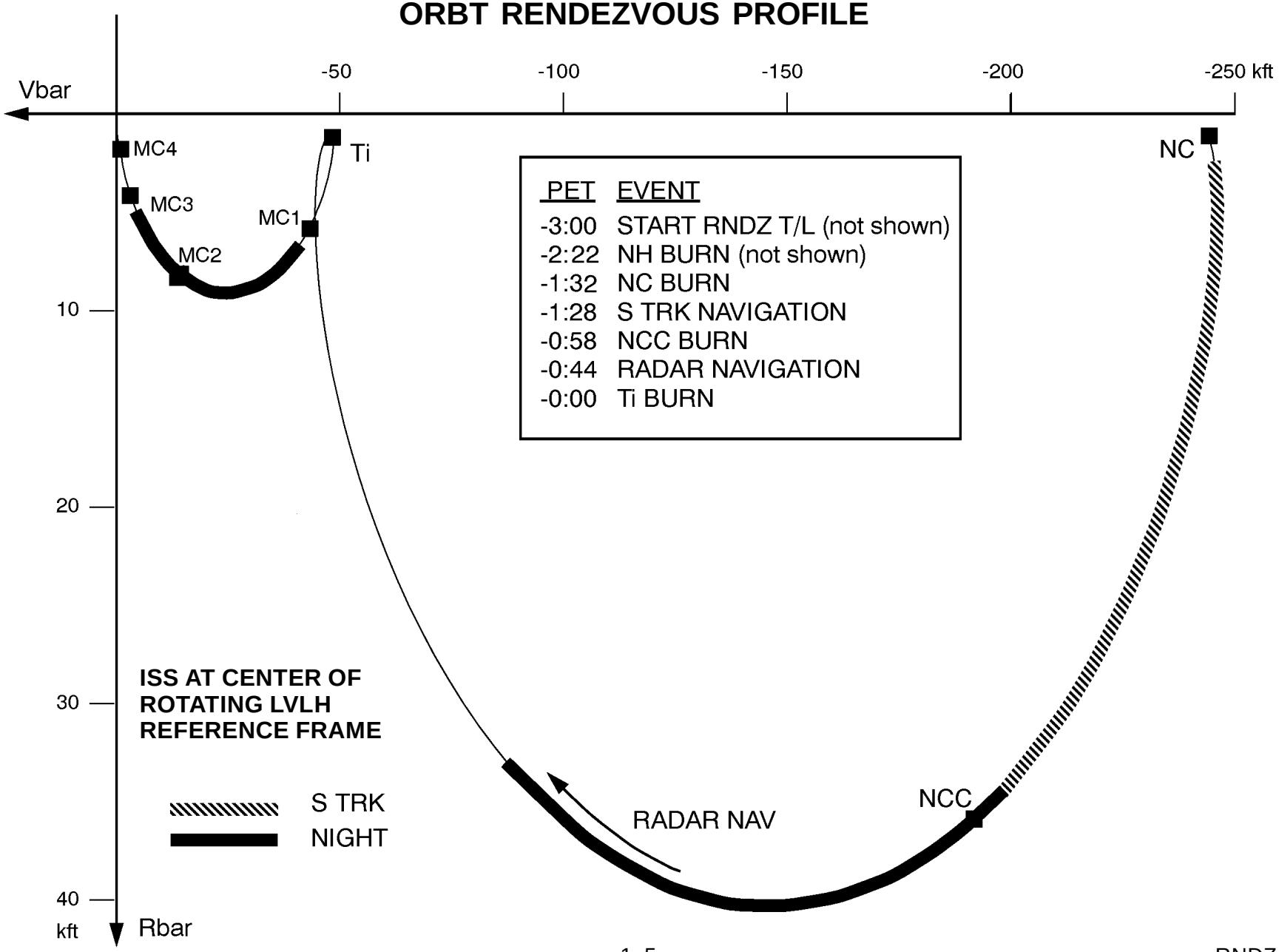
RNDZ BURN ENGINE SELECTION GUIDELINES

DELTA V	ENGINE
< 4 fps	RCS – Primary technique is multi–axis
4 to 6 fps	RCS – Primary technique is +X
> 6 fps	OMS – Single engine

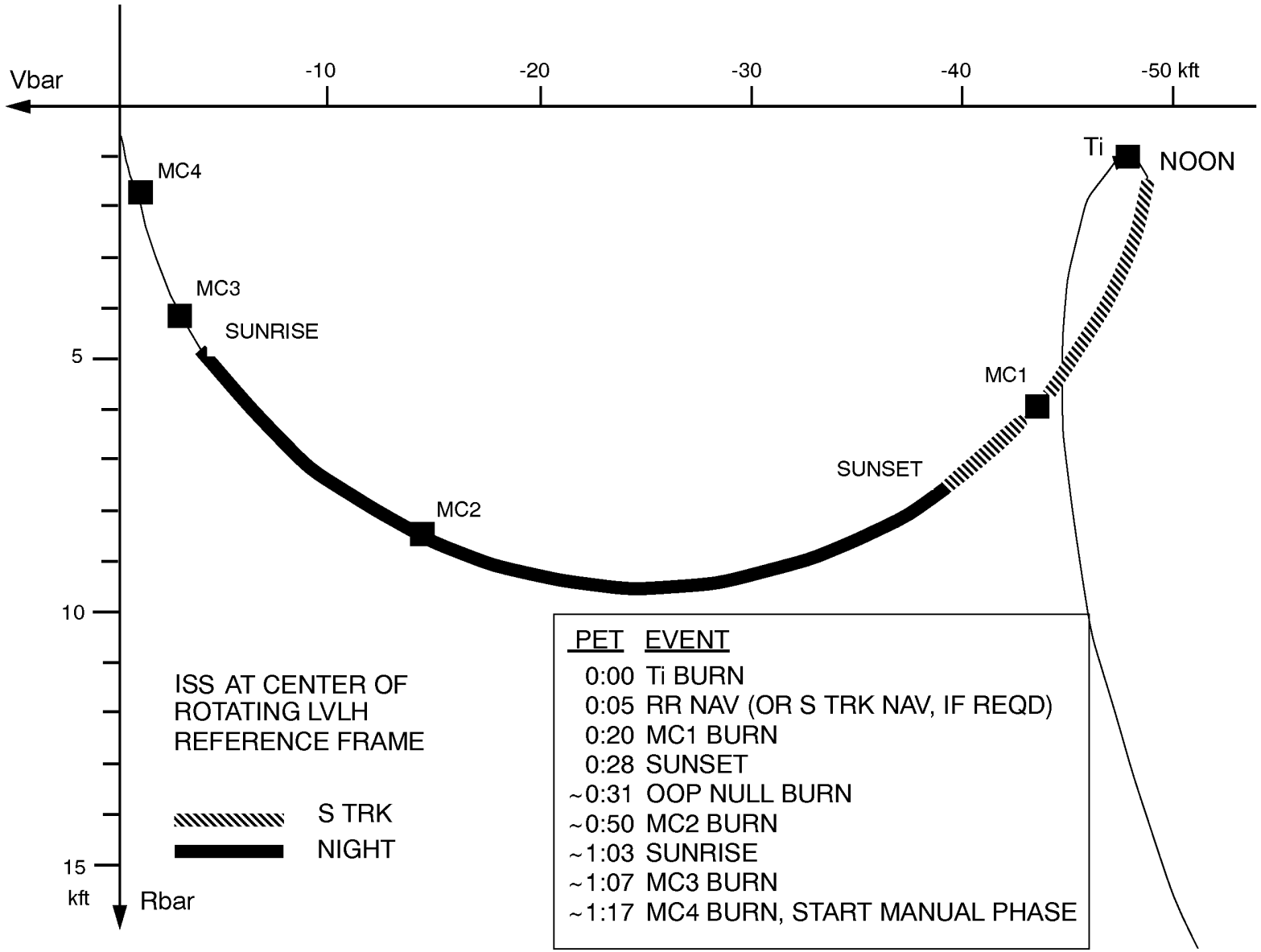
RNDZ FAILURE/RESPONSE SUMMARY

FAILURE	RESPONSE
No sensor data (RR, STRK, or COAS) during RNDZ and no visual acquisition	Breakout Burn by MC2 + 20 min
Good sensor data (RR, STRK, or COAS) during RNDZ, but no visual or RR acquisition	Breakout Burn by MC2 + 24 min
Target > 30 deg from COAS horizontal at start of radar fail correction	Breakout ASAP; use RNDZ BREAKOUT (CONTINGENCY OPS), 5–18, until RBAR arrival
Prop quantities violate bingo numbers on RNDZ PRPLT PAD (Cue Card) or Orbiter systems malfunctions require breakout	Breakout per overview on 1–2
SYSTEMS: DPS: < 2 GNC GPCs	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
GNC: Loss of redundant + Z Trans or PRCS TRANS, any axis ↓ or PRCS ROT, any axis ↓ or AFT THC (–Z sense), > 1 TX contact ↓, all TY contacts ↓, all TZ contacts ↓ or AFT RHC, all channels, any axis ↓ or < 2 IMUs	PROX OPS within 250 ft not permitted
Loss of VRCS	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
Loss of LO Z Braking	During Approach: Continue approach; if braking reqd, then If prior to +VBAR: Wait for natural RDOT bleed down If on +VBAR: Limited NORM Z braking allowed During Separation: NORM Z with ISS solar arrays positioned to minimize plume loads See LOSS OF LO Z BRAKING (CONTINGENCY OPS), 5–29
MECH: 1 KU ANTENNA STOW MOTOR ↓	Normal ops

ORBT RENDEZVOUS PROFILE

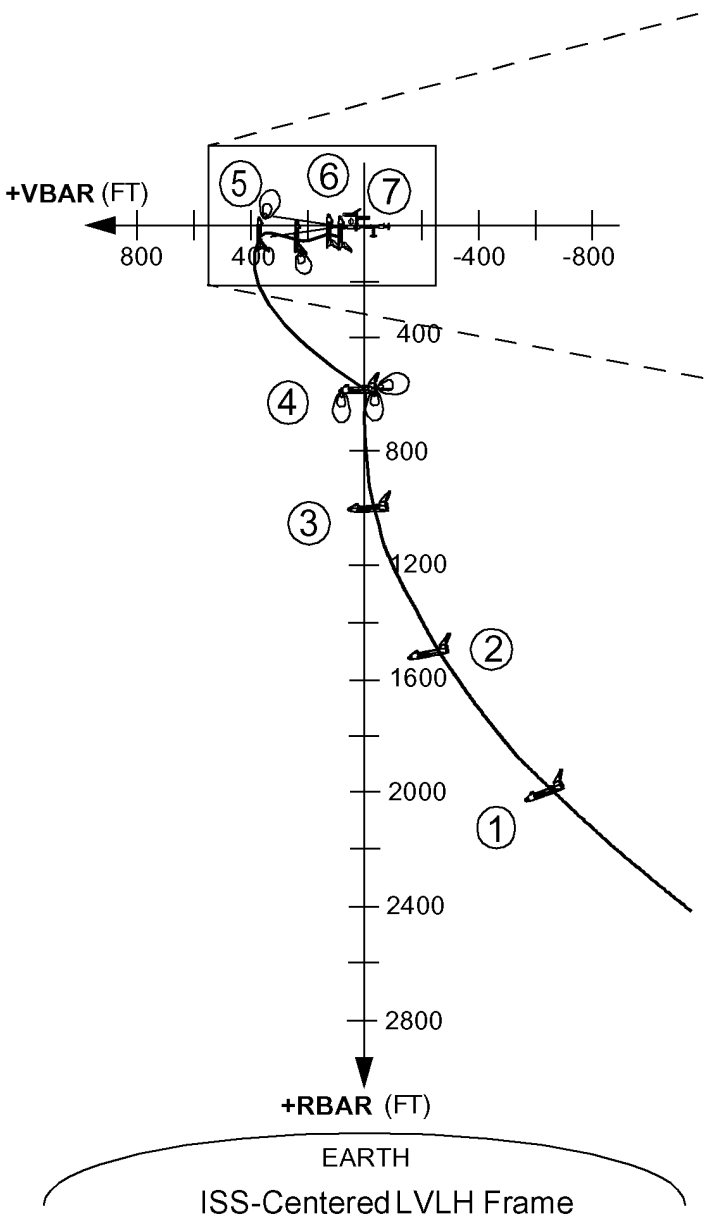


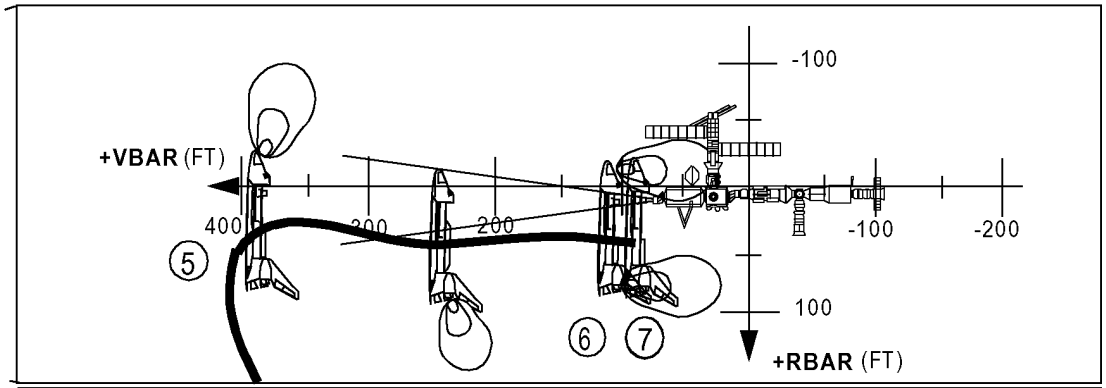
ORBT POST Ti PROFILE



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

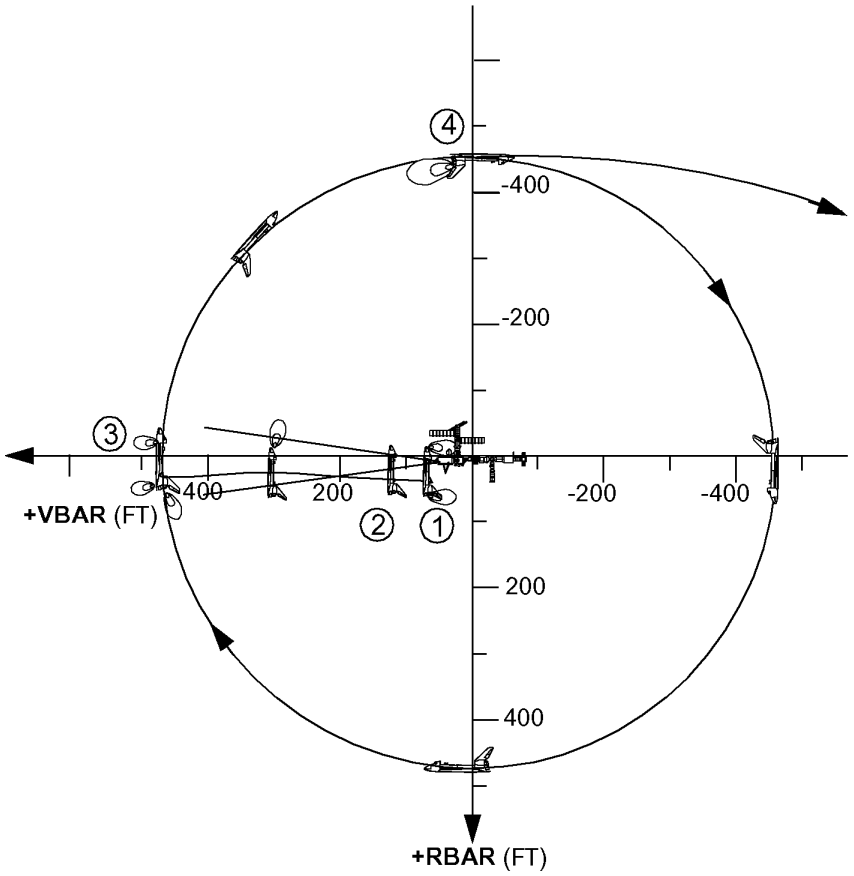
TERMINAL PHASE, TORVA, AND VBAR APPROACH





	APPROX. PET (h:mm)	EVENT
1	0:00	MANUAL PHASE TAKEOVER (POST-MC4) 2000 FT RANGE RATE GATE (RDOT = -3.0 FPS)
	0:02	1700 FT RANGE RATE GATE (RDOT = -2.6 FPS)
2	0:03	1500 FT RANGE RATE GATE (RDOT = -2.3 FPS)
3	0:08	1000 FT RANGE RATE GATE (RDOT = -1.5 FPS) TRANSITION TO LOWZ
4	0:13	600 FT (RDOT = -0.8 FPS) BEGIN TORVA, PERFORM DAP A +X PULSES AS REQ'D TO NULL TARGET MOTION (APPROX. 22 PULSES)
5	0:25	320 FT (INT-TO-INT) VBAR ARRIVAL (RDOT = -0.2 FPS)
	0:41	110 FT (RDOT = -0.15 FPS)
	0:45	75 FT TRANSITION TO NORMZ, CONFIGURE FOR SINGLE -X JET (DESELECT F1F/F2F)
6	0:53	30 FT STATIONKEEP FOR 5 MINUTES IF REQUIRED
7	1:04	DOCKING

UNDOCKING, TORF, AND FINAL SEPARATION



EARTH
ISS-Centered LVLH Frame

	APPROX PET (h:mm)	EVENT
	-0:03	**BEGIN UNHOOKING PROCESS** – ORBITER & ISS IN FREE DRIFT (ISS LVLH 0,0,0 ATTITUDE)
1	0:00	**AT SS-10 min,** UNDOCK **AT 2 FT** – MODE TO LVLH HOLD & 4 DAP B (10 SEC INTERVALS) +Z NORM Z BURNS **3 MIN LATER & > 30 FT -** +Z NORM Z BURNS (Rdot = +0.15 FPS) MAINTAIN THE 8 DEGREE CORRIDOR
	0:04	**> 50 FT** – RESELECT F RCS –X JETS (F1F & F2F)
2	0:07	**75 FT** – LOW Z
	0:14	**150 FT** – DAP TO AUTO (MANEUVER TO UNDOCKING ATTD) MAINTAIN 8 DEG. CORRIDOR, Rdot = +0.15 FPS UNTIL CG-CG IS APPROXIMATELY R>400 FT
		450 FT – NULL Rdot
3	0:46*	**POST SUNRISE & WITH R 400 – 500 FT CG-CG** – INITIATE TORF CONTINUE FOR 1 & ¼ LAP
4	1:44*	**2ND R BAR CROSSING – FINAL SEP BURN** +X, LOW Z, 3 FPS RETROGRADE BURN

*BASED ON ZERO DEGREE BETA ANGLE

UNDOCKING/SEPARATION TIMELINE

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UNDOCKING/SEPARATION PAD 4A

Undocking Time:

Nominal: | | / | | | : | | | : | | |

Backup: | | / | | | : | | | : | | |

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>>

MET: 008:16:10

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

-00:40

MCC UPLINK
Config 760
TFL 184

ENABLE RENDEZVOUS NAV 5B

SSV OUT RATE - 3

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

On RPOP PGSCs:
Perform RPOP INITIALIZATION (RNDZ TOOLS), 7-8, then:
Perform RPOP OPS (RNDZ TOOLS), 7-9, then:
In RPOP, set POR - ORB DP to TGT DP, then:
HHL Angle Source to DOCK CAM, then:
HHL aim point to centerline target, then:

-00:35

Perform TCS ACTIVATION, steps 1 thru 3 (RNDZ TOOLS), 7-18, then:
Perform TCS MANUAL ACQUISITION (RNDZ TOOLS), 7-19
(Set RANGE = 4 ft, AZIMUTH = 0, ELEVATION = 0)

Perform HHL CHECKOUT (RNDZ TOOLS), 7-6

-00:30

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

-00:25

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

-00:20

-00:15

CONFIGURE FOR SEPARATION 5A

GNC 20 DAP CONFIG

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)

O14:E √cb MNA, C DDU AFT (two) - cl
O16:E

R1 O2 TK3 HTR A - AUTO

A6U ADI ATT - LVLH
ERR - MED
RATE - LO
SENSE - -Z
√FLT CNTLR PWR - OFF

CRT GNC 23 RCS

RCS F – ITEM 1 EXEC (∗)
JET DES F1U – ITEM 17 EXEC (no ∗)
F3U – ITEM 19 EXEC (no ∗)
F2U – ITEM 21 EXEC (no ∗)

GNC UNIV PTG

CRT TGT ID √+2
BODY VECT √+5
P √+180
Y √+0
OM √+0
√TRK - ITEM 19 EXEC (CUR - ∗)
√ERR TOT - ITEM 23 EXEC (∗)

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 OPERATIONS [6A]

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

[GNC 33 REL NAV]
CRT ORB TO TGT - ITEM 10 EXEC
[GNC 25 RM ORBIT]
SW RM INH, ITEM 16 EXEC (*)
A6U FLT CNTLR PWR – ON
SW RM INH, ITEM 16 EXEC (no *)

2. RECONFIGURE DAP

[GNC UNIV PTG]
When ATT and RATES per ATTITUDE AND RATE LIMITS [6B]:
-03:00 > DAP: FREE
[GNC 23 RCS]
√RCS F – ITEM 1 EXEC (∗)
JET DES F3F – ITEM 33 EXEC (no ∗)

[GNC 20 DAP CONFIG]
Config DAP A,B to A9,B9
X Jets ROT ENA – ITEM 7 EXEC (no ∗)
DAP: B/FREE/VERN (ALT)
DAP TRANS: NO LO Z
√DAP TRANS: PULSE/PULSE/PULSE
√SENSE: -Z

3. COMMAND UNDOCKING

[SM 167 DOCKING STATUS]

∗ If HOOKS 1(2) OPEN lt failed ON: ∗
∗ APDS PWR A_{DS} - OFF (√A_{DS} and failed lt off) ∗

A7L APDS CIRC PROT OFF pb - push (lt on)

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

CRT ∗ If Hooks 1(2) fail to drive (Hooks 1(2) DRV CMD - OFF): ∗
A7L ∗ OPEN HOOKS pb - push ∗
∗ If Hooks 1(2) appear to stop before reaching end of travel ∗
∗ [Hooks 1(2) Pos > 4% + not decr]: ∗
∗ Allow for single motor drive time (~4:40) before performing ∗
∗ PWR OFF pb - push ∗

-00:30 > √INTERF SEALED lt - off
√RDY TO HOOK lt - off [HOOKS 1,2 POS approx 30%]

00:00 √HOOKS 1, HOOKS 2 OP lts (two) - on [HOOKS 1,2 POS ≈ 4%]
√UNDOCK COMPLETE lt - on

∗ (+02:20) If HOOKS 1(2) fail to open ∗
∗ (confirmed by no physical separation): ∗
∗ Inform MCC: “Hooks failed to open” ∗
∗ PWR OFF pb - push ∗
∗ PWR ON pb - push ∗
∗ CLOSE HOOKS pb - push ∗
∗ √HOOKS 1,2 POS (two) incr ∗
∗ √HOOKS 1(2) CL lt - on ∗
∗ (HOOKS 1(2) POS=92±3%) ∗
∗ PWR OFF pb - push ∗
∗ Perform DOCKING MECHANISM PWRDN (APDS), 8-6 ∗
∗ √MCC for IFM capability ∗
∗ Prepare for 96 BOLT EVA TIMELINE (EVA FS, ORB CONT EVA), ∗
∗ then, ∗
∗ Perform ODS HOOKS OPEN-CONTINGENCY (APDS),8-25 >> ∗

4. POST UNDOCKING
00:00 > Inform MCC-H and ISS:
“Physical Separation - Executing SEP Burn”

When petals clear:
DAP: B/LVLH/VERN(ALT)
√DAP TRANS: PULSE/PULSE/PULSE, NO LO Z
THC: +Z (out) 4 pulses at 10 sec intervals
Record last pulse TIG: ____ / ____ : ____ : ____
THC: as reqd to maintain C/L target within 8 deg corridor on C/L camera
√TCS AUTO ACQ ena per TCS MANUAL ACQUISITION, step 3 (RNDZ TOOLS), 7-19
At last pulse TIG+3:00 and when R>30 ft (DP-DP):
THC: +Z as reqd to establish and maintain RDOT > 0.15 fps
When R=50 ft (DP-DP):
[GNC 23 RCS]
√RCS FWD – ITEM 1 EXEC (*)
JET DES F1F – ITEM 31 EXEC (no ∗)
F2F – ITEM 35 EXEC (no ∗)

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

ATTITUDE AND RATE LIMITS [6B]

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)**

MET:008:16:40

PET

-00:15

Confirm ISS arrays feathered per SEPARATION SOLAR ARRAY CONFIG (6-11).
Report config to MCC.

A12(B12)

√MCC: GO FOR UNDOCKING

MCC UPDATE
GO for
Undocking

-00:10

-00:05 ← UNDOCKING OPERATIONS 6A

A9(B9)

00:00 ← **UNDOCK COMPLETE**

00:05

00:10

00:15

UNDOCKING / SEPARATION TIMELINE

SEP/FLYAROUND 8A

√Flyaround terminate criteria per 4A

* If Breakout required during flyaround *
* Go to SHUTTLE NOSE IN-PLANE BREAKOUT *
* (CONTINGENCY OPS), 5-16 >> *

1. When R > 75 ft (DP-DP):
   DAP: LO Z
   THC: Maintain C/L tgt within 8 deg corridor on C/L camera

   If TCS not tracking during corridor sep or flyaround, provide periodic HHL range updates to MCC

2. When Rng > 100 ft (DP-DP): If radar desired, INIT RADAR ACQ 9A

3. When Rng > 150 ft (DP-DP):
   DAP: A(B)/AUTO/VERN(ALT)
   THC: +Z (out) as reqd to maintain opening rate of 0.15 fps
   Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6

4. When Rng > 250 ft: Set RPOP POR: ORB CG - TGT CG

5. When RNG = 450 ± 50 FT (CG-CG)
   * If VERNs failed: *
   * GNC 20 DAP CONFIG *
   * ITEM 11 +2.0 EXEC *
   * ITEM 31 +2.0 EXEC *
   GNC UNIV PTG
   TGT ID √+2
   BODY VECT √+5
   P +90 (-RBAR)
   Y √+0
   OM √+0
   √ERR TOT – ITEM 23 (∗)
   TRK – ITEM 19 EXEC (∗)
   DAP: A/AUTO/VERN(PRI)
   THC: Maintain flyaround range of 450 ± 50 ft (CG-CG)
   Maintain ISS cg inside 8 degree corridor on CL camera

   If no flyaround, Go to SEP BURN 8B

6. Prior to –Rbar crossing (Aft ADI P = 90):
   GNC UNIV PTG
   P +0 (-VBAR)
   TRK - ITEM 19 EXEC (CUR - ∗)

7. Prior to -Vbar crossing (Aft ADI P = 180):
   GNC UNIV PTG
   P +270 (+RBAR)
   TRK - ITEM 19 EXEC (CUR - ∗)

8. Prior to +Rbar crossing (Aft ADI P = 270):
   GNC UNIV PTG
   P +180 (+VBAR)
   TRK - ITEM 19 EXEC (CUR - ∗)

9. Prior to +Vbar crossing (Aft ADI P = 0):
   GNC UNIV PTG
   P +90 (-RBAR)
   TRK - ITEM 19 EXEC (CUR - ∗)

10. Repeat steps 5 thru 8 as reqd to continue flyaround

11. At flyaround completion -10 minutes:
    If radar not tracking target:
    INITIAL RADAR ACQ 9A

12. When flyaround cmplt (on +/-Rbar per Undock/Flyaround message),
    Go to SEP BURN 8B

SEP BURN 8B

1. When in +/-Rbar attitude:

A6U √SENSE: -Z
√FLT CNTLR PWR - ON
√DAP: LO Z
DAP: A/LVLH/PRI
DAP TRANS: NORM/PULSE/PULSE
Perform retrograde burn:
If on -Rbar:
THC: +X (up) 12 sec (3.0 fps)
If on +Rbar:
THC: -X (dn) 12 sec (3.0 fps)

DAP TRANS: PULSE/PULSE/PULSE
DAP: A/LVLH/VERN(PRI)
FLT CNTLR PWR-OFF
Inform MCC when SEP complete

2. If RR data going into nav and SV updates small:
   Load target track attitude:
   GNC UNIV PTG

CRT TGT ID +1
BODY VECT +3
P √+90
Y √+0
OM +0

TRK - ITEM 19 EXEC (CUR - ∗)
DAP: A/AUTO/VERN(PRI)

3. When RNG > 800 ft:
   KU RADAR OUTPUT-HI

4. When R > 1000 ft:
   DAP: NO LO Z
   Go to TERMINATE SEP OPS 8C

TERMINATE SEP OPS 8C

If KU MODE – RDR PASSIVE,
Perform KU OPS, step 4 (Cue Card)
GNC UNIV PTG

CRT 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

O2 TK3 HTR A – OFF

Go to FLIGHT PLAN

INITIAL RADAR ACQ 9A

GNC 33 REL NAV

CRT √INH RNG, ITEM 18 - (*)
√RDOT, ITEM 21 - (*)
√Angles, ITEM 24 - (*)
KU ANT ENA - ITEM 2 EXEC (*)
GNC I/O RESET EXEC
√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 MODE - RR PASSIVE
RADAR OUTPUT - LO
√sel - GPC
CNTL - PNL
√PWR - ON

IF NO RADAR LOCK-ON WITHIN 2 MIN

KU - AUTO TRK
SLEW EL,AZ to 0,0 deg

KU SEARCH - SEARCH

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

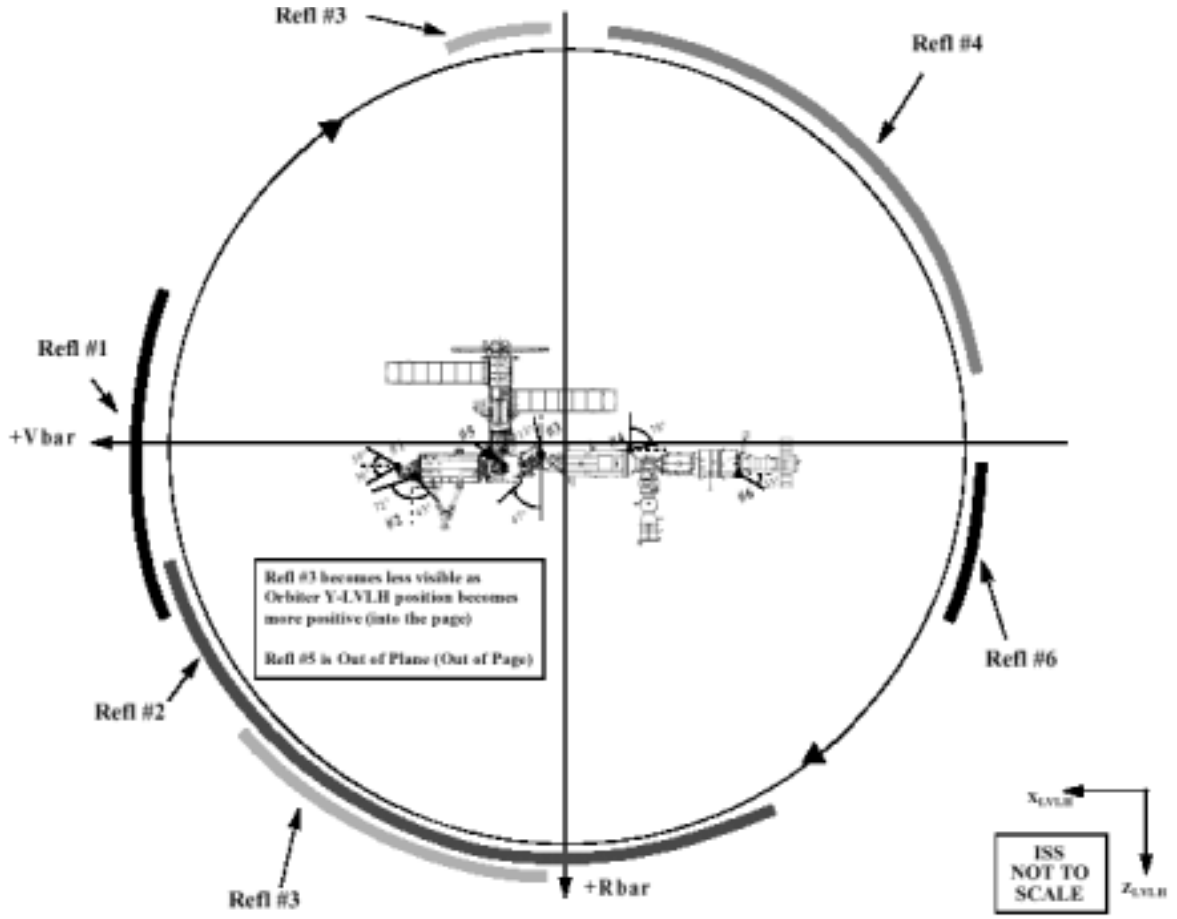
NOTE

Range conversion assumes ISS cg in center of centerline camera at a cg-cg range of 450 ft, with HHL aim point directly between HHL and ISS cg

450 FT cg to cg
HHL RANGE CONVERSION

HHL Aim Point	Raw HHL Range (ft)
US Lab - Fwd	385
Centerline Target	378
ISS Airlock	426
P6 Truss - End	392
Progress - Aft	353

TCS Reflector Visibility During Flyaround for STS-113 (11A)



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MANEUVER PADS

PRELIMINARY ORBITAL MANEUVER PAD FOR NC

OMS BOTH 1
L 2
R 3
RCS SEL 4
+X
–X
MULTI–AXIS

TV ROLL 5

TRIM LOAD
P 6 ( )
LY 7 ( )
RY 8 ( )

WT 9

TIG 10

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

BURN ATT
R 24
P 25
Y 26

ΔVTOT
TGO

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

HA HP
TGT ( )

NOTES

OMS GMBL CK:
PRE POST–BURN
L PRI
L SEC
R PRI
R SEC

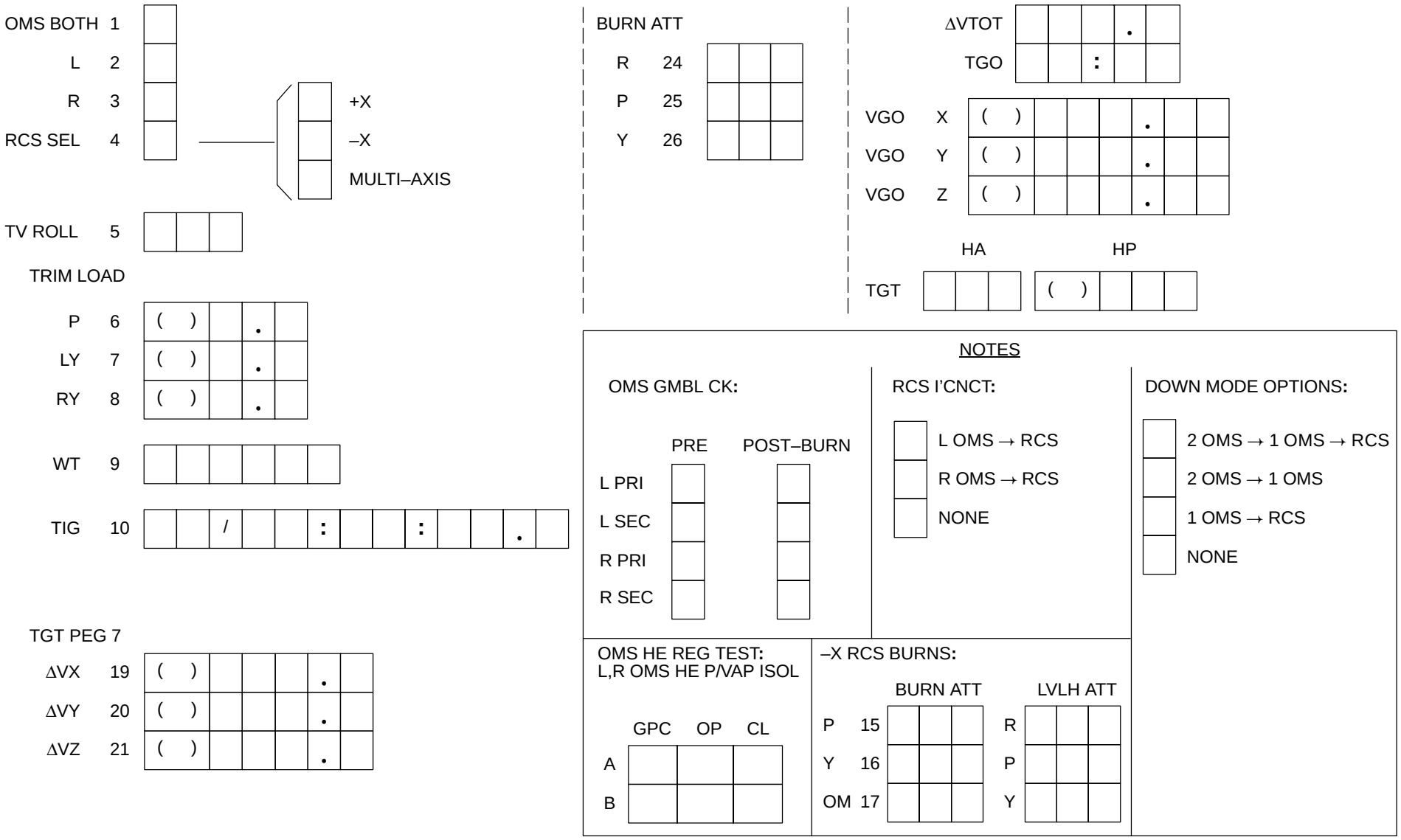
RCS I'CNCT:
L OMS → RCS
R OMS → RCS
NONE

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

OMS HE REG TEST:
L,R OMS HE P/VAP ISOL
GPC OP CL
A
B

–X RCS BURNS:
BURN ATT LVLH ATT
P 15 R
Y 16 P
OM 17 Y

FINAL ORBITAL MANEUVER PAD FOR NC



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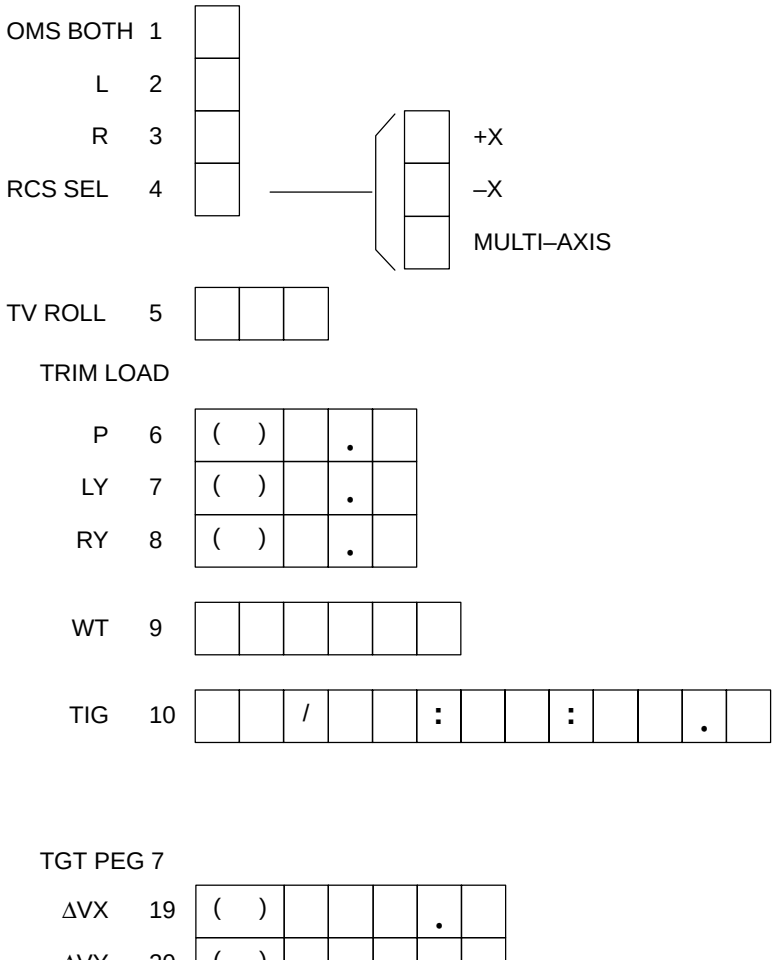

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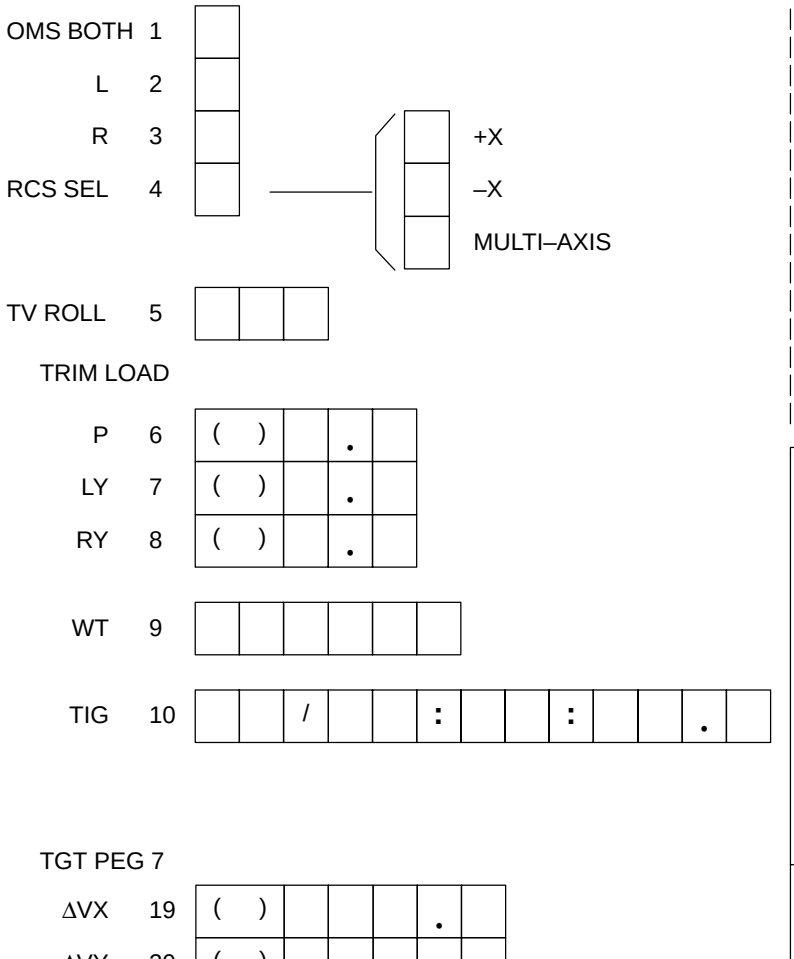

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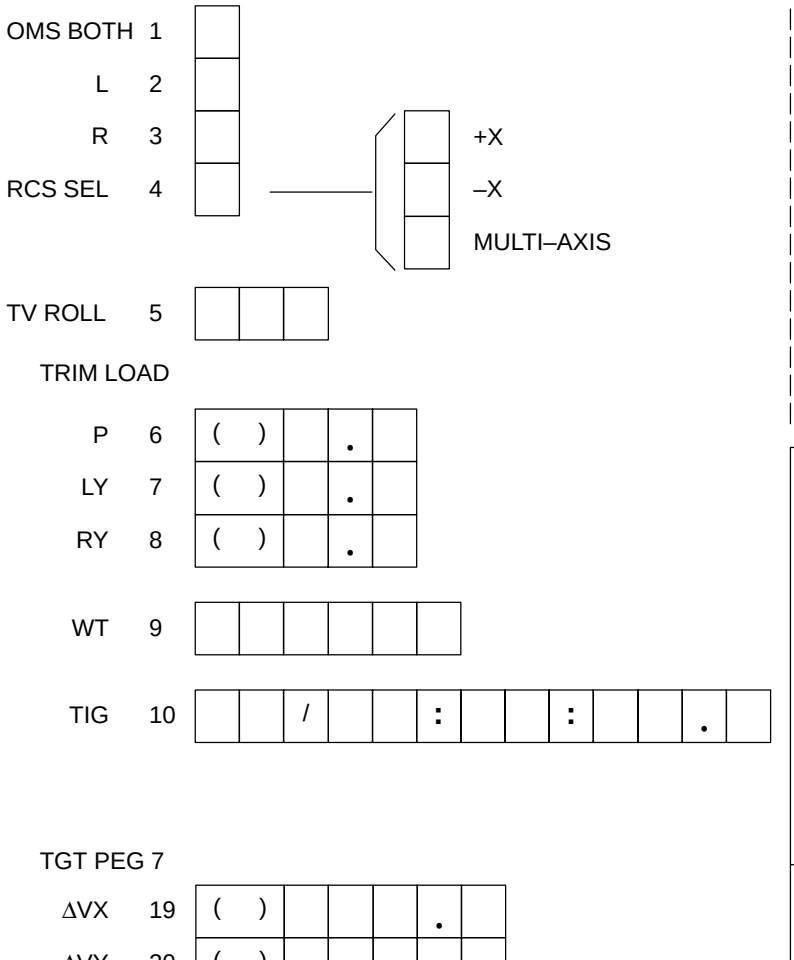
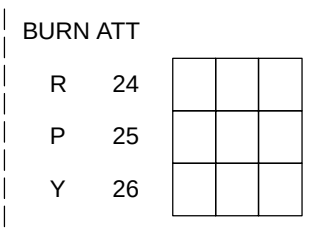
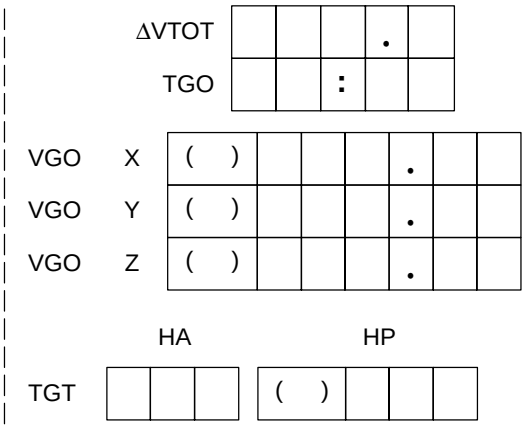






NOTES

OMS GMBL CK:

	PRE	POST–BURN
L PRI		
L SEC		
R PRI		
R SEC		

RCS I'CNCT:

- L OMS → RCS
- R OMS → RCS
- NONE

DOWN MODE OPTIONS:

- 2 OMS → 1 OMS → RCS
- 2 OMS → 1 OMS
- 1 OMS → RCS
- NONE

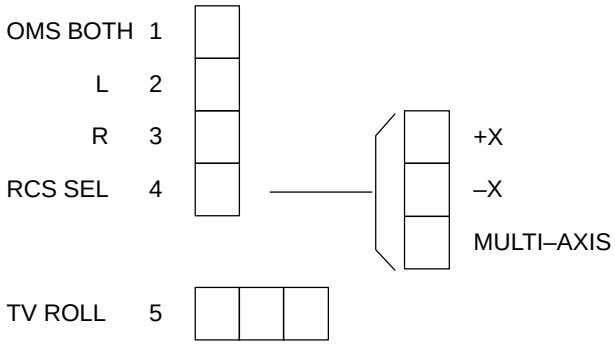
OMS HE REG TEST:
L,R OMS HE P/VAP ISOL

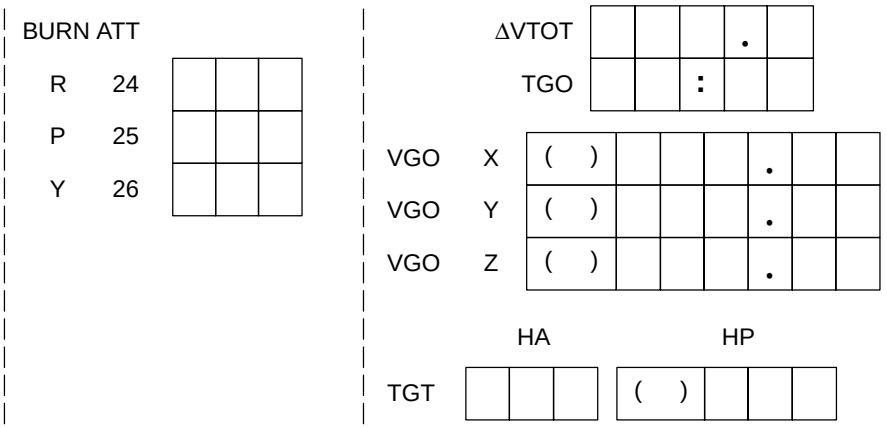
	GPC	OP	CL
A			
B			

–X RCS BURNS:

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

FINAL ORBITAL MANEUVER PAD FOR Ti





NOTES

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L PRI		
L SEC		
R PRI		
R SEC		

RCS I'CNCT:

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- R OMS → RCS
- NONE

DOWN MODE OPTIONS:

- 2 OMS → 1 OMS → RCS
- 2 OMS → 1 OMS
- 1 OMS → RCS
- NONE

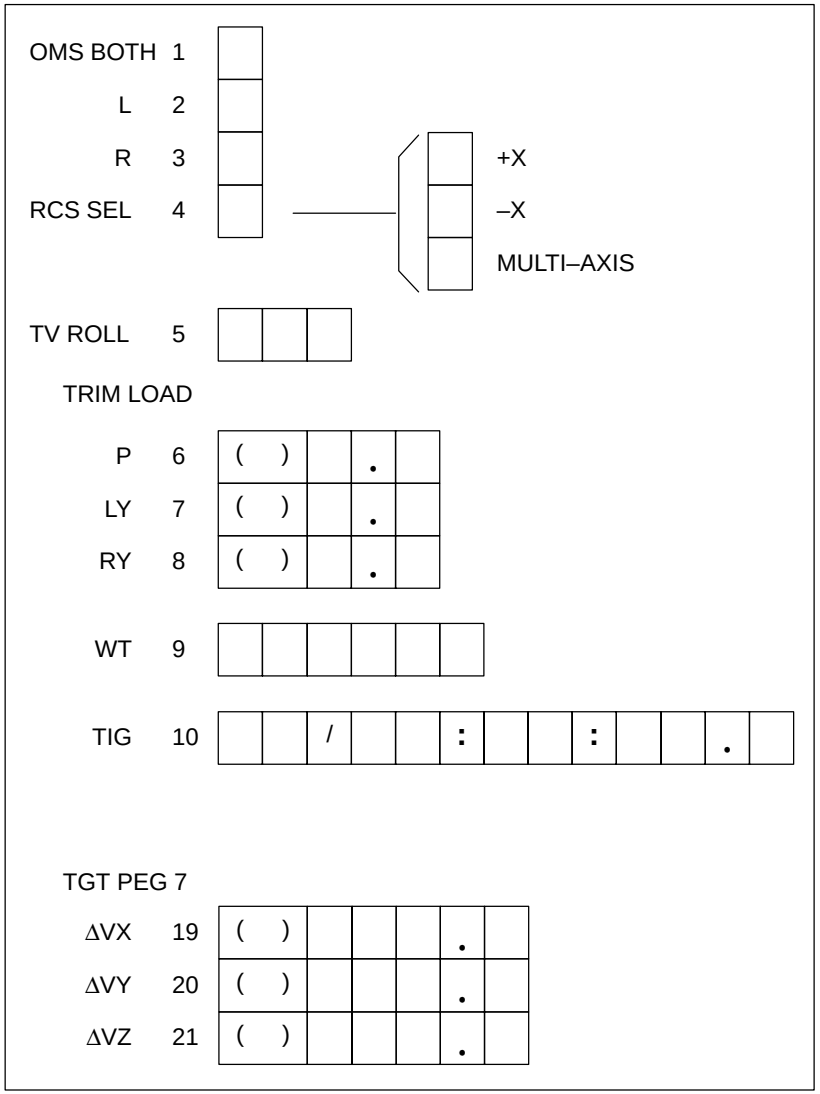
OMS HE REG TEST:
L,R OMS HE P/VAP ISOL

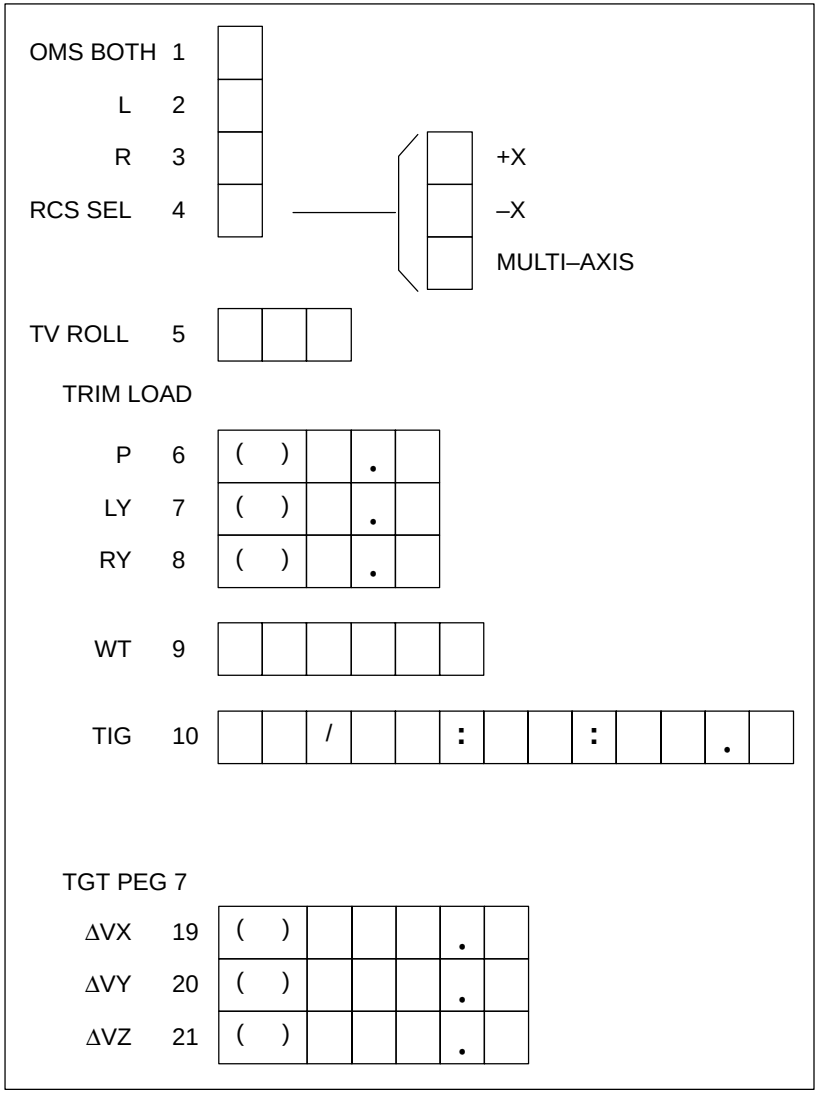
	GPC	OP	CL
A			
B			

–X RCS BURNS:

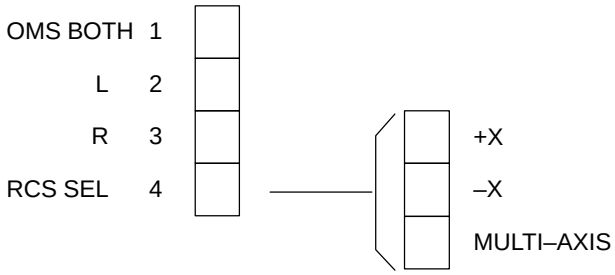
	BURN ATT				LVLH ATT		
P	15				R		
Y	16				P		
OM	17				Y		

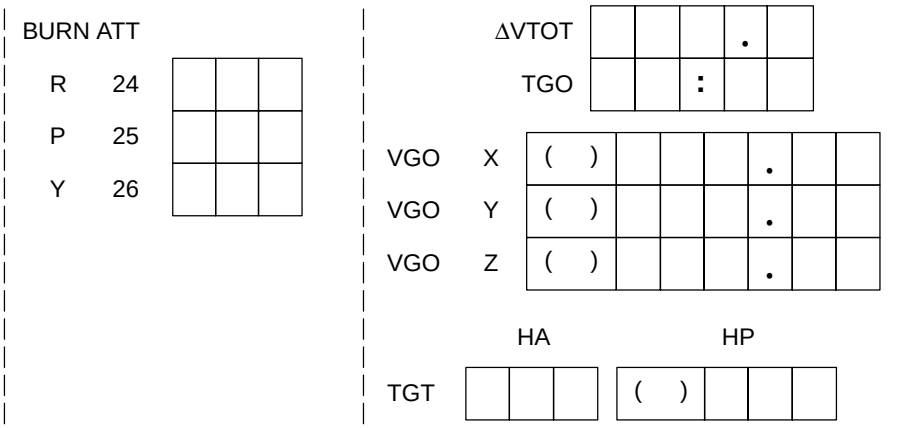
Ti DELAY PAD


OMS BOTH 1
L 2
R 3
RCS SEL 4
+X
–X
MULTI–AXIS
TV ROLL 5
TRIM LOAD
P 6
LY 7
RY 8
WT 9
TIG 10
TGT PEG 7
ΔVX 19
ΔVY 20
ΔVZ 21


OMS BOTH 1
L 2
R 3
RCS SEL 4
+X
–X
MULTI–AXIS
TV ROLL 5
TRIM LOAD
P 6
LY 7
RY 8
WT 9
TIG 10
TGT PEG 7
ΔVX 19
ΔVY 20
ΔVZ 21

ORBITAL MANEUVER PAD FOR _____





NOTES

OMS GMBL CK:

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L SEC		
R PRI		
R SEC		

RCS I'CNCT:

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- R OMS → RCS
- NONE

DOWN MODE OPTIONS:

- 2 OMS → 1 OMS → RCS
- 2 OMS → 1 OMS
- 1 OMS → RCS
- NONE

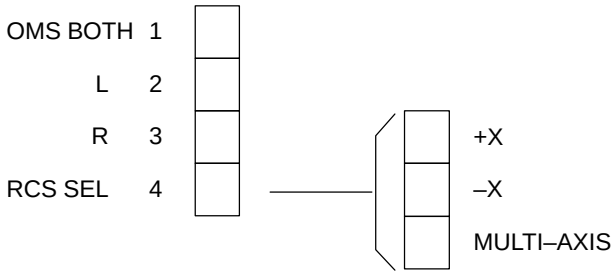
OMS HE REG TEST:
L,R OMS HE P/VAP ISOL

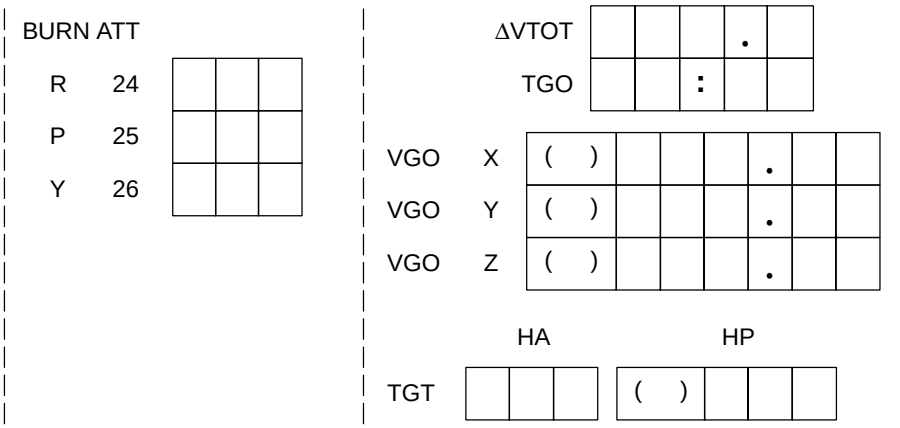
	GPC	OP	CL
A			
B			

–X RCS BURNS:

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

ORBITAL MANEUVER PAD FOR _____





NOTES

OMS GMBL CK:

	PRE	POST–BURN
L PRI		
L SEC		
R PRI		
R SEC		

RCS I'CNCT:

- L OMS → RCS
- R OMS → RCS
- NONE

DOWN MODE OPTIONS:

- 2 OMS → 1 OMS → RCS
- 2 OMS → 1 OMS
- 1 OMS → RCS
- NONE

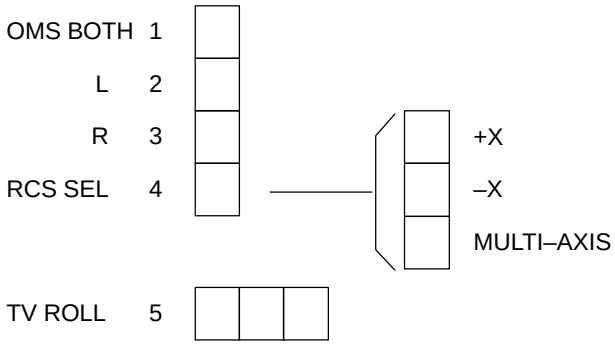
OMS HE REG TEST:
L,R OMS HE P/VAP ISOL

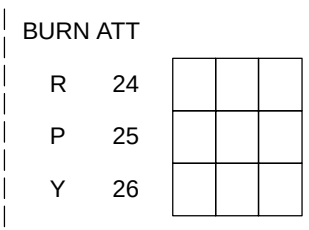
	GPC	OP	CL
A			
B			

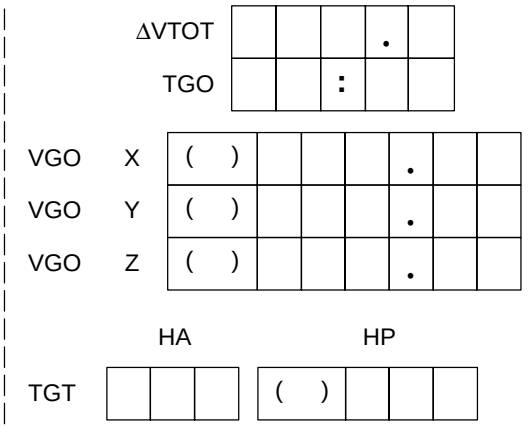
–X RCS BURNS:

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

ORBITAL MANEUVER PAD FOR _____







NOTES

OMS GMBL CK:

	PRE	POST–BURN
L PRI		
L SEC		
R PRI		
R SEC		

RCS I'CNCT:

- L OMS → RCS
- R OMS → RCS
- NONE

DOWN MODE OPTIONS:

- 2 OMS → 1 OMS → RCS
- 2 OMS → 1 OMS
- 1 OMS → RCS
- NONE

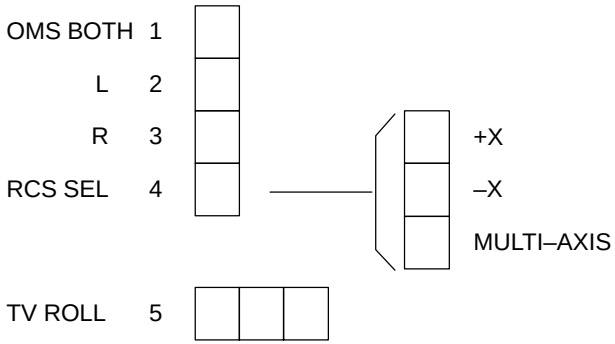
OMS HE REG TEST:
L,R OMS HE P/VAP ISOL

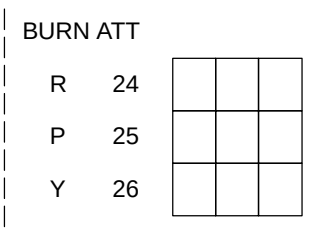
	GPC	OP	CL
A			
B			

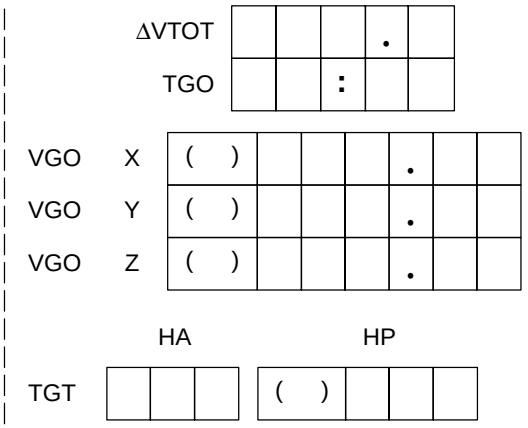
–X RCS BURNS:

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

ORBITAL MANEUVER PAD FOR _____







NOTES

OMS GMBL CK:

	PRE	POST–BURN
L PRI		
L SEC		
R PRI		
R SEC		

RCS I'CNCT:

- L OMS → RCS
- R OMS → RCS
- NONE

DOWN MODE OPTIONS:

- 2 OMS → 1 OMS → RCS
- 2 OMS → 1 OMS
- 1 OMS → RCS
- NONE

OMS HE REG TEST:
L,R OMS HE P/VAP ISOL

	GPC	OP	CL
A			
B			

–X RCS BURNS:

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

RENDEZVOUS TIMELINE

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AFT FLT STATION CONFIG FOR RNDZ 4A

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 - ON
sel - MAN SLEW
MODE - RDR PASSIVE
RADAR OUTPUT - HI
CNTL - PNL
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 - 888.8
DIGI-DIS sel - EL/AZ

CRT SELF TEST - ITEM 7 EXEC (no *)

A1U KU MODE - COMM
sel - GPC
CNTL - CMD

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

MET: 001:12:48

PET

-03:00

CDR AFT FLT STATION CONFIG FOR RNDZ [4A]

A7(B7) PLT RNDZ OPS INITIALIZATION [5A]

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

MCC UPLINK
ORB SV
TGT SV

-02:55

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

-02:50

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

Postburn DAP: A/LVLH/VERN(ALT)

-02:45

-02:40

-02:35

-02:30

RNDZ OPS INITIALIZATION [5A]

√DPS Config for Rndz Ops - String 1233

[SM 2 TIME]
Set SM TIMER counting to Ti TIG per burn Pad, 3-6

Config DAP A,B to A7,B7

Record nominal TIGs in burn solution blocks per Execute Package:

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

[GNC 55 GPS STATUS]
√INH GPS to G&C, ITEM 33 - (*)
NAV, ITEM 36 - (*)

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PET

-02:30

A7(B7)

← TIG-5 MIN

-02:25

If reqd,

← NH TIG

Postburn DAP: A/LVLH/VERN(ALT)

-02:20

-02:15

PLT ENABLE RENDEZVOUS NAV 7A

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

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

-02:10

MS Perform HHL CHECKOUT (RNDZ TOOLS), 7-6

-02:05

MCC UPDATE
Final NC Burn Pad, 3-3

-02:00

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

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PET

-02:00

A7(B7)

CDR LOAD TARGET TRACK 9A

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

-01:55

-01:50

-01:45

-01:40

← TIG-5 MIN

-01:35

← NC TIG

CDR INITIATE TARGET TRACK 9B

-01:30

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

LOAD TARGET TRACK 9A

√DAP: A/LVLH/VERN(ALT)
GNC UNIV PTG

CRT CNCL - ITEM 21 EXEC
TGT ID +1

	-Z AXIS	-Y STRK
BODY VECT	+3 (-Z)	+4
P	√+90	√+0
Y	√+0	√+280.57
OM	+0	+90

Do not INITIATE TARGET TRACK 9B until post NC

INITIATE TARGET TRACK 9B

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

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

STAR TRACKER NAV [10A]

1. CONFIG FOR STRK NAV

√DAP: A/AUTO/VERN(ALT)

Turn down cabin lights to optimize target viewing through -Z COAS/overhead window

IMU for Deselect _____ (If no comm, use IMU 1 for deselect)

[GNC 21 IMU ALIGN]

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

√MCC for NAV selected IMU _____

[GNC 33 REL NAV]

If first NAV pass,
| √SV SEL, ITEM 4 - PROP

If previous NAV,
√SV SEL, ITEM 4 - FLTR

√INH Angles, ITEM 24 - (*)

√S TRK, ITEM 12 - (*)

[GNC 22 S TRK/COAS CNTL]

-Y THOLD – ITEM 13 +3 EXEC

-Z THOLD – ITEM 14 +3 EXEC

-Z (-Y) TGT TRK - ITEM 6(5) EXEC (*)

√STATUS - blank

√SHUTTER - op

2. INITIAL MEASUREMENT EVALUATION

[GNC 22 S TRK/COAS CNTL]

When S PRES - (*), continue

[GNC 33 REL NAV]

Monitor RESID V and H each NAV cycle for at least four consecutive cycles (~30 sec)

Record init RESID V = _____ _____ _____ _____

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 [10B]

[GNC 33 REL NAV]

CRT INH Angles - ITEM 24 EXEC (*)

[GNC 21 IMU ALIGN]

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

MET: 001:14:18

PET

-01:30

PLT STAR TRACKER NAV 10A

A7(B7)

MCC UPDATE
Nav Selected IMU___

-01:25

MCC UPDATE
Ground NCC Burn Solution

When NAV converged (SV UPDATES small and stable):

-01:20

CDR TARGET NCC BURN 11A (Intermediate)

√MCC for burn type. If no comm:
- If ΔVT > 6, at TIG-17:
  - Perform RNDZ OMS BURN (CONTINGENCY OPERATIONS), 5-4
- If 4 ≤ ΔVT ≤ 6, at TIG-17:
  - Perform +X RCS burn, RCS BURN (Cue Card)
- If ΔVT< 4, at TIG-5:
  - Perform multi-axis RCS burn, RCS BURN (Cue Card)

-01:15

← TIG-17 MIN

-01:10

-01:05

PLT END S TRK NAV 10B

PLT TARGET NCC BURN 11A (Final)

← TIG-5 MIN

CDR Perform RCS BURN (Cue Card)

-01:00

TARGET NCC BURN 11A

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

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

FINAL SOLUTION
If > 40 marks in current sensor pass and SV UPDATE POS < 0.5 for the last 4 marks:
- Burn FLTR soln

If FLTR within ground solution limits:
- Burn FLTR soln

If PROP within ground solution limits:
- Burn PROP soln

If none of the above:
- Burn ground soln EXT ΔVs

NCC BURN SOLUTION

TIG ___ / ___ : ___ : ___

	PRELIMINARY	INTERMEDIATE	FINAL	GROUND	FINAL - GROUND LIMITS
ΔVX	( ) .	( ) .	( ) .	( ) .	(0.5)
ΔVY	( ) .	( ) .	( ) .	( ) .	(1.5)
ΔVZ	( ) .	( ) .	( ) .	( ) .	(1.8)
ΔVT	.	.	.	.	

-Z AXIS TARGET TRACK 12A

GNC UNIV PTG

CRT	√TGT ID	+1
	BODY VECT	+3 (-Z)
	OM	+0
C3	DAP: B/AUTO/ALT	
CRT	TRK - ITEM 19 EXEC (CUR - ∗)	

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

MET: 001:14:48

PET

-01:00

A7(B7)

← NCC TIG

-00:55

PLT TARGET Ti BURN 13A (Preliminary)

MCC UPDATE
RNDZ PRPLT PAD

IF Y S TRK TRACK

CDR -Z AXIS TARGET TRACK 12A

-00:50

When:
GNC 33 REL NAV
NAV RNG < 150 KFT:

MS KU OPS, step 1 (Cue Card)

-00:45

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

MS KU OPS, step 2 (Cue Card)

-00:40

When RR RNG < 135 KFT:

PLT Perform RR NAVIGATION 13B

-00:35

When NAV converged (SV UPDATES small and stable):

PLT TARGET Ti BURN 13A (Intermediate)

-00:30

TARGET Ti BURN 13A

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

RR NAVIGATION 13B

GNC 33 REL NAV

CRT RR - ITEM 13 EXEC (*)
√Elev, Az approx 0

Record Initial RESID RANGE = _____
RDOT = _____

IF RESID RANGE > 5.0 or
RDOT > 3.0

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

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

Record 1st SV UPDATE POS = _____

IF SV SEL = PROP
When SV UPDATE POS < 0.3 and MARK ACPT > 9:
SV SEL - ITEM 4 EXEC (FLTR)

Ti BURN SOLUTIONS

PREL FLTR				
( )			.	
( )			.	
( )			.	
			.	

INTER FLTR				
( )			.	
( )			.	
( )			.	
			.	

FINAL FLTR				
( )			.	
( )			.	
( )			.	
			.	

GND				
( )			.	
( )			.	
( )			.	
			.	

FINAL Ti Burn Pad, 3-7

PROP (If Reqd)				
( )			.	
( )			.	
( )			.	
			.	

FINAL - GROUND LIMITS	
ΔVX	(0.6)
ΔVY	(1.1)
ΔVZ	(0.9)

MET: 001:15:18

PET

-00:30

A7(B7)

√MCC for burn type. If no comm:
If ΔVT > 6, at TIG-17:
| Perform RNDZ OMS BURN (CONTINGENCY OPERATIONS), 5-4
If 4 ≤ ΔVT ≤ 6, at TIG-17:
| Perform +X RCS burn, RCS BURN (Cue Card)
If ΔVT< 4, at TIG-5:
Perform multi-axis RCS burn, RCS BURN (Cue Card)

-00:25

MCC UPDATE
Ti Final Ground Soln, 3-7
Ti DELAY Burn PAD, 3-8

-00:20

IF RNDZ DELAY
CDR Perform Ti DELAY BURN (CONTINGENCY OPS), 5-25

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

-00:15

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

MCC UPDATE
GO for Ti

-00:10

-00:05

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

00:00

← Ti TIG

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
√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

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

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

NIGHTTIME STRK OPS 16B

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

At sunset,

2. GNC 22 S TRK/COAS CNTL
-Z(-Y) THOLD - ITEM 14(13) +0 EXEC

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

MET: 001:15:48

PET

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

A7(B7)

When MNVR to att cmplt:

CDR POST Ti NAV 16A

MCC UPDATE
Prox Ops Cov Matrix

00:05

00:10 — When NAV converged, (SV UPDATES small and stable):

PLT TARGET MC 1 BURN 17A (Intermediate)

MS √Time of OOP null

00:15

← TIG-3 MIN

PLT TARGET MC 1 BURN 17A (Final)
Perform RCS BURN (Cue Card)

00:20 ← MC 1 TIG

PLT TARGET MC 2 BURN 17B (Preliminary)

00:25 — When Y = 0:

PLT MANUAL OUT-OF-PLANE NULL 19A

IF S TRK NAV
At sunset:
PLT NIGHTTIME STRK OPS 16B

00:30

TARGET MC 1 BURN 17A

CRT √SV SEL correct
GNC 34 ORBIT TGT
TGT NO - ITEM 1 +1 1 EXEC
√TGT Set data:
T1 TIG = MC1 BURN SOLUTION TIG
EL +0
ΔT +56.9
ΔX -0.9
ΔY +0
ΔZ +1.8
COMPUTE T1 - ITEM 28 EXEC
Record solution in PAD

MC 1 BURN SOLUTION

TIG ( ) / : :

	PRELIMINARY	INTERMEDIATE	FINAL	MEAN ± (3σ VARIATION)
ΔVX	( ) .	( ) .	( ) .	-0.1 ± (0.6)
ΔVY	( ) .	( ) .	( ) .	0.0 ± (0.5)
ΔVZ	( ) .	( ) .	( ) .	+0.3 ± (1.6)
ΔVT	.	.	.	

TARGET MC 2 17B (Preliminary)

CRT √SV SEL correct
GNC 34 ORBIT TGT
TGT NO - ITEM 1 +1 2 EXEC
√TGT Set data:
T1 TIG = MC2 BURN SOLUTION TIG
EL +29.07
ΔT +27.0
ΔX -0.9
ΔY +0
ΔZ +1.8
COMPUTE T1 - ITEM 28 EXEC
NOTE
If TGT EL ANG Alarm,
ΔV still valid for current TIG,
TIG slip limits still apply
Record solution in PAD

TARGET MC 2 BURN 18A (Intermediate)

CRT √SV SEL correct
GNC 34 ORBIT TGT
TGT NO - ITEM 1 +1 2 EXEC
COMPUTE T1 - ITEM 28 EXEC
Record solution in PAD

TARGET MC 2 BURN 18B (Final)

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

IF TIG CHANGE < -3 OR > +7 MIN

Set BASE TIME to (Nominal MC 2 TIG -3 or +7 min as appropriate)
LOAD - ITEM 26 EXEC
TGT NO - ITEM 1 +1 9 EXEC
√TGT 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 33 REL NAV
CRT FLTR TO PROP - ITEM 8 EXEC

MC 2 BURN SOLUTION

	PRELIMINARY	INTERMEDIATE
ΔVX	( ) .	( ) .
ΔVY	( ) .	( ) .
ΔVZ	( ) .	( ) .
ΔVT	.	.

	FINAL	MEAN ± (3σ VARIATION)
ΔVX	( ) .	+0.1 ± (0.6)
ΔVY	( ) .	+0.0 ± (0.2)
ΔVZ	( ) .	+0.9 ± (3.2)
ΔVT	.	

	TIG	TIG SLIP (COMPUTED-NOM)
PREL	/ : : :	:
INTER	/ : : :	:
FINAL	/ : : :	:
NOMINAL	/ : : :	

END S TRK NAV 18C

GNC 33 REL NAV
CRT INH Angles - ITEM 24 EXEC (∗)

GNC 21 IMU ALIGN
IMU DES - ITEM 7(8,9) EXEC (no ∗)

-Z AXIS TARGET TRACK 18D

GNC UNIV PTG
CRT √TGT ID +1
BODY VECT +3 (-Z)
OM +0
C3 DAP: B/AUTO/ALT
CRT TRK - ITEM 19 EXEC (CUR - ∗)

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

MET: 001:16:18

PET

00:30 — A7(B7)

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

00:35

PLT When NAV converged (SV UPDATES small and stable):
TARGET MC 2 BURN 18A (Intermediate)

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

MC2 ET

00:40 — -00:10

On RPOP PGSC:
MS Perform TCS ACTIVATION, steps 2-4 (RNDZ TOOLS), 7-18
(Set AUTO ACQ to 10,000 ft)

If S TRK NAV,
At TIG - 6 min
PLT END STAR TRACKER NAV 18C

00:45 — -00:05 ←

TIG-5 MIN
PLT TARGET MC 2 BURN 18B (Final)
Perform RCS BURN (Cue Card)

00:50 — 00:00 ← MC 2 TIG

PLT TARGET MC 3 BURN 19B (Preliminary)

IF -Y S TRK TRACK
PLT -Z AXIS TARGET TRACK 18D

00:55 — 00:05

MS When R < 10,000 ft:
SSOR comm check with ISS

IF INITIAL RR ACQ POST-MC2
CDR Perform LATE RR NAV 20E

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

01:00 — 00:10

MANUAL OUT-OF-PLANE NULL 19A

GNC 33 REL NAV

CRT When Y = 0:
F7 FLT CNTLR PWR - ON
DAP: A/AUTO/PRI
DAP TRANS: as reqd

THC: Null YDOT

If -Z AXIS TRACK,
+YDOT = FWD THC left
AFT THC right
If -Y S TRK TRACK,
+YDOT = FWD THC down
AFT THC out

F7 FLT CNTLR PWR - OFF
DAP: A/AUTO/ALT
When rates nulled:
DAP: VERN(ALT)

TARGET MC 3 19B

CRT √SV SEL correct
GNC 34 ORBIT TGT
TGT NO - ITEM 1 +1 3 EXEC
√TGT Set data:
T1 TIG = BASE TIME + 0/00:17:00
EL +0
ΔT +10.0
ΔX -0.9
ΔY +0
ΔZ +1.8
COMPUTE T1 - ITEM 28 EXEC
Record solution in PAD

MC 3 BURN SOLUTION

TIG ___ ___ ___ / ___ ___ : ___ ___ : ___ ___

	PRELIMINARY	FINAL	MEAN ± (3σ VARIATION)
ΔVX	( ) ___ ___ . ___	( ) ___ ___ . ___	+0.5 ± (1.8)
ΔVY	( ) ___ ___ . ___	( ) ___ ___ . ___	+0.0 ± (0.5)
ΔVZ	( ) ___ ___ . ___	( ) ___ ___ . ___	+0.9 ± (3.1)
ΔVT	___ ___ . ___	___ ___ . ___	

MC 4 BURN SOLUTION

TIG ___ / ___ : ___ : ___

	PRELIMINARY	FINAL	MEAN ± 3σ VARIATION
ΔVX	( ) .	( ) .	+0.5 ± (2.1)
ΔVY	( ) .	( ) .	+0.1 ± (0.6)
ΔVZ	( ) .	( ) .	+0.0 ± (2.6)
ΔVT	.	.	

TARGET MC 4 BURN 20A

CRT √SV SEL correct
GNC 34 ORBIT TGT
TGT NO - ITEM 1 +1 4 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

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 +5
P +270
Y +0
OM +0

Do not initiate Target Track until ESTABLISH RBAR 20C

LATE RADAR NAV 20E

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

RADAR FAIL PROCEDURE 20D

Note: When TGT visible, report TGT Tally-Ho to MCC
MS If TGT outside COAS reticle, config CCTV as reqd to measure vertical position

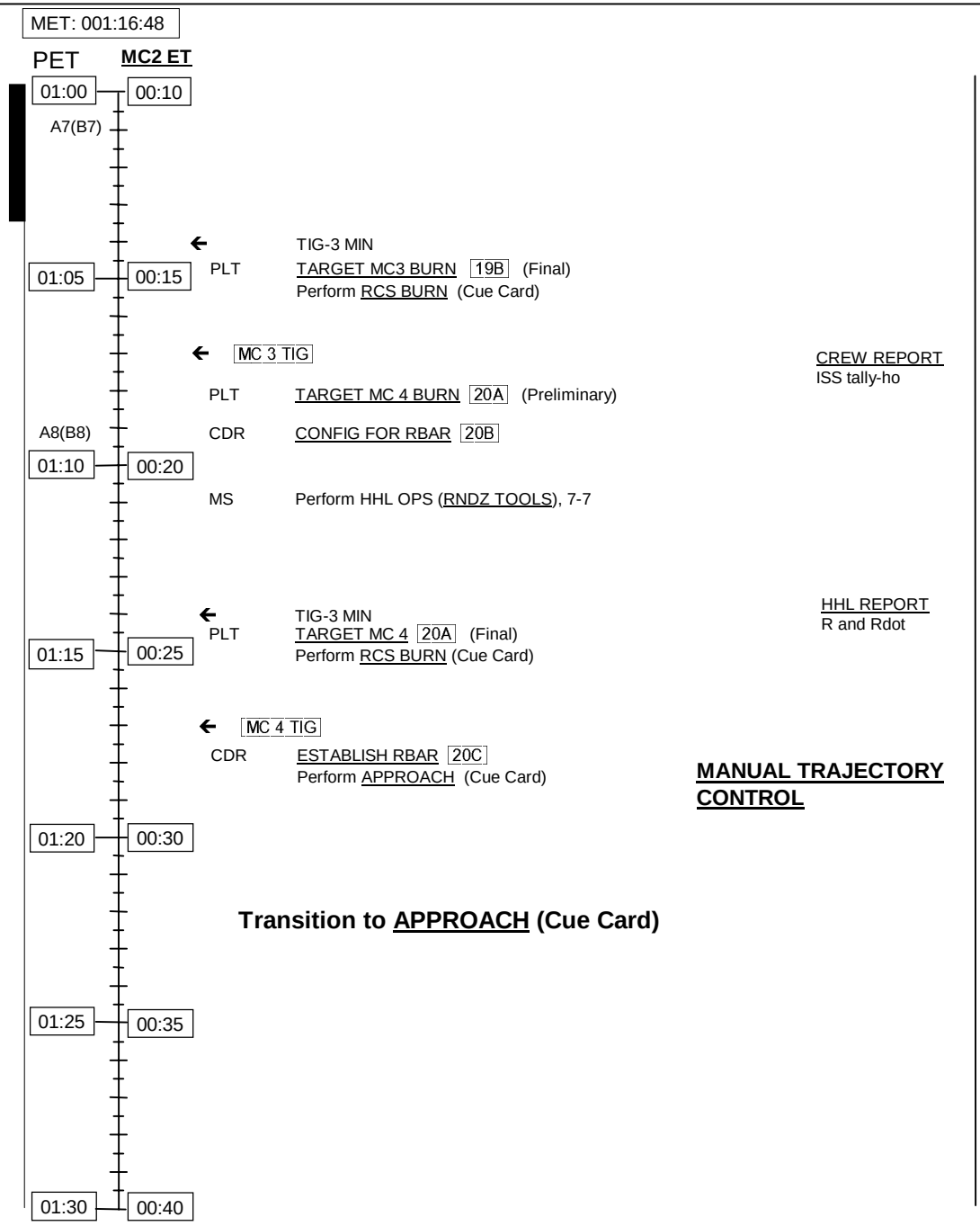
1. At MC2 TIG+14:00 (MC3 TIG-3:00):
PLT TARGET MC3 19B (final)
CDR Perform RCS BURN (Cue Card)

AT MC2+18 IF NO VISUAL ACQUISITION OR
TARGET > 30 DEG FROM COAS HORIZONTAL
CDR Go to RNDZ BREAKOUT (CONTINGENCY OPS), 5-18 >>

2. At MC2 TIG + 19:00:
A6U FLT CNTLR PWR - ON
√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)


MET: 001:16:48
PET
MC2 ET
01:00
00:10
A7(B7)
TIG-3 MIN
PLT
TARGET MC3 BURN 19B (Final)
Perform RCS BURN (Cue Card)
01:05
00:15
MC 3 TIG
CREW REPORT
ISS tally-ho
PLT
TARGET MC 4 BURN 20A (Preliminary)
A8(B8)
CDR
CONFIG FOR RBAR 20B
01:10
00:20
MS
Perform HHL OPS (RNDZ TOOLS), 7-7
TIG-3 MIN
HHL REPORT
R and Rdot
PLT
TARGET MC 4 20A (Final)
Perform RCS BURN (Cue Card)
01:15
00:25
MC 4 TIG
CDR
ESTABLISH RBAR 20C
Perform APPROACH (Cue Card)
MANUAL TRAJECTORY CONTROL
01:20
00:30
Transition to APPROACH (Cue Card)
01:25
00:35
01:30
00:40

TERMINATE RNDZ OPS 22A

PLT GNC 23 RCS
CRT RCS F – ITEM 1 EXEC (*)
JET DES F3F – ITEM 33 EXEC (*)
If docking complete:
F1U – ITEM 17 EXEC (*)
F3U – ITEM 19 EXEC (*)
F2U – ITEM 21 EXEC (*)

Exit RPOP - [Shift]/[F10]
Perform TCS DEACTIVATION (RNDZ TOOLS), 7-20
-Z COAS - OFF
Config DAP A,B to A12,B12
GNC 20 DAP CONFIG
X JET ROT ENA – ITEM 7 EXEC (*)

DAP: LO Z
If Loss of Verns:
DAP: B/ALT
DAP: LVLH
If VERN:
DAP: LVLH
* If ISS attitude control required, *
* Perform HANDOVER ATTITUDE CONTROL ORBITER TO *
* CMG TA, (SODF: JOINT OPS, MATED OPERATIONS) *

MS Perform DOCKING MECHANISM POWERDOWN (APDS), 8-6
Perform HHL STOW (RNDZ TOOLS), 7-6

CDR A6U √FLT CNTLR PWR - OFF

GNC 33 REL NAV
RNDZ NAV ENA - ITEM 1 EXEC (no *)
GNC 22 S TRK/COAS CNTL
-Z(-Y) STAR TRK - ITEM 4(3) EXEC (*)
-Z THOLD - ITEM 14 + 0 EXEC
-Y THOLD - ITEM 13 + 0 EXEC

A6L LTS TRUSS FWD, AFT (two) - OFF
VEST PORT, STBD (two) - OFF

CONTINGENCY OPS

RNDZ OMS BURN 5–3
SENSOR FAIL 5–7
S TRK NAV – HIGH INITIAL RESID 5–8
FLTR MINUS PROP 5–9
COAS NAVIGATION 5–10
BACKOUT/BREAKOUTS 5–11
VBAR CORRIDOR BACKOUT 5–12
BREAKOUT 5–14
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RNDZ BREAKOUT 5–18
EXPEDITED SEPS 5–19
SHUTTLE EMERGENCY SEPARATION 5–21
ANY ATTITUDE SEPARATION 5–23
Ti DELAY BURN 5–25
RNDZ NAV RECOVERY 5–27
LOSS OF VRCS 5–28
LO Z BRAKING 5–29
TGT ITER 5–30

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RNDZ OMS BURN

RNDZ OMS BURN

1. OMS BURN PREP

C2 Wedge — Install OMS2/ORBIT OMS BURNS (Cue Cards) (two) and ORBIT BURN MONITOR (Cue Cards) (two) (F6,F8)

1: GNC 20 DAP CONFIG

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

1: GNC ORBIT MNVR EXEC

2: GNC SYS SUMM 2

2. LOAD TGT DATA

If onboard computed burn:
- ✓Eng sel, TV ROLL, TRIM LOAD, and WT per Burn Pad
- ✓TIG and TGT PEG 7 ΔVs per Final ORBIT TGT solution
- ✓Guidance option is LAMBERT

If ground computed burn:
- ✓TGT data per Burn Pad (reload WT as reqd)

LOAD – ITEM 22 EXEC
TIMER – ITEM 23 EXEC
✓Burn data

C3 — DAP: A/AUTO/ALT(B/ALT as reqd)

CRT1 — MNVR – ITEM 27 EXEC (*)

If RR ops:

A1U — KU sel – AUTO TRK

1: GNC 33 REL NAV

CRT1 — INH Angles – ITEM 24 EXEC (*)

1: GNC ORBIT MNVR EXEC

When mnvr to att complete:

C3 — ✓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 F7/F8 — FLT CNTLR PWR (two) – ON
Perform OMS2/ORBIT OMS BURNS (Cue Card)

Cont next page

4. OMS POST BURN RECONFIGURATION

F7/F8 FLT CNTLR PWR (two) – OFF
O8 L,R OMS He PRESS/VAP ISOL (four) – CL

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

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

GNC, OPS 201 PRO

5. MNVR TO POST BURN ATTITUDE

1: GNC UNIV PTG

✓Desired UNIV PTG load active

C3 DAP: B/AUTO/ALT

If RR ops, when ATT ERR < 30 deg:
A1U KU sel – GPC
✓KU TRACK tb – gray

1: GNC 33 REL NAV

CRT1 AUTO Angles – ITEM 23 EXEC (*)

1: GNC UNIV PTG

When in attitude and rates nulled:
C3 DAP: A/AUTO/VERN(ALT)

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SENSOR FAIL

S TRK NAV – HIGH INITIAL RESID

1. NAV SAFING

   1: GNC 33 RR 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 RR REL NAV

CRT1 INH Angles – ITEM 24 EXEC (*)

On MCC GO (continue if no comm):

2. CHECK FOR S TRK FALSE LOCK

   2: GNC 22 S TRK/COAS CNTL

   If –Z S TRK, perform COAS visual check:

   NOTE

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

   ✓For debris near TGT position

   If no debris near TGT position or TGT not visible:

   Go to step 3

   If debris near TGT position:

   SV SEL – ITEM 4 EXEC (PROP)

   PROP TO FLTR – ITEM 9 EXEC

CRT2 –Z BREAK TRK – ITEM 8 EXEC

   When S PRES – (*):

CRT1 Monitor RESID V and H. Repeat BREAK TRK as reqd until stable lock–on

   Go to STAR TRACKER NAV, step 2 10A

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

   ✓For debris near TGT line–of–sight

   If no debris near TGT line–of–sight or TGT not visible:

   Go to step 3

   If debris near TGT line–of–sight:

   SV SEL – ITEM 4 EXEC (PROP)

   PROP TO FLTR – ITEM 9 EXEC

CRT2 –Y BREAK TRK – ITEM 7 EXEC

   When S PRES – (*):

CRT1 Monitor RESID V and H. Repeat BREAK TRK as reqd until stable lock–on

   Perform STAR TRACKER NAV, step 2 10A

3. RESUME PASS

   AUTO Angles – ITEM 23 EXEC (*)

   Continue –Z S TRK pass

   After S TRK pass, on MCC GO:

   NOTE

   SELF–TEST may false fail. ✓MCC for S TRK status

   2: GNC 22 S TRK/COAS CNTL

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

COAS NAVIGATION

NOTE

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

1. COAS NAV CONFIG

A6U
✓SENSE: –Z
✓DAP: B7/AUTO/VERN(ALT)

GNC 22 STRK/COAS CNTL

CRT
COAS: SIGHT MODE – ITEM 22 EXEC (*)
REQD ID – ITEM 21 +1 EXEC
✓POS –Z: ITEM 27 (*)

GNC 33 REL NAV

INH Angles – ITEM 24 EXEC (*)
✓SV SEL, ITEM 4 – FLTR
If TGT NOT in COAS FOV:
✓MCC
If TGT in COAS FOV:
FLTR TO PROP – ITEM 8 EXEC
COAS – ITEM 14 EXEC (*)

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

2. COAS MARKS

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

When TGT centered in COAS, ATT REF pb – push

GNC 33 REL NAV

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

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

At sunset,

3. END COAS NAV

A6U
DAP: A7/AUTO/VERN(ALT)

GNC 22 STRK/COAS CNTL

CRT
COAS: DES – ITEM 25 EXEC (*)

Resume rendezvous timeline

BACKOUT/BREAKOUTS

VBAR CORRIDOR BACKOUT

CAUTION
Constraints for use:
Orbiter on + Vbar in approach corridor
Range < 170 ft int to int

1. ESTABLISH OPENING RATE
   - ✓DAP: B/AUTO
   - ✓DAP: LO Z/NO LO Z per VBAR APPROACH (Cue Card)

   THC: +Z (out) as reqd to establish +0.1 ft/sec opening rate

When opening rate established:

2. PERFORM CORRIDOR BACKOUT OR BREAKOUT

   NOTE: DAP A allowed for ±X and –Z (in) THC inside 75 ft

   If PCT ARMED:
   DISARM PCT: SPDBRK/THROT pb – AUTO
   ✓lt – OFF
   If BREAKOUT desired:
   Perform VBAR BREAKOUT, 5–14
   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
   Verify angular alignment and perform AUTO ANGULAR FLYOUT (Cue Card) if reqd
   If 170 ft STATIONKEEPING desired:
   DAP config: A9/B9
   Maintain 8 deg corridor
   When RNG = 75 ft:

   NOTE: DAP A allowed for ±X and ±Z THC outside 75 ft

   GNC 23 RCS
   RCS F – ITEM 1 EXEC (*)
   JET DES F1F – ITEM 31 EXEC (no *)
   F2F – ITEM 35 EXEC (no *)
   DAP: LO Z
   When RNG = 170 ft:
   THC: –Z (in) as reqd to establish 170 ± 10 ft stationkeeping
   Resume nominal VBAR attitude (if reqd):
   GNC UNIV PTG
   ✓TGT ID +2
   ✓BODY V +5
   PITCH +179
   YAW +0
   OM +0
   TRK – ITEM 19 EXEC (CUR – *)
   ✓DAP: AUTO

3. REAPPROACH
If reqd, set GNC TIMER to count down to new docking time

Approach PET 0:00 =		/			:			:		

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

VBAR BREAKOUT

CAUTION
Constraints for use:
Orbiter on ± Vbar in approach attitude
Range < 500 ft cg to cg
Tgt stable on orbiter –Z axis
Orbiter X and Z axes are in–plane

1. AFT STATION CONFIG
   ✓SENSE: –Z

If RNG < 75 ft:

2. 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:

3. PERFORM RADIAL BURN ON ±VBAR
   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 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

4. PERFORM POSIGRADE/RETROGRADE BURN
   ✓MCC for breakout direction

   NOTE
   Posigrade burn performed if second docking attempt desired

   GNC, OPS 202 PRO

   GNC ORBIT MNVR EXEC

   ✓RCS SEL – ITEM 4 EXEC (*)

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

Set TIG to Radial Burn + 28 min:
If Posigrade Sep:
TGT PEG 7 ΔVX – ITEM 19 +3 EXEC
ΔVY – ITEM 20 +0 EXEC
ΔVZ – ITEM 21 +0 EXEC
If Retrograde Sep:
TGT PEG 7 ΔVX – ITEM 19 –3 EXEC
ΔVY – ITEM 20 +0 EXEC
ΔVZ – ITEM 21 +0 EXEC

LOAD – ITEM 22 EXEC
TIMER – ITEM 23 EXEC

When RNG > 1000 ft:
DAP: NO LO Z

At TIG –8:00:
DAP: B/AUTO/ALT
MNVR – ITEM 27 EXEC

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

At TIG, deflect THC to null VGOs

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

Inform MCC when SEP complete

GNC, OPS 201 PRO

SHUTTLE NOSE IN–PLANE BREAKOUT (R < 500 ft)

CAUTION
Constraints for use:
Orbiter X and Z axes in–plane
Range ≤ 500 ft cg to cg
Tgt stable on orbiter –Z axis

1. AFT STATION CONFIG
   ✓SENSE: –Z

If RNG < 75 ft:

2. INITIATE CORRIDOR BACKOUT
   ✓DAP: B/AUTO/VERN(PRI), no LO Z

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

When RNG > 75 ft:

3. PERFORM +X OR –X BURN
   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: A/AUTO/VERN(PRI), LO Z
   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: INRTL

   Record (± X) Burn TIG ___/___:___:___

4. PERFORM FINAL BURN (+X Burn, Posigrade/Retrograde and Out–of–Plane)

GNC, OPS 202 PRO

GNC ORBIT MNVR EXEC

✓RCS SEL – ITEM 4 EXEC (*)

✓MCC for breakout direction

NOTE

Posigrade burn will be performed if second docking attempt desired

If Posigrade Sep:

Set TIG to (± X) burn + 30 min:
TGT PEG 7 ΔVX – ITEM 19 +3.5 EXEC
ΔVY – ITEM 20 +3 EXEC
ΔVZ – ITEM 21 +0 EXEC

If Retrograde Sep:

Set TIG to (± X) burn + 30 min:
TGT PEG 7 ΔVX – ITEM 19 –3.5 EXEC
ΔVY – ITEM 20 +3 EXEC
ΔVZ – ITEM 21 +0 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

At TIG, deflect THC to null VGOs

FLT CNTLR PWR – OFF

GNC, OPS 201 PRO

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

RNDZ BREAKOUT

NOTE
This procedure may be performed anytime between Ti and 500 ft

1. BREAKOUT BURN PREP

C3 DAP: A/AUTO/PRI
F7/F8 FLT CNTLR PWR – ON

2. 3 FPS RETROGRADE

CRT OPS 202 PRO

GNC ORBIT MNVR EXEC

✓RCS SEL – ITEM 4 (*)
Set TIG to current time
TGT PEG 7 ΔVX – ITEM 19 –3 EXEC
ΔVY – ITEM 20 +0 EXEC
ΔVZ – ITEM 21 +0 EXEC
LOAD – ITEM 22 EXEC
TIMER – ITEM 23 EXEC
DO NOT MNVR TO BURN ATT
DAP TRANS: as reqd
Deflect THC to null VGOs
F7/F8 FLT CNTLR PWR – OFF

CRT OPS 201 PRO
C3 DAP: A/AUTO/VERN(ALT)

EXPEDITED SEPS

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SHUTTLE EMERGENCY SEPARATION

1. 1st BURN (+Z)
   ✓SENSE: –Z
   DAP: NO LO Z
   ✓DAP: A7(B7)
   ✓FLT CNTLR PWR – ON

   When petals clear:
   DAP: A7/INRTL/VERN(PRI)
   DAP TRANS: PULSE/PULSE/NORM
   THC: +Z (out) 2 sec (~0.6 ft/s)
   Wait 1 min
   THC: +Z (out) 2 sec (~0.6 ft/s)
   Wait 1 min
   THC: +Z (out) 2 sec (~0.6 ft/s)

   Record final Burn TIG ___/___:___:___

   DAP: LO Z

2. 2nd BURN (Out–of–Plane)
   OPS 202 PRO
   GNC ORBIT MNVR EXEC
   RCS SEL – ITEM 4 EXEC (*)

   Set TIG to 1st Burn + 12 min
   TGT PEG 7 ΔVX – ITEM 19 +0 EXEC
   ΔVY – ITEM 20 +5.4 EXEC
   ΔVZ – ITEM 21 +0 EXEC
   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC

   ✓VGO Z ≥ 0; if VGO Z < 0 then:

   * TGT PEG 7 ΔVY – ITEM 20 –5.4 EXEC *
   * LOAD – ITEM 22 EXEC *
   * TIMER – ITEM 23 EXEC *
   * ✓VGO Z ≥ 0 *

   Do not MNVR to BURN ATT

   At TIG –00:30:
   DAP: NO LO Z

   At TIG, deflect THC to null VGOs

   Record second Burn TIG ___/___:___:___

3. 3rd BURN
   If ΔVY(step 2) +5.4:
   TV ROLL – ITEM 5 +2 7 0 EXEC
   If ΔVY(step 2) –5.4:
   TV ROLL – ITEM 5 +9 0 EXEC

Perform OMS BURN no earlier than 6 min after Out–of–Plane Burn

If Deorbit Burn in less than 30 min:
✓MCC/PGSC for Deorbit Burn TIG/PAD
TV ROLL – ITEM 5 +1 8 0 EXEC
Go to EMERGENCY DEORBIT PREP/ENTRY (CONT DEORBIT PREP, EMERGENCY) >>
If PROP leak:
Go to LEAKING OMS PRPLT/He BURN (ORB PKT, OMS) >>

Otherwise:
Set TIG to 2nd BURN + 22 min
TGT PEG 7 ΔVX – ITEM 19 +3.6 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, deflect THC to null VGOs

OPS 201 PRO

ANY ATTITUDE SEPARATION

CAUTION
This procedure is valid for stack angular rates ≤ 0.12 deg/sec per axis

1. 1st BURN (+Z)
   DAP: B9/FREE/VERN(PRI), NO LO Z
   ✓SENSE: –Z
   ✓FLT CNTLR PWR – ON

   When capture latches/hooks open:
   THC: +Z (out) 4 pulses at 10 sec intervals
   Record final pulse TIG ___/___:___:___
   If no spring–assisted separation:
   DAP: FREE
   If spring–assisted separation:
   DAP: INRTL
   THC: as reqd to maintain 8 deg corridor

   At final pulse TIG +3:00 and when RNG > 30 ft (DP to DP):
   DAP: A(B)/INRTL/VERN(PRI)
   THC: as reqd to maintain RDOT > 0.2 fps and maintain 8 deg corridor

   When RNG > 75 ft (DP to DP):
   RCS FWD – ITEM 1 EXEC (*)
   JET DES F1F – ITEM 31 EXEC (no *)
   F2F – ITEM 35 EXEC (no *)
   Config DAP A,B to A7,B7
   DAP: LO Z

2. 2nd BURN (+X)
   When RNG > 150 ft (Interface–to–Interface):
   DAP TRANS: NORM/PULSE/PULSE
   THC: +X (up) for 8 sec (2.0 fps)
   DAP TRANS: PULSE/PULSE/PULSE

3. ROTATE TO PLACE AND MAINTAIN ISS IN OVHD WINDOW
   DAP: A7/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

4. 3rd BURN (Out–Of–Plane)
   When RNG > 1000 ft:
   DAP: NO LO Z
   DAP ROT: DISC/DISC/DISC

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

   Set TIG to current time + 1 min
   TGT PEG 7 ΔVX – ITEM 19 +0 EXEC
   ΔVY – ITEM 20 +2 EXEC
   ΔVZ – ITEM 21 +0 EXEC

   LOAD – ITEM 22 EXEC
   TIMER – ITEM 23 EXEC

✓VGO Z ≥ 0; if VGO Z < 0 then:

```
*  TGT PEG 7 ΔVY  –  ITEM 20 –2 EXEC  *
*  LOAD  –  ITEM 22 EXEC              *
*  TIMER –  ITEM 23 EXEC              *
* ✓VGO Z ≥ 0                         *
```

Do not MNVR to BURN ATT

At TIG, deflect THC to null VGOs

Record 3rd Burn TIG ___/___:___:___

5. 4th BURN (Posigrade/Retrograde)
✓MCC for breakout direction

If Posigrade Sep:
- If ΔVY (step 4) +2:
  - TV ROLL – ITEM 5 +2 7 0 EXEC
- If ΔVY (step 4) –2:
  - TV ROLL – ITEM 5 +9 0 EXEC
- Set TIG to 3rd Burn + 22 min
- TGT PEG 7 ΔVX – ITEM 19 +6.0 EXEC
  ΔVY – ITEM 20 +0 EXEC
  ΔVZ – ITEM 21 +0 EXEC

If Retrograde Sep:
- If ΔVY (step 4) +2:
  - TV ROLL – ITEM 5 +9 0 EXEC
- If ΔVY (step 4) –2:
  - TV ROLL – ITEM 5 +2 7 0 EXEC
- Set TIG to 3rd Burn + 22 min
- TGT PEG 7 ΔVX – ITEM 19 –6.0 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:
- DAP: A/INRTL/PRI

At TIG, deflect THC to null VGOs
FLT CNTLR PWR – OFF
DAP: A/INRTL/VERN(ALT)
GNC, OPS 201 PRO

Ti DELAY BURN

1. OPS 202 PRO
   GNC ORBIT MNVR EXEC
   Load Ti Delay Pad, 3–8

   If RCS:
   Perform RCS BURN (Cue Card)

   If OMS:
   Perform RNDZ OMS BURN, 5–4

2. Reload new BASETIME per MCC
   GNC 34 ORBIT TGT
   TGT NO – ITEM 1 +1 EXEC
   Set BASETIME to new Ti TIG ___/___:___:___
   Load – ITEM 26 EXEC
   Reset ET, SM timers to new Ti TIG

3. Perform Post Ti Nav 16A, 4–16, then

   Return to RENDEZVOUS TIMELINE at PET: –01:15, 4–11

   NOTE
   Extra NCC Burn and Ti Onboard Solution pads, 5–26

NCC BURN SOLUTION

TIG ___ ___ ___ / ___ ___ : ___ ___ : ___ ___

	PRELIMINARY	INTERMEDIATE
ΔVX	( ) ___ ___ . ___	( ) ___ ___ . ___
ΔVY	( ) ___ ___ . ___	( ) ___ ___ . ___
ΔVZ	( ) ___ ___ . ___	( ) ___ ___ . ___
ΔVT	___ ___ . ___	___ ___ . ___

	FINAL	GROUND	FINAL–GROUND LIMITS
ΔVX	( ) ___ ___ . ___	( ) ___ ___ . ___	(.)
ΔVY	( ) ___ ___ . ___	( ) ___ ___ . ___	(.)
ΔVZ	( ) ___ ___ . ___	( ) ___ ___ . ___	(.)
ΔVT	___ ___ . ___	___ ___ . ___	

Ti ONBOARD SOLUTIONS

PREL FLTR	1ST INTER FLTR	2ND INTER FLTR (IF REQD)
( ) ___ ___ . ___	( ) ___ ___ . ___	( ) ___ ___ . ___
( ) ___ ___ . ___	( ) ___ ___ . ___	( ) ___ ___ . ___
( ) ___ ___ . ___	( ) ___ ___ . ___	( ) ___ ___ . ___
___ ___ . ___	___ ___ . ___	___ ___ . ___

FINAL FLTR	PROP (IF REQD)	FINAL–GROUND LIMITS
( ) ___ ___ . ___	( ) ___ ___ . ___	( ) ___ ___ . ___
( ) ___ ___ . ___	( ) ___ ___ . ___	( ) ___ ___ . ___
( ) ___ ___ . ___	( ) ___ ___ . ___	( ) ___ ___ . ___
___ ___ . ___	___ ___ . ___	___ ___ . ___

FINAL Ti PAD (MNVR PADS)

RNDZ NAV RECOVERY

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

   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 UNV PTG

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

   TRK – ITEM 19 (CUR – *)

C3 3. DAP: ALT
   DAP: A/AUTO
   DAP ROT: DISC/DISC/DISC
   When in attitude, DAP: VERN

   If NAV sensor data available:
      If STRK NAV:
         Go to STAR TRACKER NAV 10A , 4–10 >>
      If RR NAV:
         GNC 33 REL NAV
CRT
         KU ANT ENA – ITEM 2 (*)
         GNC I/O RESET
         Go to RR NAVIGATION 13B, 4–13

LOSS OF VRCS

NOTE

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

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

COAS NAV cannot be performed if VERN fail

Attitude deadbands must be increased to 2 deg for TORVA (per Approach Cue Card) and for flyarounds (per Separation timeline, 2–9)

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

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

Twelve hooks reqd for mated attitude control in ALT

LOSS OF LO Z BRAKING

No NORM Z braking allowed between 1000 ft and 75 ft

During approach:
- ✓DAP: LO Z/NO LO Z per VBAR APPROACH (Cue Card)
  - Continue approach; if braking reqd, then:
  - If prior to +VBAR arrival:
    - Wait for natural RDOT bleed–down
  - If on +VBAR:
    - When R < 75 ft, perform NO LO Z braking per VBAR APPROACH (Cue Card)

For Undocking and Separation:
- Perform nominal corridor sep through 150 ft
- Do not perform +Z translations when 75 < RNG < 150 ft
- When RNG > 150 ft (DP–DP), go to VBAR BREAKOUT, 5–14

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 >>

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STS–113 ISS RNDZ OPS DAP CONFIGURATIONS

	RNDZ		TERMINAL PHASE		PROX OPS		DOCKING	
	A7	B7	A8	B8	A9	B9	A10	B10
PRI								
ROT RATE	0.2000	0.5000	0.0500	0.0500	0.1300	0.1300	0.0500	0.0500
ATT DB	2.00	2.00	2.00	2.00	1.00	1.00	0.50	0.50
RATE DB	0.20	0.20	0.20	0.20	0.10	0.10	0.10	0.10
ROT PLS	0.10	0.04	0.10	0.04	0.10	0.04	0.10	0.04
COMP	.000	.000	.000	.000	.000	.000	.000	.000
P OPTION	ALL	ALL	ALL	ALL	TAIL	TAIL	TAIL	TAIL
Y OPTION	ALL	ALL	ALL	ALL	TAIL	TAIL	TAIL	TAIL
TRANS PLS	0.10	0.05	0.10	0.05	0.05	0.01	0.05	0.01
ALT								
RATE DB	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
JET OPT	ALL	ALL	ALL	ALL	TAIL	TAIL	TAIL	TAIL
# JETS	2	2	2	2	2	2	2	2
ON TIME	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
DELAY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VERN								
ROT RATE	0.0160	0.2000	0.0500	0.0500	0.1300	0.1300	0.0500	0.0500
ATT DB	1.000	1.000	1.000	1.000	1.000	1.000	0.500	0.500
RATE DB	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
ROT PLS	0.010	0.002	0.050	0.020	0.050	0.020	0.050	0.020
COMP	.000	.000	.000	.000	.000	.000	.000	.000
CNTL ACC	0	0	0	0	0	0	0	0

POST–CONTACT THRUST (PCT) REFERENCE DATA

PBI FUNCTION WHENEVER IN OPS 2:

PBI	When PCT is disarmed. . .	When PCT is armed. . .	When PCT is active. . .
L or R AUTO SB PBI (PBI lit when PCT armed/active)	Arms PCT	Disarms PCT	Disarms and Terminates PCT [1]
L AUTO/MAN BF PBI or DAP: Spare PBI (PBI lit when PCT active)	No Effect	Modes to DAP: FREE/PRI and activates PCT [2]	Terminates PCT [1]
DAP: FREE PBI	Normal Function	Normal Function	Terminates PCT [1]

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

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

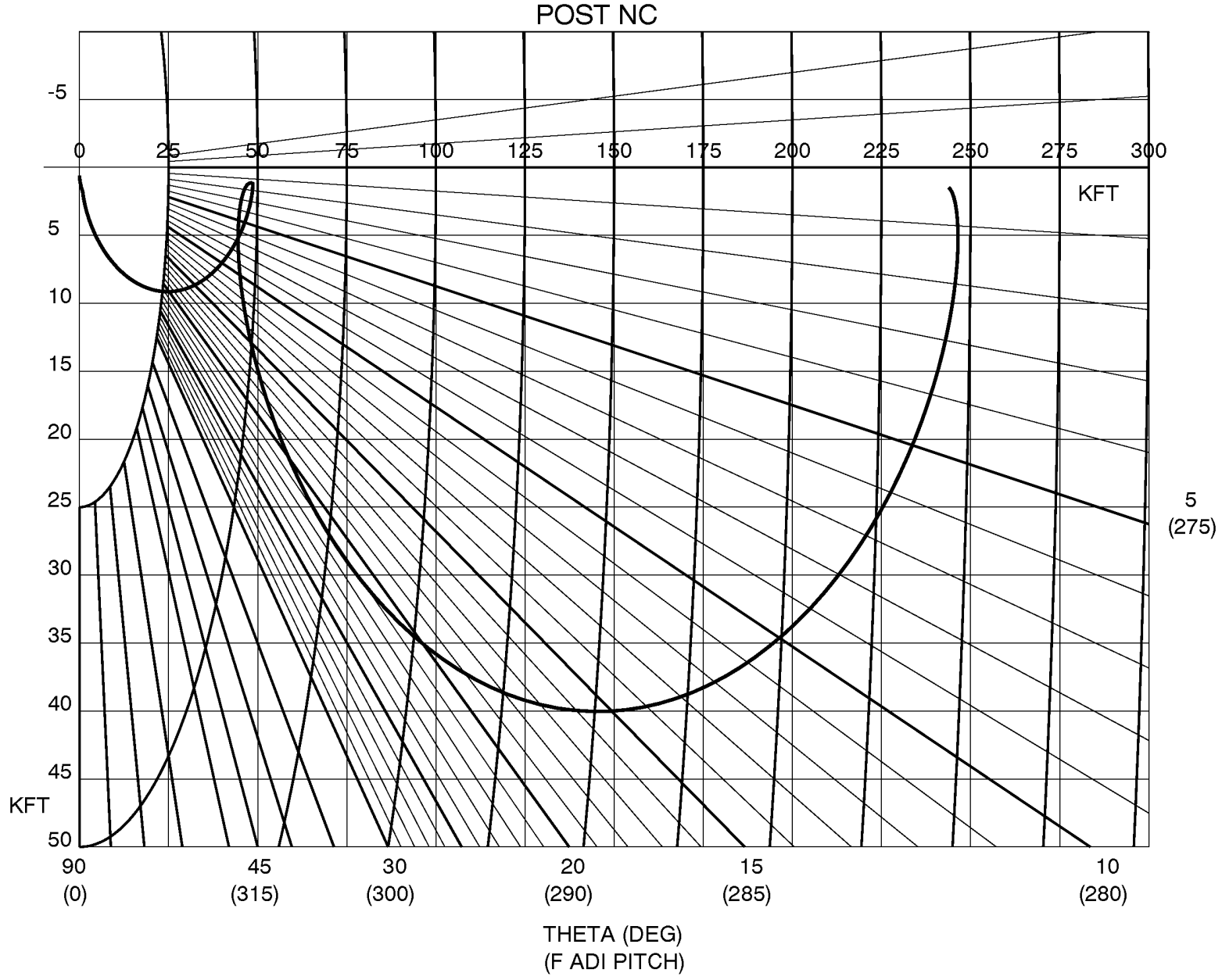
- PCT firing sequence can also be aborted by taking RHC/THC out of detent

TARGETING DATA

SPEC 34 ITEM NO	1			6	17	18	19	20	
TGT ALTITUDE	TGT NO	DESCRIPTION	T1 REL TO BASETIME	EL (DEG)	DT (MIN)	DX (KFT)	DY (KFT)	DZ (KFT)	NOTES
	9	NCC	–0/00:55:48	0	55.8	–48.6	0	+1.2	BASETIME = Ti TIG
	10	Ti	0/00:00:00	0	74.4	–0.9	0	+1.8	
	11	MC1	0/00:20:00	0	54.4	–0.9	0	+1.8	
130	12	MC2	0/00:47:24	28.45	27.0	–0.9	0	+1.8	
	13	MC3	0/00:17:00	0	10.0	–0.9	0	+1.8	BASETIME = MC2 TIG
	14	MC4	0/00:27:00	0	13.0	0	0	+0.6	
	19	MC2 ON TIME	0/00:00:00	0	27.0	–0.9	0	+1.8	
	9	NCC	–0/00:56:18	0	56.3	–48.6	0	+1.2	BASETIME = Ti TIG
	10	Ti	0/00:00:00	0	75.1	–0.9	0	+1.8	
	11	MC1	0/00:20:00	0	55.1	–0.9	0	+1.8	
150	12	MC2	0/00:48:06	28.46	27.0	–0.9	0	+1.8	
	13	MC3	0/00:17:00	0	10.0	–0.9	0	+1.8	BASETIME = MC2 TIG
	14	MC4	0/00:27:00	0	13.0	0	0	+0.6	
	19	MC2 ON TIME	0/00:00:00	0	27.0	–0.9	0	+1.8	
	9	NCC	–0/00:56:48	0	56.8	–48.6	0	+1.2	BASETIME = Ti TIG
	10	Ti	0/00:00:00	0	75.7	–0.9	0	+1.8	
	11	MC1	0/00:20:00	0	55.7	–0.9	0	+1.8	
170	12	MC2	0/00:48:42	28.66	27.0	–0.9	0	+1.8	
	13	MC3	0/00:17:00	0	10.0	–0.9	0	+1.8	BASETIME = MC2 TIG
	14	MC4	0/00:27:00	0	13.0	0	0	+0.6	
	19	MC2 ON TIME	0/00:00:00	0	27.0	–0.9	0	+1.8	
	9	NCC	–0/00:57:12	0	57.2	–48.6	0	+1.2	BASETIME = Ti TIG
	10	Ti	0/00:00:00	0	76.3	–0.9	0	+1.8	
	11	MC1	0/00:20:00	0	56.3	–0.9	0	+1.8	
190	12	MC2	0/00:49:18	28.85	27.0	–0.9	0	+1.8	
	13	MC3	0/00:17:00	0	10.0	–0.9	0	+1.8	BASETIME = MC2 TIG
	14	MC4	0/00:27:00	0	13.0	0	0	+0.6	
	19	MC2 ON TIME	0/00:00:00	0	27.0	–0.9	0	+1.8	
	9	NCC	–0/00:57:42	0	57.7	–48.6	0	+1.2	BASETIME = Ti TIG
	10	Ti	0/00:00:00	0	76.9	–0.9	0	+1.8	
	11	MC1	0/00:20:00	0	56.9	–0.9	0	+1.8	
210	12	MC2	0/00:49:54	29.07	27.0	–0.9	0	+1.8	
	13	MC3	0/00:17:00	0	10.0	–0.9	0	+1.8	BASETIME = MC2 TIG
	14	MC4	0/00:27:00	0	13.0	0	0	+0.6	
	19	MC2 ON TIME	0/00:00:00	0	27.0	–0.9	0	+1.8	

TARGETING DATA (Cont)

SPEC 34 ITEM NO	1			6	17	18	19	20	
TGT ALTITUDE	TGT NO	DESCRIPTION	T1 REL TO BASETIME	EL (DEG)	DT (MIN)	DX (KFT)	DY (KFT)	DZ (KFT)	NOTES
	9	NCC	–0/00:58:12	0	58.2	–48.6	0	+1.2	BASETIME = Ti TIG
	10	Ti	0/00:00:00	0	77.6	–0.9	0	+1.8	
	11	MC1	0/00:20:00	0	57.6	–0.9	0	+1.8	
230	12	MC2	0/00:50:36	29.32	27.0	–0.9	0	+1.8	
	13	MC3	0/00:17:00	0	10.0	–0.9	0	+1.8	BASETIME = MC2 TIG
	14	MC4	0/00:27:00	0	13.0	0	0	+0.6	
	19	MC2 ON TIME	0/00:00:00	0	27.0	–0.9	0	+1.8	
	9	NCC	–0/00:58:42	0	58.7	–48.6	0	+1.2	BASETIME = Ti TIG
	10	Ti	0/00:00:00	0	78.2	–0.9	0	+1.8	
	11	MC1	0/00:20:00	0	58.2	–0.9	0	+1.8	
250	12	MC2	0/00:51:12	29.55	27.0	–0.9	0	+1.8	
	13	MC3	0/00:17:00	0	10.0	–0.9	0	+1.8	BASETIME = MC2 TIG
	14	MC4	0/00:27:00	0	13.0	0	0	+0.6	
	19	MC2 ON TIME	0/00:00:00	0	27.0	–0.9	0	+1.8	
	9	NCC	–0/00:59:06	0	59.1	–48.6	0	+1.2	BASETIME = Ti TIG
	10	Ti	0/00:00:00	0	78.9	–0.9	0	+1.8	
	11	MC1	0/00:20:00	0	58.9	–0.9	0	+1.8	
270	12	MC2	0/00:51:54	29.80	27.0	–0.9	0	+1.8	
	13	MC3	0/00:17:00	0	10.0	–0.9	0	+1.8	BASETIME = MC2 TIG
	14	MC4	0/00:27:00	0	13.0	0	0	+0.6	
	19	MC2 ON TIME	0/00:00:00	0	27.0	–0.9	0	+1.8	
	9	NCC	–0/00:59:36	0	59.6	–48.6	0	+1.2	BASETIME = Ti TIG
	10	Ti	0/00:00:00	0	79.5	–0.9	0	+1.8	
	11	MC1	0/00:20:00	0	59.5	–0.9	0	+1.8	
290	12	MC2	0/00:52:30	30.03	27.0	–0.9	0	+1.8	
	13	MC3	0/00:17:00	0	10.0	–0.9	0	+1.8	BASETIME = MC2 TIG
	14	MC4	0/00:27:00	0	13.0	0	0	+0.6	
	19	MC2 ON TIME	0/00:00:00	0	27.0	–0.9	0	+1.8	
	9	NCC	–0/00:60:06	0	60.1	–48.6	0	+1.2	BASETIME = Ti TIG
	10	Ti	0/00:00:00	0	80.1	–0.9	0	+1.8	
	11	MC1	0/00:20:00	0	60.1	–0.9	0	+1.8	
310	12	MC2	0/00:53:06	30.25	27.0	–0.9	0	+1.8	
	13	MC3	0/00:17:00	0	10.0	–0.9	0	+1.8	BASETIME = MC2 TIG
	14	MC4	0/00:27:00	0	13.0	0	0	+0.6	
	19	MC2 ON TIME	0/00:00:00	0	27.0	–0.9	0	+1.8	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75
100
125
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175
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225
250
275
300
KFT
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10
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5
(275)
90
(0)
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(300)
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(290)
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(285)
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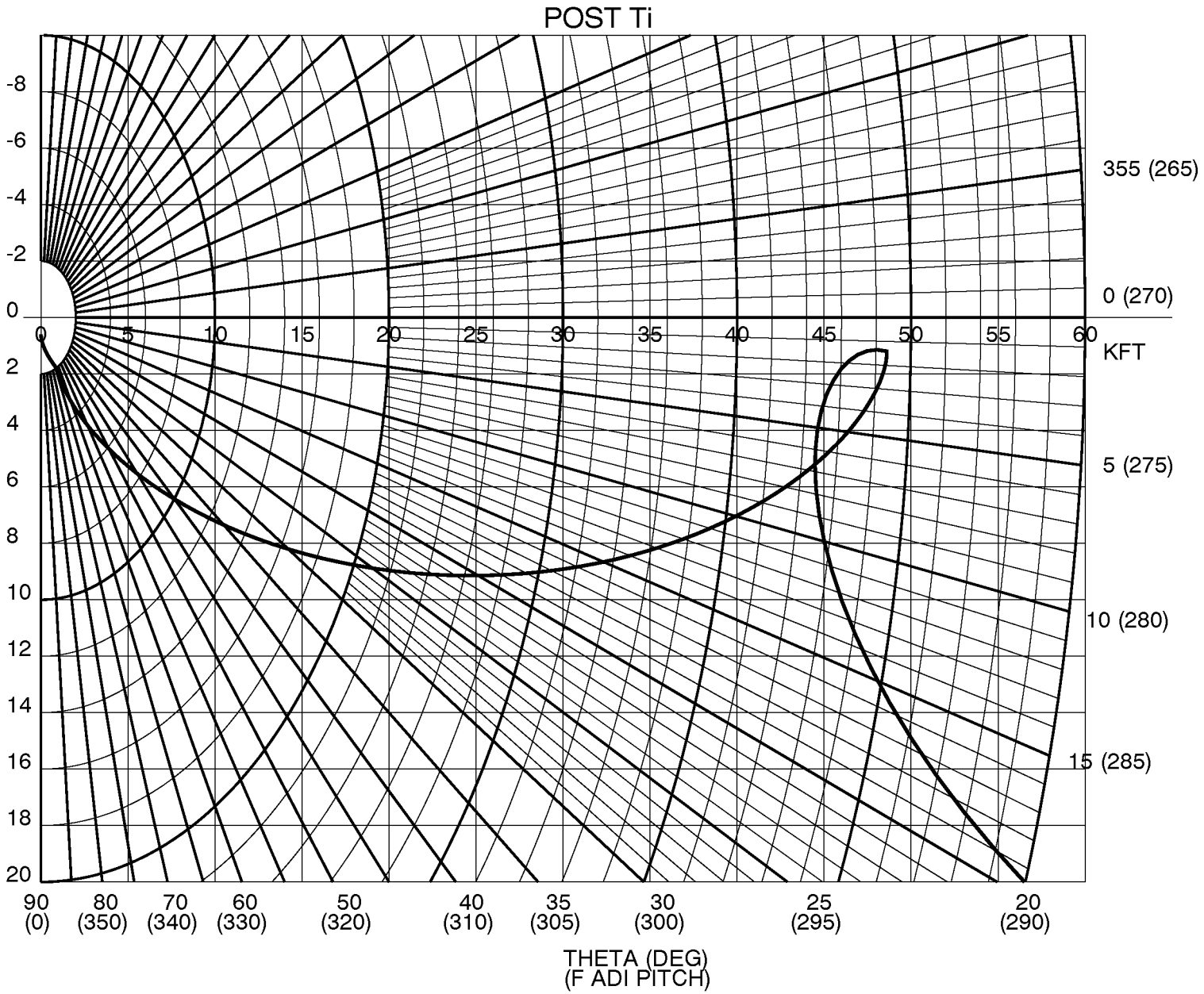
(280)
THETA (DEG)
(F ADI PITCH)


POST Ti
-8
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-4
-2
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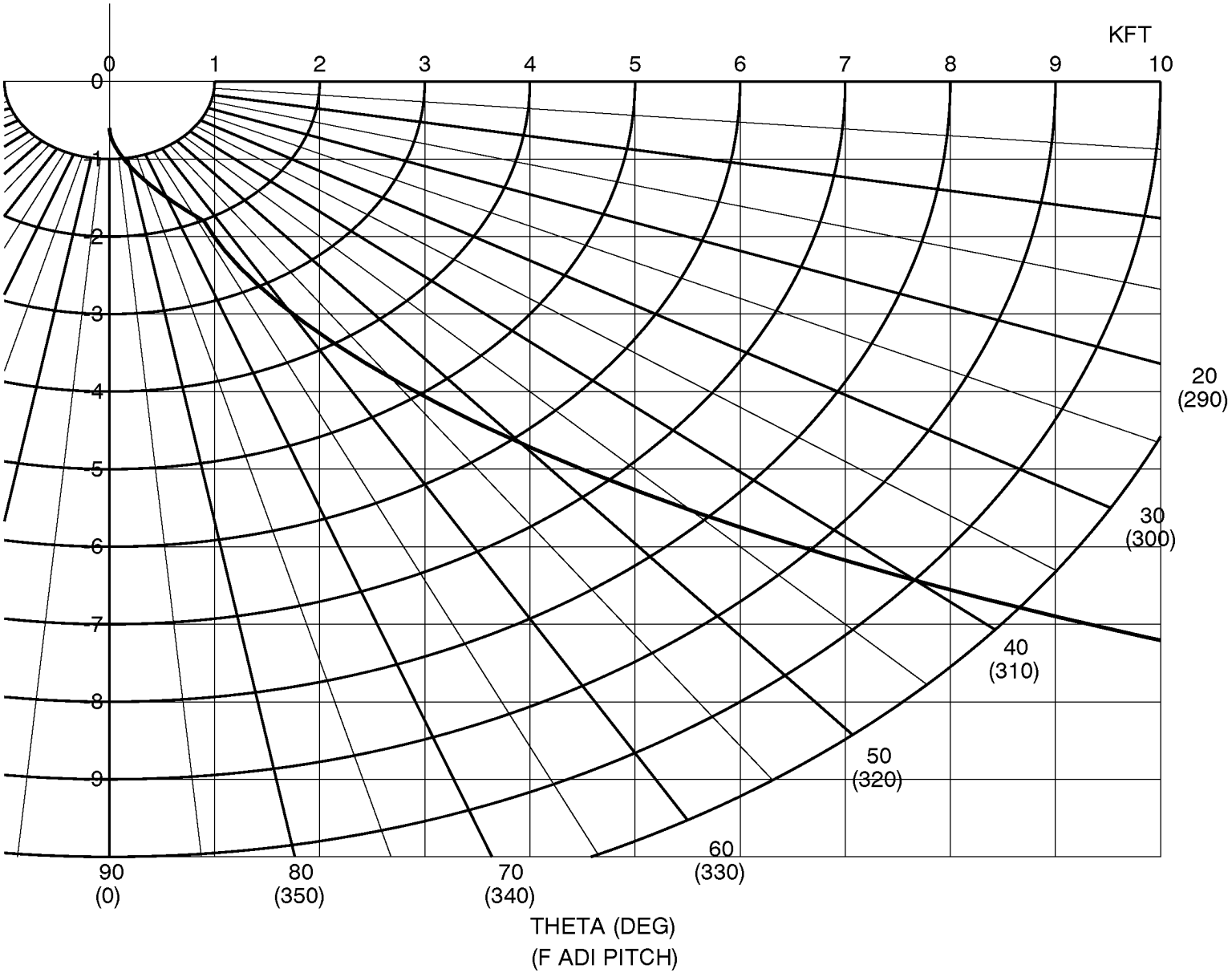
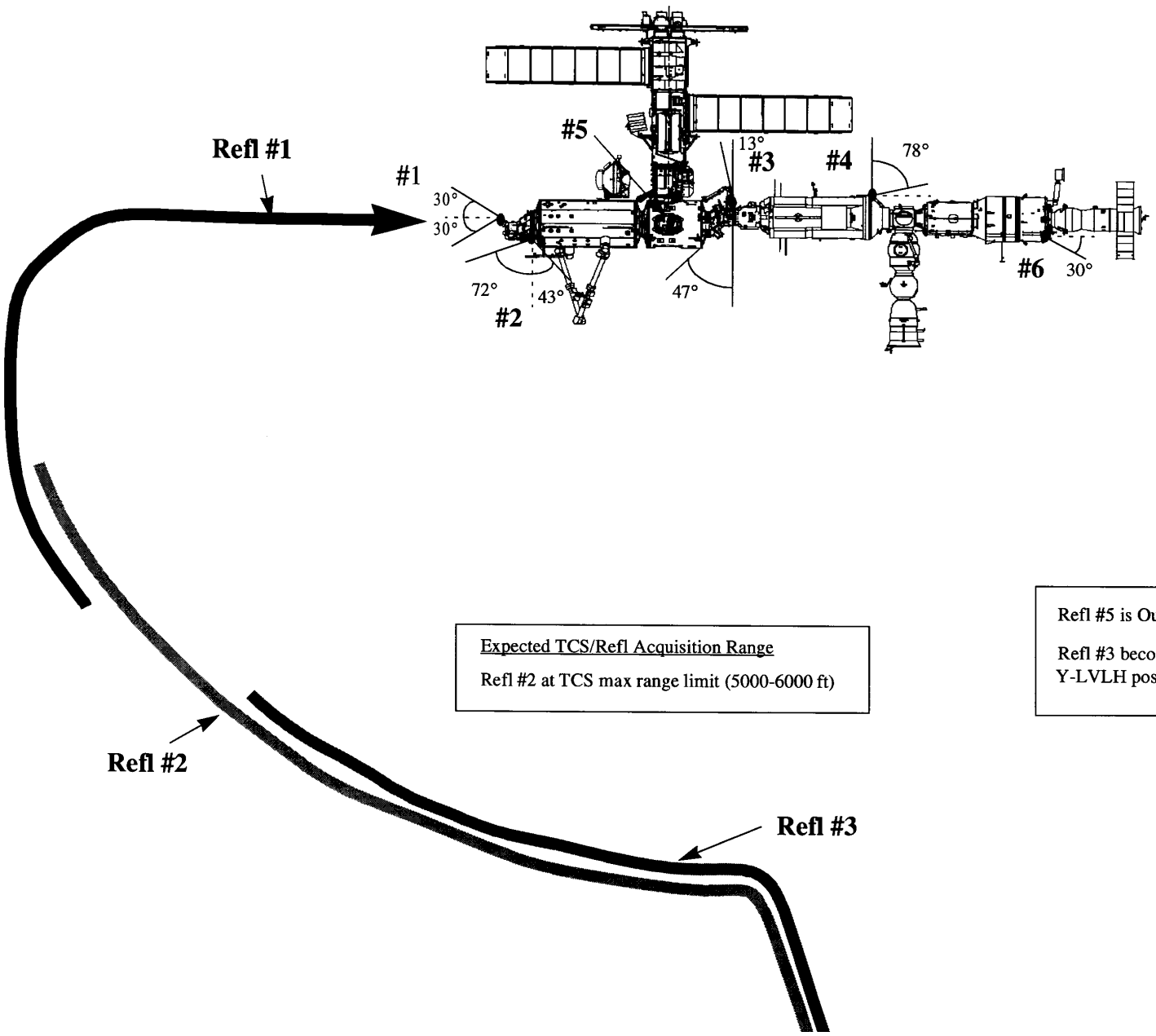
KFT
355 (265)
0 (270)
5 (275)
10 (280)
15 (285)
90 (0)
80 (350)
70 (340)
60 (330)
50 (320)
40 (310)
35 (305)
30 (300)
25 (295)
20 (290)
THETA (DEG)
(F ADI PITCH)

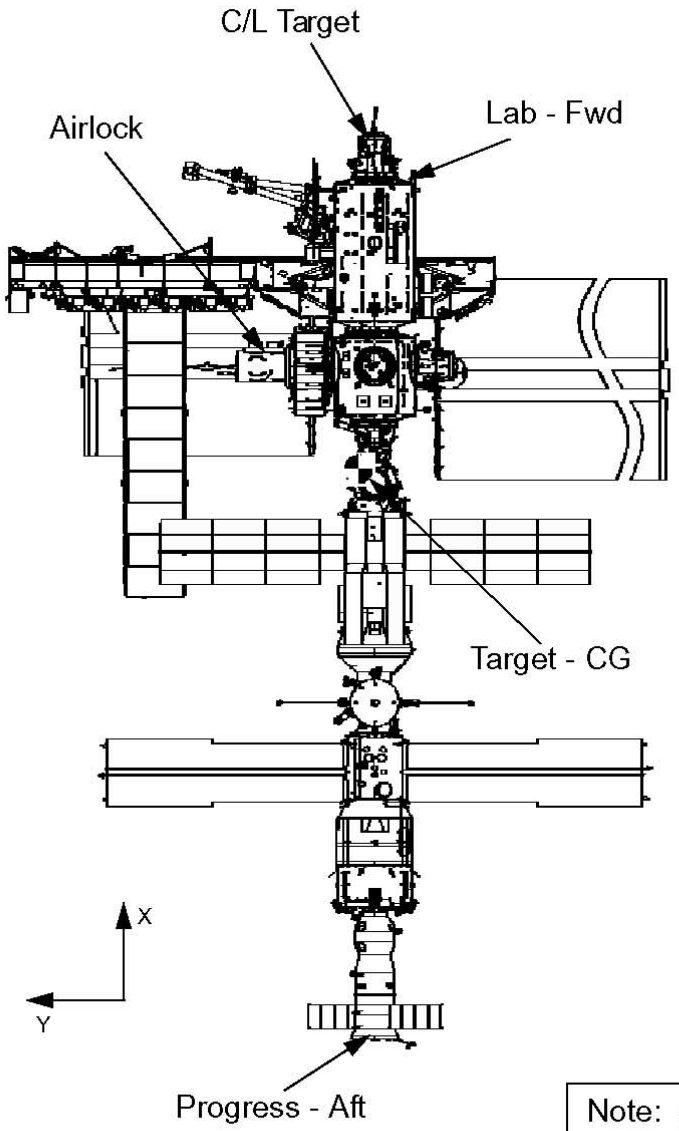
POST MC3

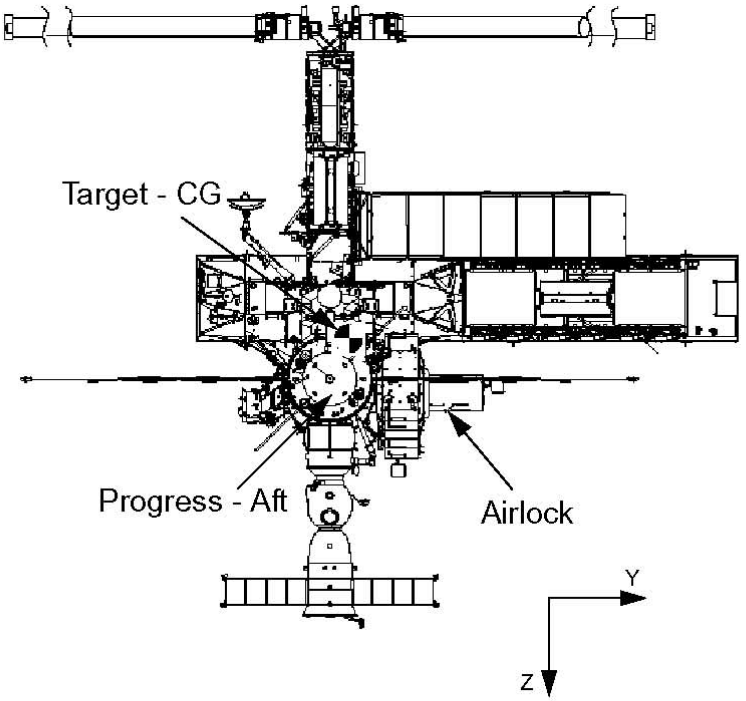

KFT
0
1
2
3
4
5
6
7
8
9
10
20
(290)
30
(300)
40
(310)
50
(320)
60
(330)
90
(0)
80
(350)
70
(340)
THETA (DEG)
(F ADI PITCH)

TCS REFLECTOR VISIBILITY DURING APPROACH FOR FLIGHT ISS–11A (STS–113)



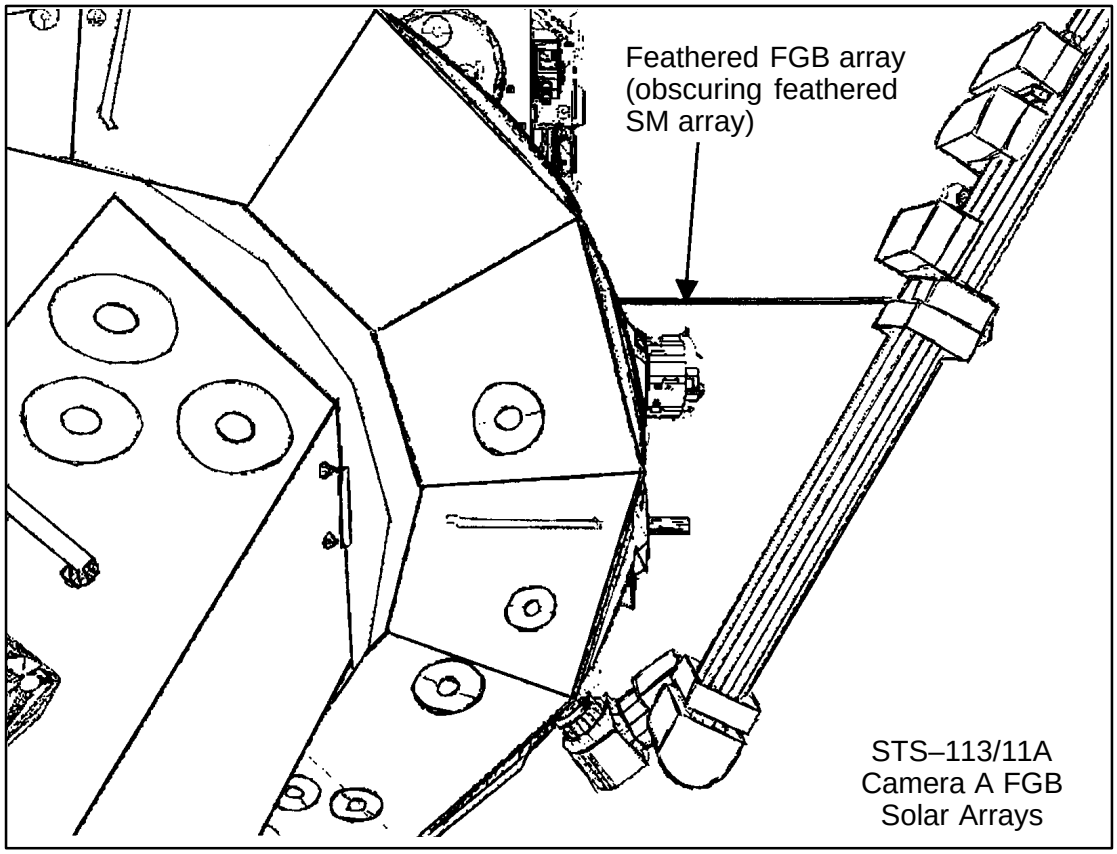
STS–113 HHL AIMING LOCATIONS

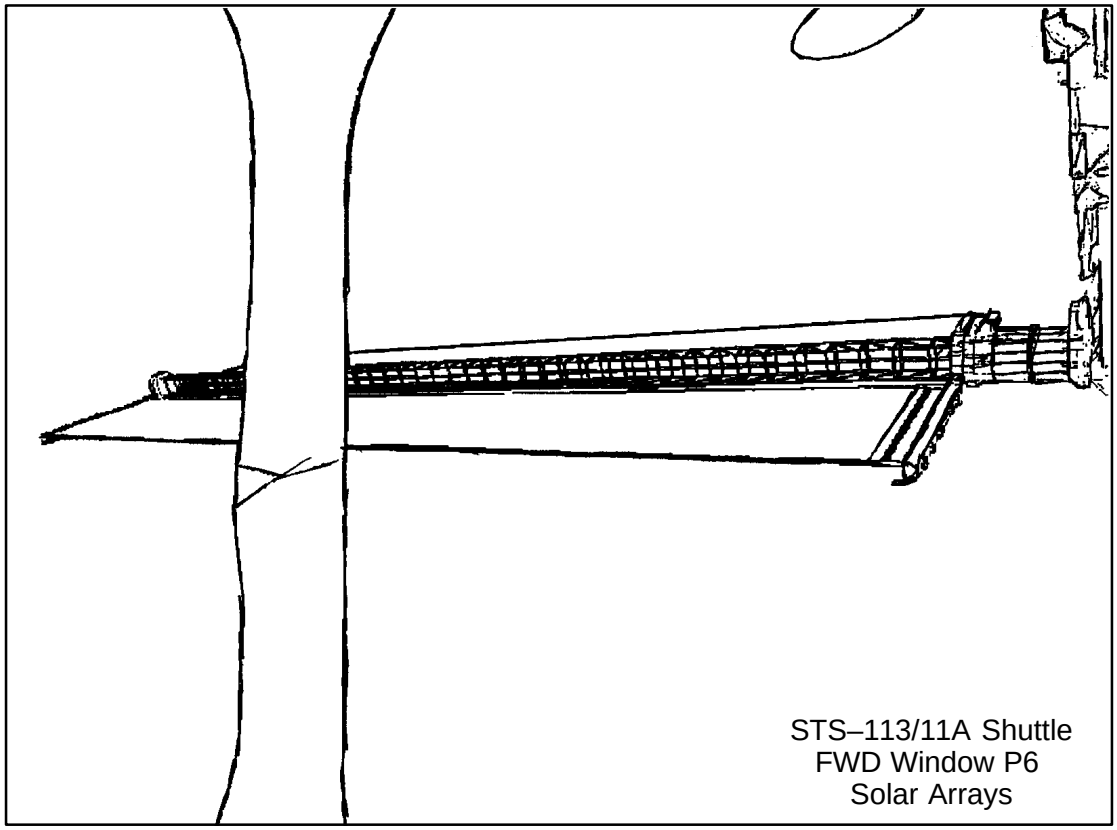




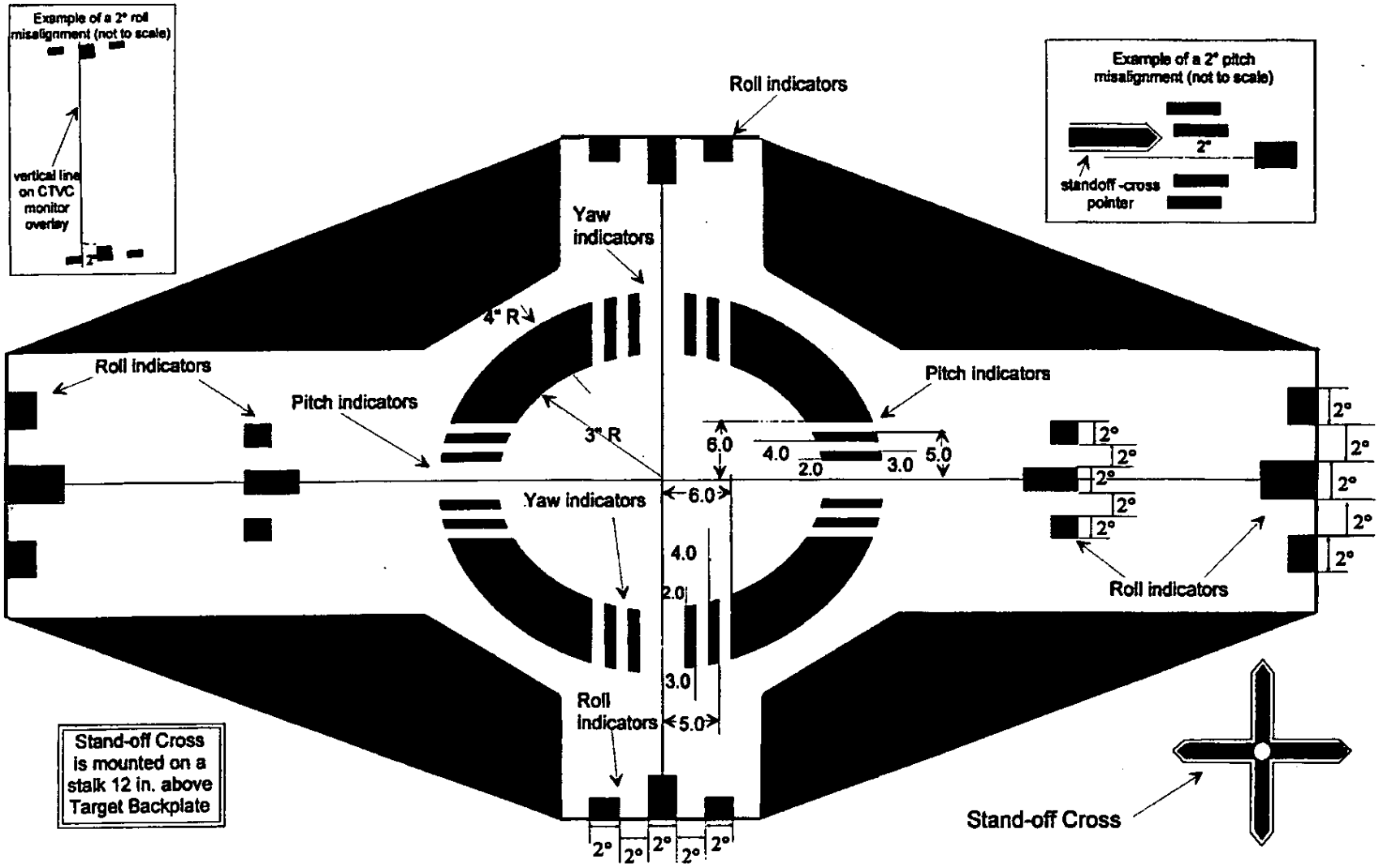
Note: Array Feathering Not Shown

SEPARATION SOLAR ARRAY CONFIGURATION





SHUTTLE CENTERLINE TARGET



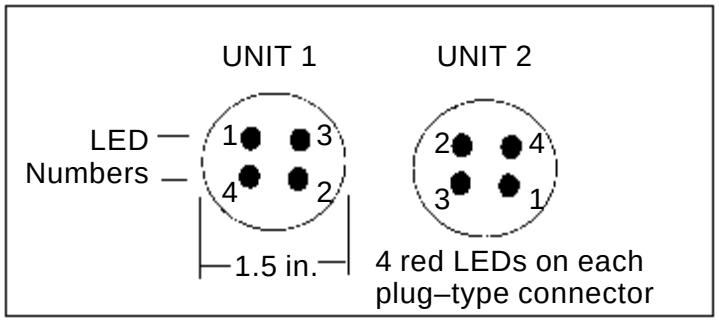
Roll indicators are to be used with the vertical and horizontal lines on the CTVC monitor overlays. All six sets of roll indicators are sized to give roll misalignments in increments of 2 degrees. At least two sets of roll indicators on opposite sides of the target backplate are required during roll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

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

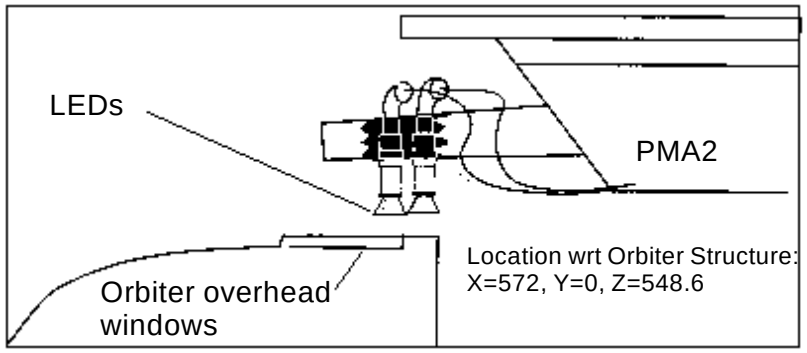
ISS ATTITUDE CONTROL SYSTEM MODING INDICATORS

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

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



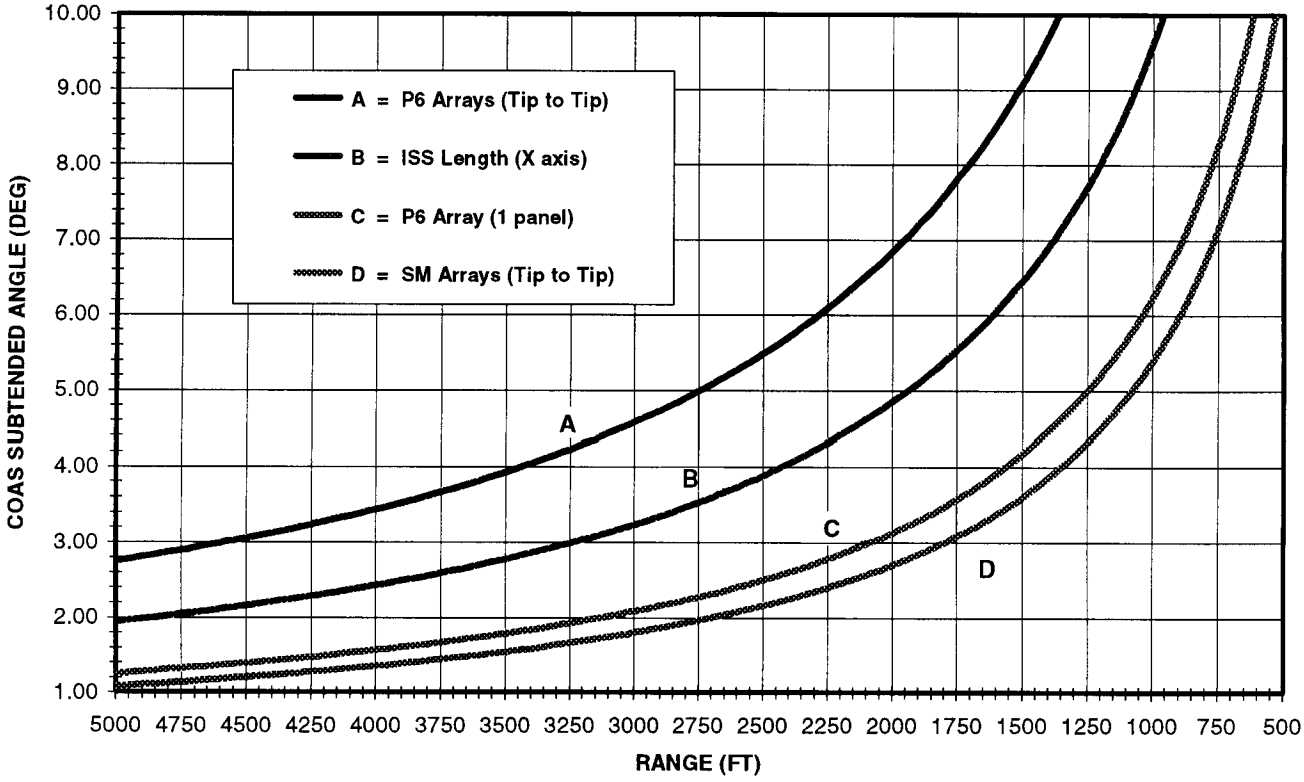
Bottom View



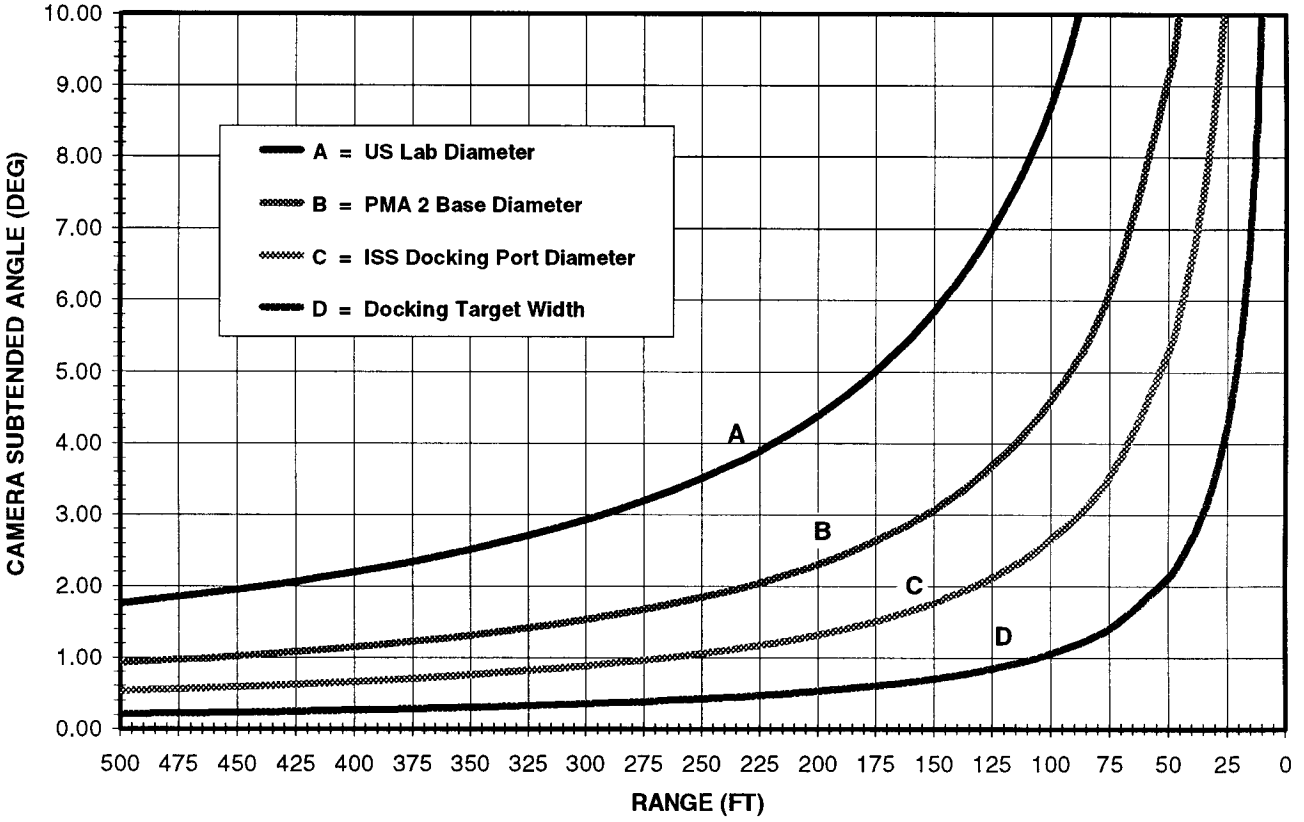
Side View

ISS–11A RANGING CHARTS

COAS SUBTENDED ANGLE VS RANGE



CAMERA SUBTENDED ANGLE VS RANGE



COAS SUBTENDED ANGLES (DEG) VS RANGE (FT)
(SA DIMENSIONS TIP TO TIP)

Deg	US SA	SM SA	FGB SA	Lab Dia.
0.5	27490	11178	9046	1730
1	**13745**	**5589**	**4523**	**865**
1.5	9163	3726	3015	577
2	**6872**	**2794**	**2261**	**433**
2.5	5497	2235	1809	346
3	**4581**	**1863**	**1507**	**288**
3.5	3926	1596	1292	247
4	**3435**	**1397**	**1130**	**216**
4.5	3053	1241	1005	192
5	**2747**	**1117**	**904**	**173**
5.5	2497	1015	822	157
6	**2289**	**931**	**753**	**144**
6.5	2112	859	695	133
7	**1961**	**797**	**645**	**123**
7.5	1830	744	602	115
8	**1715**	**698**	**564**	**108**
8.5	1614	656	531	102
9	**1524**	**620**	**502**	**96**
9.5	1444	587	475	91
10	**1371**	**558**	**451**	**86**
10.5	1305	531	430	82
11	**1246**	**507**	**410**	**78**
11.5	1191	484	392	75
12	**1141**	**464**	**376**	**72**

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RENDEZVOUS TOOLS

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CCTV CONFIG FOR DOCKING/UNDOCKING

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

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

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

3. SET CAMERA ZOOM SETTINGS

CAMERA	ZOOM	OVERLAY
Centerline	40.0° (Corridor)	Corridor
	10.1° (full zoom)	Grid

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

5. ZERO PTU ANGLES
   MON 2 – Camr A
   Zoom to full zoom in
   Center A on B
   MON 2 – Camr B
   Zoom to full zoom in
   Center B on A
   MON 2 – Camr A
   Recenter A on B (slow rate)
   Pan/Tilt – Reset
   MON 2 – Camr B
   Recenter B on A (slow rate)
   Pan/Tilt – Reset

   Repeat for Camrs D,C

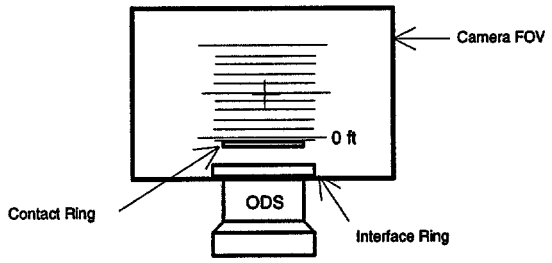
6. CAMERA SETUP – CAMERA A,D

A7 MON 2 – Camr A (Range Ruler), D (Backup Range Ruler)
Zoom = 74.4° FOV (full unzoom), Focus = 12 ft
Pan/Tilt: as reqd for Range Ruler (see figure below)
Tilt: as reqd until bottom of ODS Interface Ring touches bottom of screen (see figure below)

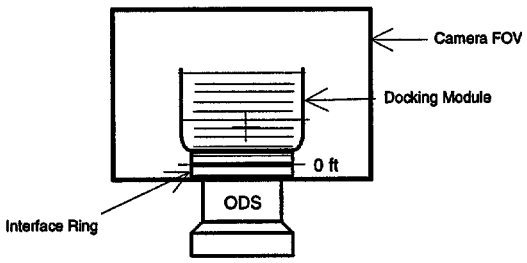
7. FINAL CONFIG FOR APPROACH AND UNDOCKING/SEP
MON 1 – CENTERLINE
MON 2 – RANGE RULER

Install CORRIDOR overlay:
Use green XHair to center overlay

Install RANGE RULER overlay:
Place contact ring line on top of ODS Contact Ring (see figure below)



Camr A,D RANGE RULER View
DOCKING



Camr A,D RANGE RULER View
UNDOCKING

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, UTIL PWR)

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

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

   On MCC GO:
5. Perform TCS ACTIVATION, steps 1 and 2, 7–18

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

7. When checkout complete, perform TCS DEACTIVATION, 7–20, then:
   Exit RPOP – [SHIFT]/[F10], then:
   HHL PWR SW – OFF, then:
   Temp stow Rndz Tools as reqd

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

RNDZ TOOLS TROUBLESHOOTING

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

TCS CADS NOT RECEIVING TCS DATA

1. ✓Windows system tray for PC card icon to verify good connection to MCIU/Quatech card
2. ✓TX/RX end of TCS data cable connected to MCIU/Quatech card COM2
3. ✓Correct port config in TCS CADS s/w
4. Quit and restart TCS CADS
5. Change out TCS data cable and MCIU/Quatech card
6. Reboot PGSC and restart TCS CADS
7. On MCC GO, perform TCS DEACTIVATION, 7–20, followed by TCS ACTIVATION, 7–18
8. ✓MCC

RPOP NOT RECEIVING PCMMU DATA

1. ✓Windows system tray for PC card icon to verify good connection to MCIU/Quatech card
2. ✓Correct end of RS–422 Y data cable connected to MCIU/Quatech card COM4
3. ✓Correct port config in RPOP s/w
4. Quit and restart RPOP
5. Change out RS–422 Y data cable and MCIU/Quatech card
6. Reboot PGSC and restart RPOP
7. ✓MCC

RPOP NOT RECEIVING HHL DATA

1. ✓HHL cable securely connected to HHL unit and COM1
2. ✓RPOP port config set to COM1 for HHL
3. Quit and restart RPOP
4. Reboot RPOP PGSC and restart RPOP
5. Connect HHL cable to backup RPOP PGSC COM1 to check data flow. Swap to backup HHL data cable or backup HHL as reqd
6. ✓MCC

RPOP NOT RECEIVING TCS DATA (TCS CADS IS RECEIVING DATA ON SAME PGSC)

1. ✓RPOP configured to receive TCS data via DLL
2. Quit and restart RPOP
3. Reboot RPOP PGSC and restart RPOP and TCS CADS
4. ✓MCC

HAND–HELD LIDAR CHECKOUT

1. Unstow HHL, Battery Pack(s), and RS–232 cable

   Connect RS–232 cable from HHL to PGSC
   Plug Battery Pack into HHL

   Verify RPOP program enabled per RPOP INITIALIZATION, 7–8

2. Perform HAND–HELD LIDAR OPS, 7–7

3. Take multiple (~10) Range and Velocity measurements using top center of aft PLB bulkhead or S0 Truss Segment as TGT
   ✓HHL data received by RPOP (HHL trajectory source must be selected)

   Range check:
   ✓Range from aft port window to bulkhead = 60 ft
   or
   ✓Range from overhead window to S0 Truss Segment = ~23 ft

   Velocity check:
   Depress trigger for 5 sec
   ✓Velocity = 0.0 fps

   Report range and velocity discrepancies to MCC

   Self–Test: Press and hold Test Mode button, ✓8.8.8.8. Select range

HAND–HELD LIDAR STOW

Power sw – OFF

Remove RS–232 cable
Unplug Battery Pack

Stow HHL, Battery Pack(s), and RS–232 cable

HAND–HELD LIDAR OPS

Power sw – ON

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

Display Intensity knob – Adjust intensity to minimum acceptable level

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

Center red dot on TGT

Depress trigger for each measurement
Hold trigger for velocity measurements

Velocity accuracy increases with trigger hold duration:

Duration	Accuracy
0.5	0.15
1.0	0.06
2.0	0.03
5.0	0.01

As reqd, mount HHL on multiuse arm, in port OVHD window

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, UTIL PWR)

2. From Startup Menu, select appropriate Expansion Chassis config

3. Select Shuttle Apps Icon
   Select RPOP folder
   Select appropriate RPOP icon

   RPOP logo display

   RPOP Initialization

4. Enter current MET:
   Days>____/Hrs>___:Min>___:Sec>___

   Click [OK] to continue

   NOTE

   Time synchronized on [OK]

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

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

6. Update target LVLH attitude as reqd – [SHIFT]/[F6]

   Enter Target Vehicle Attitude Info

   Select appropriate Attitude (PYR Seq.)

   Pitch > _____ Yaw > _____ Roll > _____

   Select appropriate attitude rate

   Enter rates (as reqd)

   Click [OK] to continue

RPOP OPS

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

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

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

   Select [Update MET. . .] button
   Update MET

   Update MET and click [OK] when finished

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

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

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

   NOTE
   TCS source for RPOP must be set to DLL

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

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

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

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

   Select [Average Rdot] button – [A]
   Enter time until docking (countdown time)
   Min > _____
   Sec > _____
   Select [Start]. Timer starts when [Start] pressed
   Click [OK] when finished

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
   [F#–TCS]
   Select Nav option – [N]
   Click [OK] when finished

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

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

   NOTE

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

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

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

RPOP FUNCTION KEY SUMMARY

TRAJECTORY DATA KEYS (Columns F1→F4)

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

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

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

NOTE

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

GENERAL FUNCTION KEYS (Columns F5 → F12)

[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)

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

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

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

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

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

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

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

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

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

Update MET**...**
Change the mission elapsed time

Altitude**...**
Change altitude of target vehicle

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

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

Views**...**
Enable/disable Tgt– and Orb–Centered views

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

THC "What if"**...**
Select DAP setting (trans pulse size) to be used for THC "What if" inputs
Options include**:** Rndz DAP, Prox Ops DAP, and a User–Configurable DAP

GENERAL FUNCTION KEYS (Columns F5 → F12, Cont)

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

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

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

RPOP KEYSTROKE SUMMARY

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

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

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

NOTE

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

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

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

	DAP A8	DAP B8
Z IN	[SHIFT]/[→]	[→]
Z OUT	[SHIFT]/[←]	[←]
X UP	[SHIFT]/[↑]	[↑]
X DOWN	[SHIFT]/[↓]	[↓]

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 resids 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 no

CCTV CLOSED CIRCUIT TELEVISION CAMERAS

Manually enter FWD and AFT CCTV tilt angles

Options include:

Config... – Reconfigure Trajectory Data Source for this function key

TCS TRAJECTORY CONTROL SENSOR

Options include:

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

TCS ACTIVATION

1. CADS BOOTUP

✓RPOP/TCS PGSC powered ON

PGSC ✓Data cables installed per PGSC Usage Chart (if available) or UTILITY OUTLET PLUG–IN PLAN ORBIT CONFIGURATION (REF DATA, 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 *

PGSC TCS Self Test

	Status	Override
✓Shutter:	Passed	Off
✓Z Latch:	Passed	Off
✓CW Laser:	Passed	Off
✓Pulse Laser:	Passed	Off

✓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
✓Skin Trk: Dis
✓Att: Inact

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

PGSC — TCS C&DI

>Macros>SHUTDOWN

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

TCS OPS

✓Shutter: Closed

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

2. SECURE Z AXIS

NOTE

Perform this step only if this final TCS deactivation for mission.
Otherwise, proceed to step 3

> Commands > Lock Z Axis Latch

TCS OPS

✓Z Latch: Locked

* If Z Latch fails to lock: *
* > Commands > Lock Z Axis Latch *

3. POWERDOWN

L12 — TCS PWR – OFF (tb–bp)

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

PGSC — TCS C&DI

> File > Exit TCS CAD

TCS LIMITS

TEMPERATURE (degC)	LOW ALERT	HIGH	
		ALERT	AUTOSAFE
CW Laser	–40.0	45.0	50.0
APD	–40.0	65.0	70.0
CPU	–40.0	80.0	85.0
DC Power	–40.0	80.0	85.0
Galvos	–40.0	80.0	85.0

VOLTAGES	LOW ALERT	HIGH ALERT
5V	4.75	5.25
5.5V	5.00	6.00
12V	11.00	12.75
15V	14.25	15.50

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

Phase	**Prime Source:** Configuration	**Backup Source:** Configuration
1. Manual Takeover thru TCS lock–on (R > 3000 ft assumed for TCS nominal lock–on*)	**State data:** SV	**Rdot window:** HHL FLTR NOTE**:** Configure HHL angle source to Dock Cam and lock angles to 0
2. TCS lock–on thru 15 ft	**State data:** TCS NAV	**Rdot window:** HHL FLTR NOTE**:** Configure HHL angle source to Dock Cam and lock angles to 0
3. 15 ft thru dock	**Rdot Window:** Range Ruler (F12) **Raw data:** TCS Raw	

*If no joy on TCS lock–on by 1200 ft, start subtended angle operations so that subtended angle estimates can back up the HHL Fltr inside of 1000 ft

RADAR FAIL

Phase	Prime Source: Configuration	Backup Source: Configuration
1. Manual Takeover thru TCS lock–on* NOTE: RPOP State data: (HHL/SV) can be suspect	**Rdot window:** HHL FLTR & HHL/Dt NOTE: Configure HHL angle source to Dock Cam and lock angles to 0	**Rdot window:** Subtended angles
2. TCS lock–on thru 15 ft	**State data:** TCS NAV	**Rdot window:** HHL FLTR NOTE: Configure HHL angle source to Dock Cam and lock angles to 0
3. 15 ft thru dock	**Rdot Window:** Range Ruler(F12) **Raw data:** TCS Raw	

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

TCS FAIL

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

*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 can not 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

Phase	Prime Source: Configuration	Backup Source: Configuration
1. Manual Takeover thru TCS lock–on	**State data:** SV	**Rdot window:** Subtended Angle
2. TCS lock–on thru 15 ft	**State data:** TCS NAV	**Spec 33:** Raw RR* **Rdot window:** Subtended Angle
3. 15 ft thru dock	**Rdot Window:** Range Ruler(F12) **Raw data:** TCS Raw	

*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

Phase	Prime Source: Configuration	Backup Source: Configuration
1. Manual Takeover thru ~1200 ft NOTE: Transition from phase 1 to 2 should be gradual. Start transition at ~1500 ft and complete it prior to 1000 ft braking gate NOTE: RPOP state data is bad	**Spec 33:** FLTR	**Rdot window:** HHL/Dt 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" **TCS CADS:** Raw TCS (pulse active) NOTE: Range data good, rdot can be quite noisy NOTE: Resize and reposition the RPOP window so that the TCS mode (pulse/CW) is visible
2. ~1200 ft thru TCS CW lock–on(~800 ft) NOTE: RPOP State data is bad	**Rdot window:** HHL/Dt NOTE: RPOP uses the last two marks with Dt > 30 sec to calculate the Rdot estimate	**TCS CADS:** Raw TCS (pulse active) NOTE: Range data good, rdot can be quite noisy **Rdot window:** Generic NOTE: Manually enter raw TCS range marks. RPOP uses the last two marks with Dt > 30 sec to calculate the Rdot estimate
3. TCS CW lock–on (~800 ft) thru Vbar arrival NOTE: RPOP State data is bad	**TCS CADS:** Raw TCS (cw active)	**Rdot window:** HHL/Dt
4. Vbar arrival thru 15 ft	**TCS CADS:** Raw TCS (cw active) and/or **State Data:** TCS AUTO NOTE: Check Orb Att = (90/0/0), and set TCS frequency to 30 sec[CNTRL F10]	**Rdot window:** HHL/Dt
5. 15 ft thru dock	**TCS CADS:** TCS Raw (cw active) **Rdot window:** Range Ruler(F12)	

*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)

Phase	Prime Source: Configuration	Backup Source: Configuration
1. Manual Takeover thru ~1200 ft (noisy RR angles)	**Spec 33:** SV, Raw RR	For range – **HHL (back of unit):** Raw HHL For Rdot – **Rdot vs. ΔRng/Δt Cue Card:** Record Raw HHL range and times on cue card
2. ~1200 ft thru 15 ft	For Range: **HHL (back of unit):** Raw HHL(short pulls) For Rdot: **HHL (back of unit):** Raw HHL(long pulls)	For range – **Subtended Angle table(6–16):** COAS or Centerline Cam subtended angle For Rdot– **Rdot vs. ΔRng/Δt Cue Card:** Record subtended angle range and times on cue card
3. 15 ft thru dock	For Range: **Range Ruler Overlay:** Camera A/D For Rdot: **HHL (back of unit):** Raw HHL (long trigger pulls) **Rdot table on Range Ruler Overlay:** Dt between 1 ft DRange	

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APDS

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APDS NOMINAL

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DOCKING MECHANISM INITIALIZATION

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

A7L 2. ✓CNTL PNL PWR A,B,C (three) – OFF
✓HTRS/DCU PWR (three) – OFF
✓APDS PWR A_{DS},B_{DS},C_{DS} (three) – OFF
✓A_{DS},B_{DS},C_{DS} lts (three) – off
✓STATUS lts (eighteen) – off
✓PYROS A_P,B_P,C_P (three) – OFF
✓A_P,B_P,C_P lts (three) – off
✓PYRO CIRC PROT OFF lt – off

A6L 3. SYS PWR MN A,MN B (two) – ON (hold 5 sec)
✓SYS 1, SYS 2 tb (two) – ON
✓VEST DEP VLV SYS 1,SYS 2 VENT (two) – ctr (tb–CL)
✓ISOL (two) – ctr (tb–CL)
cb ESS 1BC DEP SYS 1 VENT ISOL – op
2CA DEP SYS 2 VENT ISOL – op
MN A DEP SYS 1 VENT – op
B DEP SYS 2 VENT – op
✓VEST DEP VLV SYS 1,SYS 2 VENT tb (two) – bp
✓ISOL tb (two) – bp
ML86B:C cb MNA EXT ARLK HTR VEST Z1/2/3 – cl

APDS NOMINAL

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. HTRS/DCU PWR (three) – ON
CRT ✓ PWR – A/B/C
✓RNG DR BUS – 1/2
✓HKS DR BUS – 1/2
✓DAMPER BUS – 1/2
✓FIXER BUS – 1/2

A7L 3. CNTL PNL PWR A,B,C (three) – ON
CRT ✓PWR – A/B/C

A7L 4. APDS PWR A_{DS},B_{DS},C_{DS} (three) – ON
✓A_{DS},B_{DS},C_{DS} lts (three) – on
CRT ✓APDS PWR – A/B/C

A7L 5. LAMP TEST pb – push
✓STATUS lts (eighteen) – on
✓PYRO CIRC PROT OFF lt – on

* If CNTL PNL PWR A(C) tlm blank, and STATUS lts nominal, tlm failure only >> *
* If CNTL PNL PWR B tlm blank: *
* CNTL PNL PWR A(C) – OFF *
* PWR ON pb – push (✓ and report STATUS lts to MCC) *
* If any STATUS lts – on, tlm failure only *
* CNTL PNL PWR A(C) – ON *

DOCKING MECHANISM POWERDOWN

SM 167 DOCKING STATUS

A7L 1. ✓STATUS lts (eighteen) – off

2. APDS PWR A_{DS},B_{DS},C_{DS} (three) – OFF
✓A_{DS},B_{DS},C_{DS} lts (three) – off
CRT ✓APDS PWR (three) – blank

A7L 3. CNTL PNL PWR A,B,C (three) – OFF
CRT ✓CNTL PNL PWR A,B,C (three) – blank

A7L 4. HTRS/DCU PWR (three) – OFF
CRT ✓HTRS/DCU PWR (three) – blank

A6L 5. PSU PWR MN A, MN B (two) – OFF

6. If post–undocking:
VEST DEP VLV SYS 1 (SYS 2) VENT – CL (hold 5 sec) (tb–CL)
ISOL – CL (hold 5 sec) (tb–CL)
cb MNA DEP SYS 1 VENT – op
✓MNB DEP SYS 2 VENT – op
ESS 1BC DEP SYS 1 VENT ISOL – op
✓2CA DEP SYS 2 VENT ISOL – op
ML86B:C MNB (MNA) EXT ARLK HTR VEST Z1/2/3 – op

DOCKING PREP

SM 167 DOCKING STATUS

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

A7L 2. PWR ON pb – push (lt on)
✓RING ALIGNED lt – on
✓INIT POS lt – on
✓HOOKS 1,HOOKS 2 OP lts (two) – on
✓LAT CL 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. PWR ON pb – push (lt on)
✓RING ALIGNED lt – on
✓RDY TO HK lt – on
✓INTERF SEALED lt – on
✓HOOKS 1,HOOKS 2 CL lts (two) – on
✓LAT OP lt – on
✓RING FNL POS lt – on

DOCKING RING EXTENSION

SM 167 DOCKING STATUS

A7L 1. PWR ON pb – push
✓lt – on
✓RING ALIGNED lt – on
✓HOOKS 1,HOOKS 2 OP lt (two) – ON
✓LAT CL lt – on
✓RING FNL POS lt – on
CRT ✓CLUTCH – LOCK/blank

A7L 2. APDS CIRC PROT OFF pb – push (lt on)

0:00 3. RING OUT pb – push
0:10 ✓FNL POS lt – off
CRT ✓DRV CMD – ON
✓FIXERS – ON
✓PETAL POS BASE (three) incr

A7L * If RING INIT POS lt failed on (ring stops after 1 sec, *
CRT * and CLUTCH – blank/SLIP): *
A7L * FIXER OFF pb – push (FIXERS OFF lt on) *
* RING OUT pb – push *
CRT * When PETAL POS BASE (three) = 76 ± 3%: *
A7L * PWR OFF pb – push *
* ON pb – push *
* ✓FIXERS OFF lt – off *
* APDS CIRC PROT OFF pb – push *
* RING OUT pb – push *
* After 1 sec: *
CRT * ✓RING DRV CMD – OFF *
* If RING FWD POS lt failed on (ring stops after 10 sec): *
A7L * RING OUT pb – push *
* Within 10 sec: *
* APDS PWR A_{DS} – OFF *
* If RING DRV CMD – OFF after 10 sec: *
CRT * APDS PWR A_{DS} – ON *
A7L * RING OUT pb – push *
* Within 10 sec: *
* APDS PWR A_{DS},C_{DS} (two) – OFF *
* ✓A_{DS},C_{DS}, RING FWD POS lts off *
CRT * When PETAL POS BASE (three) = 76 ± 3%: *
A7L * APDS PWR A_{DS},C_{DS} (two) – ON *

3:40 4. ✓RING INIT POS lt – on
CRT ✓PETAL POS BASE (three): 76 ± 3%
3:50 ✓CLUTCH – blank/SLIP

* If CLUTCH – blank/blank: *
A7L * ✓APDS CIRC PROT OFF lt – on *
* RING OUT pb – push (expect 1 sec of drive), wait *
* 10 sec *
CRT * ✓RING DRV CMD – OFF *
A7L * If CLUTCH – LOCK/blank: *
* ✓RING INIT POS lt – on *
* ✓FIXERS OFF lt – off *
* ✓APDS CIRC PROT OFF lt – on *
* RING OUT pb – push (expect 1 sec of drive), wait *
* 10 sec *
CRT * ✓RING DRV CMD – OFF *
* If not CLUTCH – blank/SLIP: *
* ✓MCC *

A7L 5. PWR OFF pb – push
✓STATUS lts (eighteen) – off

DOCKING RING RETRACTION (NOT MATED)

SM 167 DOCKING STATUS

A7L 1. PWR ON pb – push
✓lt – on
✓RING ALIGNED lt – on
✓INIT POS lt – on
✓HOOKS 1, HOOKS 2 OP lt (two) – on
✓LAT CL lt – on
CRT ✓CLUTCH – blank/SLIP

0:00 A7L 2. RING IN pb – push
✓INIT POS lt – off
CRT ✓CLUTCH – LOCK/blank

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

3:40 3. ✓RING FNL POS lt – on
3:50 CRT ✓DRV CMD – OFF

4. PWR OFF pb – push
✓STATUS lts (eighteen) – off

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POWER FAILED OFF (STATUS LTS OFF)

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

A7L

1. CNTL PNL PWR A – OFF
   PWR ON pb – push
   If expected STATUS lts on:
   Continue in Docking Sequence, as reqd >>

2. CNTL PNL PWR A – ON
   APDS PWR A – OFF
   PWR ON pb – push
   If expected STATUS lts on:
   If Undocking:
   Continue in Undocking Operations, as reqd >>
   If Docking:
   Continue in Docking Sequence, as reqd, with the following changes:
   Prior to Retract Ring steps:
   PWR OFF pb – push
   ON pb – push
   After Load Relieve Capture Latches (Extend Ring) – MANUAL steps:
   Go to step 4

3. APDS PWR A – ON
   B – OFF
   PWR ON pb – push
   If all STATUS lts off
   ✓MCC >>
   If expected STATUS lts on:
   If Undocking:
   Continue in Undocking Operations, as reqd >>
   If Docking:
   Continue in Docking Sequence, as reqd, with the following changes:
   Prior to Retract Ring steps:
   PWR OFF pb – push
   ON pb – push
   After Load Relieve Capture Latches (Extend Ring) – MANUAL steps:
   Go to step 4

4. APDS CIRC PROT OFF pb – push (lt on)
   OPEN LATCHES pb – push
   ✓LAT CL lt – off
   APDS PWR C – OFF
   A,B (two) – ON
   If all STATUS lts off:
   APDS PWR B – OFF
   A,C (two) – ON
   PWR ON pb – push (lt on)
   APDS CIRC PROT OFF pb – push (lt on)
   OPEN LATCHES pb – push
   ✓LAT OP lt – on
   Perform Docking Sequence, Retract Ring to FNL POS – MANUAL and Power Off steps

DAMPING FAILED ON

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

SM 167 DOCKING STATUS

A6L 1**.** PSU PWR MNA – OFF
CRT If DAMPING – ON**:**
A6L PSU PWR MNA – ON
MNB – OFF
CRT If DAMPING – OFF**:**
Pre–Contact**:**
Continue Approach
Post–Capture**:**
A7L PWR OFF pb – push
ON pb – push
Continue in Docking Sequence, as reqd >>

A6L 2**.** PSU PWR MNA,MNB (two) – OFF
Pre–Contact**:**
Continue Approach
Post–Capture**:**
PSU PWR MNA,MNB (two) – ON
Continue in Docking Sequence, as reqd

CAPTURE LT FAILED ON

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

SM 167 DOCKING STATUS

If Pre–Contact**:**
CRT If DAMPING – OFF**:**
Continue Approach >>
If DAMPING – ON**:**
A6L PSU PWR MNA,MNB (two) – OFF
Continue Approach
Post–Capture (no physical separation)**:**
PSU PWR MNA,MNB (two) – ON
Continue in Docking Sequence, as reqd

FIXERS FAILED ON

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

SM 167 DOCKING STATUS

A7L 1. PWR OFF pb – push
CRT If FIXERS – ON:
A7L PWR ON pb – push
Continue Approach or Docking Sequence, as reqd >>

A7L 2. PWR ON pb – push
APDS PWR A – OFF
CRT If FIXERS – ON:
A7L APDS PWR A – ON
B – OFF
CRT If FIXERS – OFF:
Continue Approach if applicable
Post–Capture, continue in Docking Sequence, as reqd, with the following changes:
After Retract Ring steps:
A7L APDS PWR A(B) – ON >>

A7L 3. APDS PWR B – ON
If pre–contact:
A6L PSU PWR MNA,MNB (two) – OFF
Continue Approach
Post–Capture, continue in Docking Sequence, as reqd, with the following changes:
After Contact/Capture/Damping steps:
Wait for passive damping and RING ALIGN lt – on, then:
PSU PWR MNA,MNB (two) – ON

FIXERS FAILED OFF

A6L PSU PWR MNA – OFF
Continue in Docking Sequence, as reqd, with the following changes:
A7L If RING ALIGN lt – OFF while driving ring:
PWR ON pb – push
When RING ALIGNED lt on for 60 sec continuous:
RING IN pb – push
After Retract Ring steps:
A6L PSU PWR MNA – ON

FIXERS OFF LT FAILED ON

SM 167 DOCKING STATUS

Post–Capture:

CRT 1. If FIXERS – ON:
Continue in Docking Sequence, as reqd >>

A7L 2. CNTL PNL PWR A – OFF
PWR OFF pb – push
ON pb – push
If FIXERS OFF lt – off:
Continue in Docking Sequence, as reqd >>

3. CNTL PNL PWR A – ON
APDS PWR A – OFF
If FIXERS OFF lt – on:
APDS PWR A – ON
B – OFF
If FIXERS OFF lt – off:
Continue in Docking Sequence, as reqd, with the following change:
After Load Relieve Capture Latches (Extend Ring) – MANUAL steps:
APDS PWR A(B) – ON >>

4. APDS PWR B – ON

A6L PSU PWR MNA – OFF

A7L Continue in Docking Sequence, as reqd, with the following change:
After Retract Ring steps:

A6L PSU PWR MNA – ON

FIXERS OFF LT FAILED OFF

SM 167 DOCKING STATUS

Post–Capture:
If Force Alignment reqd:

A7L APDS CIRC PROT OFF pb – push
FIXER OFF pb – push
RING OUT pb – push

CRT If FIXERS – ON:

A7L PWR ON pb – push
Allow passive damping
When RING ALIGNED lt – on:
Continue with Docking Sequence, Retract Ring steps >>

CRT If FIXERS – OFF:
Continue in Docking Sequence, as reqd

RING FAILS TO DRIVE

SM 167 DOCKING STATUS

CRT If RING DRV CMD – ON:
  If CLUTCH – blank/SLIP:
A7L PWR OFF pb – push
  ON pb – push
CRT Perform CLUTCH NOT 'LOCK' >>
If RING DRV CMD – OFF:
  Perform RING DRV CMD OFF

RING DRV CMD OFF

SM 167 DOCKING STATUS

A7L 1. PWR OFF pb – push
If all STATUS lts off:
  PWR ON pb – push
  Continue in Docking Sequence, as reqd >>

2. CNTL PNL PWR A – OFF
PWR OFF pb – push
If all STATUS lts off:
  PWR ON pb – push
  Continue in Docking Sequence, as reqd >>

3. CNTL PNL PWR A – ON
APDS PWR A – OFF
PWR OFF pb – push
If any STATUS lts on:
  APDS PWR A – ON
  B – OFF
  PWR OFF pb – push
If all STATUS lts off:
  PWR ON pb – push
  Continue in Docking Sequence, as reqd, with the following changes:
    After Load Relieve Capture Latches (Extend Ring) – MANUAL steps:
      APDS PWR A(B) – ON
      OPEN LATCHES pb – push
      ✓LAT OP lt – on
      APDS PWR A(B) – OFF
      Perform Docking Sequence, Retract Ring to FNL POS – MANUAL and Power Off steps >>

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

5. Go to FAILED CAPTURE (APPROACH Cue Card) to undock

RING FORWARD POSITION LT FAILED ON

SM 167 DOCKING STATUS

Post–Capture, if Force Alignment steps reqd:
A7L APDS CIRC PROT OFF pb – push (lt on)
  FIXER OFF pb – push (lt on)
  RING OUT pb – push
  Within 10 sec:
    APDS PWR A,C (two) – OFF

CRT When any PETAL POS BASE > 92%:
A6L PSU PWR MNA,MNB (two) – OFF
Allow relative motion to damp
PSU PWR MNA,MNB (two) – ON
CRT When PETAL POS BASE (three) = 98 ± 2% for 10 sec:
A7L APDS PWR A,C (two) – ON
PWR OFF pb – push
ON pb – push
✓RING ALIGN lt – on
Continue in Docking Sequence, starting with Retract Ring steps

RING FINAL POSITION LT FAILED ON

SM 167 DOCKING STATUS

Continue in Docking Sequence, as reqd, with the following changes:
In Retract Ring steps:
A7L RING IN pb – push (expect ring to stop after 10 sec)
pb – push
CRT When PETAL POS BASE (three) = 5% and not decr for 10 sec:
A7L PWR OFF pb – push

RING FAILS TO ALIGN AT FWD POS

A7L 1. PWR ON pb – push
CRT ✓DAMPING – OFF
0:00 A7L 2. RING IN pb – push
0:10 PWR ON pb – push
Wait for relative motion to damp and ring to align

2:00 If RING ALIGNED lt – off:
APDS CIRC PROT OFF pb – push (lt on)
FIXER OFF pb – push (lt on)
0:00 RING OUT pb – push

* If RING misalignment increases: *
* PWR ON pb – push *
* ✓MCC *

0:10 ✓RING FWD POS lt – on
0:20 ✓RING ALIGN lt – on [PETAL POS BASE (three) within 1%]
✓FIXERS OFF lt – off
CRT ✓RING DRV CMD – OFF

A7L * If RING misalignment persists: *
* PWR ON pb – push *
* ✓MCC *

3. Go to RETRACT RING (DOCKING SEQUENCE Cue Card), step 9

CLUTCH NOT 'LOCK'

SM 167 DOCKING STATUS

A7L 1. APDS CIRC PROT OFF pb – push
FIXER OFF pb – push
RING OUT pb – push
After 10 sec:
PWR OFF pb – push
ON pb – push
CRT If CLUTCH – LOCK / blank:
Continue in Docking Sequence, as reqd >>

A7L 2. RING IN pb – push
After 10 sec:
PWR ON pb – push
CRT If CLUTCH – LOCK / blank:
Continue in Docking Sequence, as reqd >>

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

APDS CIRCUIT PROTECT OFF LT FAILED OFF

SM 167 DOCKING STATUS

CRT If APDS CIRC PROT – ON:
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 completed or prior to undocking as applicable

A7L 1. PWR ON pb – push
APDS PWR A – OFF
If HOOKS 1(2) OPEN lt – off:
Perform nominal Undocking Operations per nominal mission timeline with APDS PWR A – 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

CRT 1. If no hook motion when commanded:
A7L APDS PWR A – OFF
CLOSE HOOKS pb – push
If no hook motion after 10 sec:
APDS PWR A – ON
B – OFF
CLOSE HOOKS pb – push
If hook posn increasing after 10 sec:
Continue in Docking Sequence, as reqd with the following change:
After Load Relieve Capture Latches (Extend Ring):
APDS PWR A(B) – ON >>

CRT 2. If other hook gang closed:
A7L ✓APDS PWR A,B,C (three) – on
PWR OFF pb – push
ON pb – push
Continue in Docking Sequence, as reqd
Perform PMA–2/3 HOOKS CLOSE, 8–31, to secure interface with min 12 hooks >>

3. If neither hook gang closed:

A7L ✓APDS PWR A,B,C (three) – on
PWR OFF pb – push
ON pb – push
✓MCC for IFM capability
Go to APDS DIRECT DRIVE USING BOB (IFM, PROCEDURES A THRU F) and PMA–2/3 HOOKS CLOSE, 8–31, as reqd, to secure interface with min 12 hooks

4. If no IFM capability or time does not permit IFM:

A7L APDS CIRC PROT OFF pb – push (lt on)
OPEN HOOKS pb – push
CRT ✓HOOKS 1,2 POS (two) – incr
A7L ✓OPEN lts (two) – on
0:00 RING OUT pb – push
CRT ✓PETAL POS BASE (three) – incr
3:40 A7L ✓RING INIT POS lt – on
Go to FAILED CAPTURE (APPROACH Cue Card) to undock

READY TO HOOK LT FAILED ON

1. Post–Capture:

A7L APDS PWR A – OFF
If RDY TO HK lt – off:
If HOOKS 1(2) OPEN lt – off:
APDS CIRC PROT OFF pb – push
OPEN HOOKS pb – push
✓HOOKS 1,2 OPEN lts (two) – on
Continue in Docking Sequence, as reqd, with the following change:
After hooks begin to drive closed:
APDS PWR A – ON >>

2. APDS PWR A – ON
Continue in Docking Sequence, as reqd, with the following changes:
Immediately after RING IN pb – push in Retract Ring step 10:
APDS CIRC PROT OFF pb – push
OPEN HOOKS pb – push
CRT ✓HOOKS 1(2) POS decreasing to 5%
When PETAL POS BASE (three) $\leq$ 7%:
A7L CLOSE HOOKS pb – push

HOOKS 1(2) CLOSED LT FAILED ON

Post–Capture:
After Disable Dampers step:
A7L PWR OFF pb – push
ON pb – push
APDS PWR A – OFF
If HOOKS 1(2) CLOSED lt – off:
Continue in Docking Sequence, as reqd, with the following change:
After Close Hooks steps:
APDS PWR A – ON >>
If HOOKS 1(2) CLOSED lt – on:
Continue in Docking Sequence, as reqd, expecting only 6 hooks to close
After Docking Sequence complete:
Go to PMA2/3 HOOKS CLOSE, 8–31, to secure interface with 12 hooks

LATCHES OPEN LT FAILED OFF

SM 167 DOCKING STATUS

CRT 1. If CAP LAT IND – OP/blank:
Continue in Docking Sequence, as reqd >>

A7L 2. ✓APDS PWR (three) – ON (A_{DS}, B_{DS}, C_{DS} lts on)
CIRC PROT OFF pb – push
OPEN LATCHES pb – push
CRT If LAT OP lt – on or CAP LAT IND – OP/blank:
Continue in Docking Sequence, as reqd >>

A7L 3. Prior to Undocking timeline:
Use manual release to open capture latches
Perform DOCKING MECHANISM POWERUP, 8–5
PWR ON pb – push
Perform Docking Sequence, Retract Ring to FNL POS – MANUAL and Power Off steps
Go to DOCKING MECHANISM POWERDOWN, 8–6

APDS POWER FAILED OFF

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

CAUTION
Associated capture latch cannot be driven open, resulting in inability to separate interfaces

Post–Capture:
Continue in Docking Sequence, as reqd, with the following change:
After Load Relieve Capture Latches (Extend Ring) steps, go to Power Off step. Manual release of one capture latch will be reqd prior to undocking

DOCKING MECHANISM DEMATE/REMATE

NOTE

This procedure assumes vestibule leak check failed, or both ODS Hook gangs jammed simultaneously. Docking ring will recapture interface, hooks will be driven open, interface will be separated, and second mating attempt will be performed. Procedure assumes docking sequence completed

1. Perform G2 SET EXPANSION (ORB OPS, DPS) for TRIPLE G2

2. DAP: FREE

O14, O15, O16 Pri RJD LOGIC, DRIVER (sixteen) – ON

GNC 25 RM ORBIT

CRT 3. SW RM INH, ITEM 16 EXEC (*)
A6U FLT CNTLR PWR – ON
CRT SW RM INH, ITEM 16 EXEC (no *)

GNC 20 DAP CONFIG

4. Config DAP A,B to A7,B7
DAP: B/FREE/VERN (PRI)
✓DAP TRANS: LO Z
✓DAP TRANS: PULSE/PULSE/PULSE
✓SENSE: –Z

5. Perform DOCKING MECHANISM POWERUP, 8–5, if reqd

NOTE

PWR OFF pb – push must be performed within 10 sec of Capture (CAPTURE lt on) to prevent capture latches from reopening automatically

SM 167 DOCKING STATUS

6. Recapture interface:

A7L PWR ON pb – push
✓STATUS lts – on, as reqd
0:00 CLOSE LATCHES pb – push
✓LAT OP lt – off
0:05 ✓CL lt – on

CRT ✓CLUTCH – LOCK/blank
A7L APDS CIRC PROT OFF pb – push (lt on)
FIXER OFF pb – push (lt on)
0:00 RING OUT pb – push
✓FNL POS lt – off

0:10 When CAPTURE lt – on, immediately:
PWR OFF pb – push
ON pb – push
✓CAPTURE lt – off
✓LAT CL lt – on

7. Open Hooks:
APDS CIRC PROT OFF pb – push (lt on)
0:00 OPEN HOOKS pb – push
✓HOOKS 1,HOOKS 2 CL lt (two) – off
2:20 ✓OP lt (two) – on

8. Extend ring to separate interface:
CRT ✓CLUTCH – LOCK/blank
0:00 A7L RING OUT pb – push
✓INTERF SEALED lt – off
✓RDY TO HK lt – off

3:40 ✓RING INIT POS lt – on
CRT ✓CLUTCH – blank/SLIP

9. ✓Interface clear of debris or other obstruction

10. Retract ring for second mating attempt:
A7L ✓FIXERS OFF lt – off
0:00 RING IN pb – push
0:05 CRT ✓CLUTCH – LOCK/blank
A7L ✓RING INIT POS lt – off

3:35 ✓RDY TO HK lt – on
<4:15 ✓INTERF SEALED lt – on
✓HOOKS 1,HOOKS 2 OP lt (two) – off
6:15 ✓CL lt (two) – on

0:00 11. RING OUT pb – push
0:10 PWR ON pb – push

12. ✓APDS CIRC PROT OFF lt – on
✓PWR A_{DS},B_{DS},C_{DS} (three) – on (lt on)
0:00 OPEN LATCHES pb – push
✓LAT CL lt – off
0:05 ✓OP lt – on

0:00 13. RING IN pb – push
0:10 ✓FNL POS lt – on
0:20 CRT ✓DRV CMD – OFF

14. PWR OFF pb – push
✓STATUS lts (eighteen) – off

15. Perform DOCKING MECHANISM POWERDOWN, 8–6, if reqd

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

17. Return to FLIGHT PLAN

ODS HOOKS OPEN – CONTINGENCY

NOTE

Procedure assumes PMA2/3 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 PMA2/3 HOOKS OPEN – CONTINGENCY. To undock, docking ring will recapture interface in preparation for firing ODS hook pyros. Actual separation will occur by extending ring to Initial Position, opening capture latches, and performing +Z jet pulses.

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.

APDS must be powered off within 10 sec of Capture to prevent the capture latches from automatically reopening

1. Perform DOCKING MECHANISM POWERUP, 8–5, if reqd

A7L 2. PWR ON pb – push

SM 167 DOCKING STATUS

RECAPTURE INTERFACE

3. CLOSE LATCHES pb – push
   ✓LAT OP lt – off
   ✓CL lt – on

4. APDS CIRC PROT OFF pb – push (lt on)
   FIXER OFF pb – push (lt on)
   RING OUT pb – push
   ✓FNL POS lt – off [PETAL POS BASE (three) = 5%]

   When CAPTURE lt – on, immediately:
   PWR OFF pb – push
   ON pb – push
   ✓CAPTURE lt – off
   ✓LAT CL lt – on

RE–OPEN CLOSED HOOKS

5. DAP: A/FREE/VERN

6. APDS CIRC PROT OFF pb – push (lt on)
   OPEN HOOKS pb – push

7. When good HOOKS 1(2) OP lt – on and jammed HOOKS 2(1) POS not decr:
   PWR OFF pb – push
   ON pb – push

DISCHARGE ACTIVE HOOK PYROS

A6L 8. PYRO PWR MN A,MN C (two) – ON
A7L PYROS A_P,B_P,C_P (three) – ON (lt on)
PYRO CIRC PROT OFF pb – push (lt on)

9. ACT HOOKS FIRING pb – push

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

EXTEND RING TO INITIAL POSITION FOR INTERFACE SEPARATION

A7L 11. APDS CIRC PROT OFF pb – push (lt on)
FIXER OFF pb – push (lt on)
0:00 RING OUT pb – push [PETAL POS BASE (three) > 6% and incr]
✓INTERF SEALED lt – off
✓RDY TO HK lt – off
If interface separates, proceed with step 16

CRT * If no interface separation (PETAL POS BASE (three) not incr) after 20 sec: *
A7L * PWR ON pb – push *
* RING IN pb – push *
CRT * When PETAL POS BASE (three) = ~6% and not decr: *
A7L * PWR OFF pb – push *
* ON pb – push *

DISCHARGE PASSIVE HOOK PYROS

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

13. PAS HOOKS FIRING pb – push

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

REATTEMPT EXTENDING RING TO INITIAL POSITION FOR INTERFACE SEPARATION

A7L 15. APDS CIRC PROT OFF pb – push (lt on)
✓FIXERS OFF lt – on
0:00 RING OUT pb – push [PETAL POS BASE (three) > 6% and incr]
✓INTERF SEALED lt – off
✓RDY TO HK lt – off
If interface separates, proceed with step 16

CRT * If no interface separation (PETAL POS BASE (three) not incr) after 20 sec: *
A7L * PWR ON pb – push *
* RING IN pb – push *
CRT * When PETAL POS BASE (three) = ~6% and not decr: *
A7L * PWR OFF pb – push *
* Perform DOCKING MECHANISM POWERDOWN, 8–6 *
* Perform 96 BOLT EVA TIMELINE (EVA, ORB CONT EVA) >> *

~3:00

16. ✓RING INIT POS lt – on [PETAL POS BASE (three) > 76 ± 3%]
PWR ON pb – push
OPEN LATCHES pb – push
✓LAT CL lt – off
✓OP lt – on
PWR OFF pb – push

* If no physical separation: *
* ✓DAP: A/FREE/VERN *
* ✓DAP: LO Z *
* THC: +Z (OUT) 4 Continuous Pulses *

17. Proceed with SEPARATION ACTIVITIES and RENDEZVOUS

18. Go to DOCKING RING RETRACTION (NOT MATED), 8–9, prior to DOCKING MECHANISM POWERDOWN, 8–6

PMA2/3 HOOKS OPEN – CONTINGENCY

NOTE

Procedure assumes PMA2/3 hooks could not be opened nominally or ODS hooks were driven fully open and physical separation did not occur and PMA2/3 were closed at some point during the mission. For these situations, docking ring will recapture interface in preparation for firing ODS passive hook pyros. Actual separation will occur by extending ring to Initial Position, opening capture latches, and performing +Z jet pulses.

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.

APDS must be powered off within 10 sec of capture to prevent the capture latches from automatically reopening

1. Perform DOCKING MECHANISM POWERUP, 8–5, if reqd

A7L 2. PWR ON pb – push

SM 167 DOCKING STATUS

RECAPTURE INTERFACE

3. CLOSE LATCHES pb – push
   ✓LAT OP lt – off
   ✓CL lt – on

4. APDS CIRC PROT OFF pb – push (lt on)
   FIXER OFF pb – push (lt on)
   RING OUT pb – push
   ✓FNL POS lt – off [PETAL POS BASE (three) = 5%]

5. When CAPTURE lt – on [PETAL POS BASE (three) > 6%]:
   PWR OFF pb – push
   ON pb – push
   ✓CAPTURE lt – off
   ✓LAT CL lt – on

OPEN ODS HOOKS

6. DAP: A/FREE/VERN

A7L 7. APDS CIRC PROT OFF pb – push (lt on)

0:00 8. UNDOCKING pb – push
   ✓HOOKS 1,HOOKS 2 CL lt (two) – off
CRT ✓POS < 92% and decr

∗ If HOOKS 1(2) fail to drive [HOOKS 1(2) DRV ∗
∗ CMD – OFF]: ∗
A7L ∗ OPEN HOOKS pb – push ∗
∗ If HOOKS 1(2) appear to stop before reaching ∗
∗ end–of–travel [HOOKS 1(2) POS > 4% and ∗
∗ not decr]: ∗
∗ Allow for single motor drive time (~4:40) ∗
∗ before ∗
∗ PWR OFF pb – push ∗
∗ ON pb – push ∗

2:20 9. ✓HOOKS 1,HOOKS 2 OP lt (two) – on [HOOKS 1, HOOKS 2 POS = 4%]
✓UNDOCK COMPLETE lt – on

ATTEMPT TO EXTEND RING TO INITIAL POSITION FOR INTERFACE SEPARATION

A7L 10. APDS CIRC PROT OFF pb – push (lt on)
FIXER OFF pb – push (lt on)
0:00 RING OUT pb – push [PETAL POS BASE (three) > 6% and incr]
If interface separates, proceed with step 19

CRT ∗ If no interface separation (PETAL POS BASE (three) ∗
∗ not incr) after 20 sec: ∗
A7L ∗ PWR ON pb – push ∗
∗ RING IN pb – push ∗
CRT ∗ When PETAL POS BASE (three) = ~6% and not decr: ∗
A7L ∗ PWR ON pb – push ∗

DISCHARGE PASSIVE HOOK PYROS

A6L 11. PYRO PWR MN A, MN C (two) – ON
A7L PYROS A_P,B_P,C_P (three) – ON (lt on)
PYRO CIRC PROT OFF pb – push (lt on)

12. PAS HOOKS FIRING pb – push

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

REATTEMPT EXTENDING RING TO INITIAL POSITION FOR INTERFACE SEPARATION

A7L 14. APDS CIRC PROT OFF pb – push (lt on)
FIXER OFF pb – push (lt on)
0:00 RING OUT pb – push [PETAL POS BASE (three) > 6% and incr]
✓INTERF SEALED lt – off
✓RDY TO HK lt – off
If interface separates, proceed with step 19

CRT If no interface separation (PETAL POS BASE (three) not incr) after 20 sec:
A7L PWR ON pb – push
RING IN pb – push
CRT When PETAL POS BASE (three) = ~6% and not decr:
A7L PWR ON pb – push

DISCHARGE ACTIVE HOOK PYROS

A6L 15. PYRO PWR MN A, MN C (two) – ON
A7L PYROS A_P,B_P,C_P (three) – ON (lt on)
PYRO CIRC PROT OFF pb – push (lt on)

16. ACT HOOKS FIRING pb – push

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

REATTEMPT EXTENDING RING TO INITIAL POSITION FOR INTERFACE SEPARATION

A7L 18. APDS CIRC PROT OFF pb – push (lt on)
✓FIXERS OFF lt – on
0:00 RING OUT pb – push [PETAL POS BASE (three) > 6% and incr]
✓INTERF SEALED lt – off
✓RDY TO HK lt – off
If interface separates, proceed with step 19

CRT * If no interface separation (PETAL POS BASE (three) not incr) after 20 sec: *
A7L * PWR ON pb – push *
* RING IN pb – push *
CRT * When PETAL POS BASE (three) = 6% and not decr: *
A7L * PWR OFF pb – push *
* Perform DOCKING MECHANISM POWERDOWN, 8–6 *
* Go to 96 BOLT EVA TIMELINE (EVA, ORB CONT EVA) >> *

OPEN LATCHES TO SEPARATE INTERFACE

~3:00 19. ✓RING INIT POS lt on [PETAL POS BASE (three) > 76 ± 3%]
PWR ON pb – push
OPEN LATCHES pb – push
✓LAT CL lt – off
✓OP lt – on
PWR OFF pb – push

* If no physical separation: *
* ✓DAP: A/FREE/VERN *
* ✓DAP: LO Z *
* THC: +Z (OUT) four Continuous Pulses *

20. Proceed with SEPARATION ACTIVITIES, and RENDEZVOUS

21. Go to DOCKING RING RETRACTION (NOT MATED), 8–9, prior to DOCKING MECHANISM POWERDOWN, 8–6

APDS FAILED CAPTURE RECONFIG

SM 167 DOCKING STATUS

A7L 1. If LAT OP lt – on:
0:00 CLOSE LATCHES pb – push
✓LAT OP lt – off
0:05 ✓CL lt – on

2. ✓APDS CIRC PROT OFF lt – on

3. FIXER OFF pb – push (lt on)
0:00 RING OUT pb – push
CRT ✓PETAL POS BASE (three) – incr
0:05 ✓CLUTCH – LOCK/blank
A7L ✓RING INIT POS lt – on (for ~16 sec), then off

* If RING FWD POS lt failed on (ring stops after 10 sec): *
* RING OUT pb – push *
* Within 10 sec: *
* APDS PWR A_{DS} – OFF *
* If RING DRV CMD – OFF after 10 sec: *
* APDS PWR A_{DS} – ON *
* RING OUT pb – push *
* APDS PWR A_{DS},C_{DS} (two) – OFF *
* ✓A_{DS},C_{DS}, RING FWD POS lt off *
CRT * ✓PETAL POS BASE (three) – incr *
A7L * ✓RING INIT POS lt – on (for ~16 sec), then off *
* When PETAL POS BASE (three): 98 ± 2% *
* APDS PWR A_{DS},C_{DS} (two) – ON *
* Go to step 4 *

1:15 4. ✓RING FWD POS lt – on
✓ALIGNED lt – on
✓FIXERS OFF lt – off
CRT ✓PETAL POS BASE (three): 98 ± 2%

0:00 A7L 5. RING IN pb – push
CRT ✓CLUTCH – LOCK / blank
✓RING FWD POS lt – off
1:15 ✓INIT POS lt – on (for ~16 sec), then off

* If RING FNL POS lt failed on (ring stops after 10 sec): *
0:00 A7L * RING IN pb – push *
* ✓RING FWD POS lt – off *
1:15 * ✓INIT POS lt – on (for ~16 sec), then off *
4:50 CRT * When PETAL POS BASE (three) = 5 ± 3% and not decr: *
A7L * PWR ON pb – push *
* Go to step 7 *

6. ✓RING FNL POS lt – on
5:00 CRT ✓DRV CMD – OFF

0:00 A7L 7. ✓APDS CIRC PROT OFF lt – on
RING OUT pb – push
CRT ✓CLUTCH – LOCK / blank
0:10 A7L ✓RING FNL POS lt – off

* If RING INIT POS lt failed on (ring stops after 1 sec, *
* and Clutch drives to SLIP): *
* FIXER OFF pb – push (✓FIXERS OFF lt on) *
* RING OUT pb – push *
* When PETAL POS BASE (three) = 76 ± 3% *
* PWR OFF pb – push *
* ON pb – push *
* ✓FIXERS OFF lt – off *
* APDS CIRC PROT OFF pb – push *
* RING OUT pb – push *
* After 1 sec: *
* ✓RING DRV CMD – OFF *
* Go to step 8 *
* If RING FWD POS lt failed on (ring stops after 10 sec): *
* RING OUT pb – push *
* Within 10 sec: *
* APDS PWR A_{DS} – OFF *
* If RING DRV CMD – OFF after 10 sec: *
* APDS PWR A_{DS} – ON *
* RING OUT pb – push *
* APDS PWR A_{DS},C_{DS} (two) – OFF *
* ✓A_{DS},C_{DS}, RING FWD POS lt off *
CRT * ✓PETAL POS BASE (three) – incr *
* When PETAL POS BASE (three) = 76 ± 3%: *
A7L * APDS PWR A_{DS},C_{DS} (two) – ON *
* PWR ON pb – push *
* RING OUT pb – push *
* After 1 sec: *
* ✓RING DRV CMD – OFF *
* Go to step 8 *

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

* If CLUTCH – LOCK/blank: *
* ✓APDS CIRC PROT OFF lt – on *
0:00 * RING OUT pb – push *
0:01 * ✓DRV CMD – OFF *
* ✓PETAL POS BASE (three): 76 ± 3% *
0:05 * ✓CLUTCH – blank/SLIP *

9. PWR OFF pb – push
✓STATUS lts (eighteen) – off

PMA2/3 HOOKS CLOSE

> WARNING
> Procedure assumes one ODS Hook Gang has failed and one PMA2/3 Hook Gang can be used to recover a total of 12 hooks. ODS to PMA2/3 interface must be hard mated, as verified by the ODS X3/X4 connector mate indications, in order to provide PMA2/3 active hook control and tlm through the interface X–connectors

SM 167 DOCKING STATUS

CRT 1. ✓ODS CONN X3, X4 (two) – 'ON'

A6L 2. ✓cb PMA2/3 GRP 1,2 HOOKS (eight) – op
✓PMA2/3 HOOKS SYS A,SYS B (two) – ctr (tb–bp)

TO CLOSE HOOKS 1, PERFORM STEPS 3–6

3. cb PMA2/3 GRP 1 HOOKS SYS A OPEN, CLOSE (two) – cl
B OPEN, CLOSE (two) – cl
✓PMA2/3 HOOKS GRP 1 tb – OP

CRT ✓HK 1 IND OP – '1 2'
✓IND CL – blank
✓HK CL 1/3/5, 7/9/11 (two) – blank

* If any IND CL present, hooks will operate single motor: *
* ✓MCC *

0:00 A6L 4. PMA2/3 HOOKS SYS A,SYS B (two) – CL
✓GRP 1 tb – bp

CRT ✓HK 1 CMD CL – '1 2'
✓IND OP – blank

2:40 A6L 5. ✓PMA2/3 HOOKS GRP 1 tb – CL

CRT ✓HK 1 IND CL – '1 2'
✓CMD CL – blank
✓HK CL 1/3/5, 7/9/11 (two) – blank

A6L 6. PMA2/3 HOOKS SYS A,SYS B (two) – ctr
cb PMA2/3 GRP 1 HOOKS SYS A OPEN, CLOSE (two) – op
B OPEN, CLOSE (two) – op

TO CLOSE HOOKS 2, PERFORM STEPS 7–10

7. cb PMA2/3 GRP 2 HOOKS SYS A OPEN, CLOSE (two) – cl
B OPEN, CLOSE (two) – cl
✓PMA2/3 HOOKS GRP 2 tb – OP

CRT ✓HK 2 IND OP – '1 2'
✓CL – blank
✓HK CL 2/4/6, 8/10/12 (two) – blank

* If any IND CL present, hooks will operate single motor: *
* ✓MCC *

0:00 A6L 8. PMA2/3 HOOKS SYS A,SYS B (two) – CL
✓GRP 2 tb – bp

CRT ✓HK 2 CMD CL – 1,2
✓IND OP – blank

2:40 A6L 9. ✓PMA2/3 HOOKS GRP 2 tb – CL
CRT ✓HK 2 IND CL – 1,2
✓CMD CL – blank
✓HK CLS 2/4/6, 8/10/12 (two) – CL

A6L 10. PMA2/3 HOOKS SYS A,SYS B (two) – ctr
cb PMA2/3 GRP 2 HOOKS SYS A OPEN, CLOSE (two) – op
B OPEN, CLOSE (two) – op

PMA2/3 HOOKS OPEN

> WARNING
> ODS to PMA2/3 interface must remain hard mated by at least one gang of ODS hooks through entire procedure in order to provide PMA2/3 active hook control and tlm through the interface X–connector

SM 167 DOCKING STATUS

A6L 1. ✓cb PMA2/3 GRP 1,2 HOOKS (eight) – op
✓PMA2/3 HOOKS SYS A,SYS B (two) – ctr (tb–bp)

TO OPEN HOOKS 1, PERFORM STEPS 2–5

2. cb PMA2/3 GRP 1 HOOKS SYS A OPEN, CLOSE (two) – cl
B OPEN, CLOSE (two) – cl
✓PMA2/3 HOOKS GRP 1 tb – CL

CRT ✓HK 1 IND CL – ‘1 2’
✓OP – blank
✓HK CLS 1/3/5, 7/9/11 (two) – CL

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

0:00 A6L 3. PMA2/3 HOOKS SYS A,SYS B (two) – OP
✓GRP 1 tb – bp

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

2:40 A6L 4. ✓PMA2/3 HOOKS GRP 1 tb – OP

CRT ✓HK 1 IND OP – ‘1 2’
✓CMD OP – blank

∗ If PMA2/3 HOOKS fail to drive, or do not reach after ∗
∗ single motor drive time (~4:40): ∗

A6L ∗ PMA2/3 HOOKS SYS A,SYS B (two) – ctr ∗
∗ cb PMA2/3 GRP 1 HOOKS SYS A OPEN, CLOSE ∗
∗ (two) – op ∗
∗ cb PMA2/3 GRP 1 HOOKS SYS B OPEN, CLOSE ∗
∗ (two) – op ∗
∗ Perform PMA2/3 HOOKS OPEN – CONTINGENCY, ∗
∗ 8–26 ∗

5. PMA2/3 HOOKS SYS A, SYS B (two) – ctr
cb PMA2/3 GRP 1 HOOKS SYS A OPEN, CLOSE (two) – op
B OPEN, CLOSE (two) – op

TO OPEN HOOKS 2, PERFORM STEPS 6–9

6. cb PMA2/3 GRP 2 HOOKS SYS A OPEN, CLOSE (two) – cl
B OPEN, CLOSE (two) – cl
✓PMA2/3 HOOKS GRP 2 tb – CL

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

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

0:00 A6L 7. PMA2/3 HOOKS SYS A,SYS B (two) – OP
✓GRP 2 tb – bp
CRT ✓HK 2 CMD OP – ‘1 2’
✓IND CL – blank
✓HK CLS 2/4/6/, 8/10/12 (two) – blank

2:40 A6L 8. ✓PMA2/3 HOOKS GRP 2 tb – OP
CRT ✓HK 2 IND OP – ‘1 2’
✓CMD OP – blank

* If PMA2/3 HOOKS fail to drive, or do not reach *
* end–of–travel after single motor drive time (~4:40): *
A6L * PMA2/3 HOOKS SYS A, SYS B (two) – ctr *
* cb PMA2/3 GRP 2 HOOKS SYS A OPEN, CLOSE *
* (two) – op *
* cb PMA2/3 GRP 2 HOOKS SYS B OPEN, CLOSE *
* (two) – op *
* Perform PMA2/3 HOOKS OPEN – CONTINGENCY, *
* 8–26 *

9. PMA2/3 HOOKS SYS A, SYS B (two) – ctr
cb PMA2/3 GRP 2 HOOKS SYS A OPEN, CLOSE (two) – op
B OPEN, CLOSE (two) – op

APDS FAILURE/IMPACT MATRIX 8–36
(TLM) 8–38

APDS FAILURE/IMPACT MATRIX

APDS Status lt/tb	APDS FAILURE s = potential single failure m = multiple failures reqd	IMPACT
POWER ON	Failed ON (m)	Continuous PWR ON will inhibit ring and fixer commands, and PWR OFF pb. Relays may overheat preventing future powerup. [Detectable only during power up, ring drive operations, or during a power cycle]
	Failed OFF (m)	If all STATUS lts are ↓, loss of all logic power to APDS. Docking system cannot be operated. [Even if power regained pre–Capture, need to assess failure modes before continuing approach]
APDS CIRCUIT PROTECT OFF	Failed ON (m)	Manual commands are enabled
	Failed OFF (m)	No manual Ring Out, Open Latches, Open Hooks, Undocking pb capability
RING ALIGNED	Failed ON (m)	Prime alignment cue disabled. Erroneous ind with significant pitch motion (sensors rotated 360°)
	Failed OFF (s)	Prime alignment cue disabled
RING INITIAL POSITION	Failed ON (s)	Ring will only drive for 1 sec with Ring Out commands. Slip clutch will drive alternately between the SLIP and LOCK positions. [FIXERS OFF command bypasses Initial Position logic]
	Failed OFF (m)	INITIAL CONTACT lt disabled
FIXERS OFF	Failed ON (m)	If fixers failed off, alignment may be lost during ring retraction [Detectable only during ring drive operations. Single motor ring retraction will help maintain alignment]
	Failed OFF (m)	Unable to inhibit fixer operation during manual ring operations
HOOKS 1(2) OPEN	Failed ON (s)	Logic prevents Hooks from driving open. [May regain function with APDS PWR A off]
	Failed OFF (m)	Hooks will not stop driving at Open Position, OR vehicles will not separate due to jammed hook drive
LATCHES CLOSED	Failed ON (s)	Ring will stall against Capture Latches if Capture Latches failed closed. No impact if latches open on SPEC 167
	Failed OFF (m)	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]
UNDOCK COMPLETE	Failed ON (s)	No impact. Indication is not used for any logic
	Failed OFF (m)	No impact. Indication is not used for any logic

APDS FAILURE/IMPACT MATRIX (Cont)

APDS Status lt/tb	APDS FAILURE s = potential single failure m = multiple failures reqd	IMPACT
INITIAL CONTACT	Failed ON (s)	Prime contact cue disabled
	Failed OFF (m)	Prime contact cue disabled. [Not detectable prior to contact]
CAPTURE	Failed ON (m)	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
	Failed OFF (m)	Unable to activate damping / Auto Sequence post–capture
RING FORWARD POSITION	Failed ON (s)	Ring will only drive out for 10 sec at a time
	Failed OFF (m)	Ring will continue to drive at Forward Position until terminated by a PWR On/Off reset
READY TO HOOK	Failed ON (s)	Hooks will begin driving closed with manual Ring In command
	Failed OFF (m)	Manual CLOSE HOOKS command required to drive hooks closed. Ring will not stop driving at In–Between Hooks position
INTERF SEALED (no TLM)	Failed ON (s)	No impact to APDS operations. Indication is not used for any logic
	Failed OFF (m)	No impact to APDS operations. Indication is not used for any logic
HOOKS 1(2) CLOSED	Failed ON (s)	Logic prevents associated Hooks from driving closed. [May regain function with APDS A off]
	Failed OFF (m)	Hooks will not stop driving when reach Closed Position. Hooks 1,2 closed indications reqd for auto Capture Latch load relief/opening and ring retraction to Final Position. PMA–2/3 hooks may be reqd if hook gang failed in open or in mid–travel
LATCHES OPEN	Failed ON (s)	No impact to Docking Sequence if SPEC 167 indicates latches closed. [Need all 3 Latches in Open to enable a real Ind.]
	Failed OFF (m)	If Latches Failed Closed, Ring will stall against Latches if ring commanded to Final Position. If indication only failure, Latches will not stop driving until Final Position +10 sec when Docking Sequence completes
RING FINAL POSITION	Failed ON (s)	Auto Sequence will not function (Capture bus disabled), but damping will be activated nominally. 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
	Failed OFF (m)	During Ring retraction, ring will not stop driving at Final Position
APDS POWER	Failed ON (s)	One logic bus remains powered. Still two failures from any inadvertent ops
	Failed OFF (s)	Loss of 1 Capture Latch Mtr. Next failure results in loss of all APDS motor drive capability. [Next failure may require APDS Direct Drive IFM to complete docking or separate, or require manual capture latch release]
A6L SYSTEM POWER A(B) tb	Failed OFF (s)	Loss of redundancy. [Docking lights, Vestibule depress valves, APDS logic] [Two additional failures necessary before APDS Direct Drive IFM reqd to complete docking or SEP]

APDS FAILURE/IMPACT MATRIX (TLM)

APDS Status It/tb	APDS FAILURE s = potential single failure m = multiple failures reqd	IMPACT
DAMPING (TLM)	Failed ON (s) [Single open relay could cause indication]	If real, mechanism may not have compliance on contact; load capability may be exceeded. No Crit 1 concern. Powering off Dampers ensures failed on tlm does not mask a real failure. [May attempt ring drive to verify failure. Failed on dampers may slow ring drive to about single motor drive time]
	Failed OFF (s) [Single failure in DCU/MDM could cause indication]	No impact for single failure. If all dampers ↓, with large rates/misalignments, mechanism may bottom out, exceeding its load capability. No Crit 1 concern
FIXERS (TLM)	Failed ON (s)	Mechanism may not have compliance on contact; load capability may be exceeded. No Crit 1 concern
	Failed OFF (s) [Single failure in DCU/MDM could cause indication]	No impact for single Fixer failure. For multiple failure case, alignment may be lost during ring retraction. [Detectable only during ring drive operations. Single motor drive will help maintain ring alignment]
CLUTCH – SLIP (TLM)	Failed ON (s)	If slip clutch locking mechanism failed in SLIP, resistance created by dampers and/or pusher springs will load actuator sufficiently to prevent ring motion. Docking cannot be performed
	Failed OFF (s)	Slip (soft) mode of mechanism is not required for early ISS dockings
CLUTCH – LOCK (TLM)	Failed ON (s)	Slip (soft) mode of mechanism is not required for early ISS dockings
	Failed OFF (s)	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. Docking cannot be performed
MAN LATCH REL (TLM)	Failed OP (s)	If real, unable to complete docking [can't draw interfaces together]
CNTL PNL POWER (TLM)	Failed ON (s)	One logic bus remains powered. Still two failures from any inadvertent ops
	Failed OFF (s)	Next CNTL PNL loss results in loss of PWR ON/PWR OFF and other pb functions. (Pyro pbs are not affected) [Next failure may require APDS Direct Drive IFM to complete docking or separate, or require manual capture latch release]
Any DRIVE BUS 1(2) (TLM)	Failed OFF (s)	BUS 1 (MN A): Fixers 1,2; Dampers 1,2; Hooks 1,2 Mtr 1; Ring Mtr 1 ↓ BUS 2 (MN B): Fixers 3,4,5; Damper 3; Hooks 1,2 Mtr 2; Ring Mtr 2 ↓

CUE CARD CONFIGURATION

RCS BURN (+X, –X, Multi–axis) (Front) . . . . . CC 9–3
RENDEZVOUS PRPLT PAD (Back) . . . . . CC 9–4
KU OPS (Front) . . . . . CC 9–5
(Back) . . . . . CC 9–6
APPROACH (Front) . . . . . CC 9–7
VBAR APPROACH (Back) . . . . . CC 9–8
C/L CAMERA TARGET ALIGNMENT (Front) . . . . . CC 9–9
(Back) . . . . . CC 9–10
DOCKING SEQUENCE (Front) . . . . . CC 9–11
(Back) . . . . . CC 9–12
STOPWATCH RDOT CONVERSION (Front) . . . . . CC 9–13
(Back) . . . . . CC 9–14
GPC/MDM FAILURE RESPONSE DURING RNDZ (Front) . . . . . CC 9–15
RNDZ REF DATA (Back) . . . . . CC 9–16
C/L CAMERA CORRIDOR AND ALIGNMENT . . . . . CC 9–17
CAMERA A/D RANGE RULER . . . . . CC 9–18
C/L CAMERA ZOOM CALIBRATION (RING READY FOR DOCK) . . . . . CC 9–19
760 PGSC DISPLAY OF C/L CAMERA CORRIDOR AND ALIGNMENT . . . . . CC 9–20
CAMERA A/D RANGE RULER . . . . . CC 9–21
FLIGHT SUB ANG RULER . . . . . CC 9–22
V10 MONITOR CORRIDOR . . . . . CC 9–23

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HOOK VELCRO

HOOK VELCRO

RNDZ–1a/113/O/A

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)

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

HOOK VELCRO

HOOK VELCRO

RENDEZVOUS PRPLT PAD

When L or R RCS QTY < 1 :

I'CNCT: 2 OMS to RCS (ORB PKT, RCS)

When G23 3 OMS/RCS QTY > 4 :

I'CNCT TK SWITCH: (ORB PKT, RCS)

When G23 5 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 500 ft:
  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

HOOK VELCRO

KU OPS

1. CONFIGURE KU FOR RR TGT ACQ

GNC 33 REL NAV

CRT
- ✓SV SEL, ITEM 4 – FLTR
- ✓INH RNG, ITEM 18 – (*)
- RDOT, ITEM 21 – (*)
- Angles, ITEM 24 – (*)

- KU ANT ENA – ITEM 2 EXEC (*)
- GNC I/O RESET

A2
- DIGI–DIS sel – R/RDOT

A1U
- KU MODE – RDR PASSIVE
- ✓RDR OUTPUT – HI
- CNTL – PNL
- ✓PWR – ON

KU SEL – GPC >>

2. AUTO TRK ACQ

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

3. RR NAVIGATION

GNC 33 REL NAV

CRT
- ✓RADAR, ITEM 13 – (*)

* *

* If RATIO > 1.0: *
- ✓MCC

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

4. CONFIGURE KU FOR COMM

CRT

GNC 33 REL NAV

INH RNG – ITEM 18 (*)
- RDOT – ITEM 21 (*)
- Angles – ITEM 24 (*)

KU ANT ENA – ITEM 2 (no *)

A1U
- KU PWR – STBY
- MODE – COMM
- ✓sel – GPC
- CNTL – CMD

A2
- DIGI–DIS sel – EL/AZ

HOOK VELCRO

RNDZ–2a/113/O/A

(reduced copy)

TOP
BACK OF ‘KU OPS’

HOOK
VELCRO

HOOK
VELCRO

RNDZ–2b/113/O/A

(reduced copy)

HOOK
VELCRO

APPROACH

CG to CG RNG (ft)	RDOT (ft/s)	MC2 ET h:mm:ss	DAP	EVENT	HHL RNG (ft) (to ISS cg)	Raw TCS RNG* (ft) (Refl #2)
2000	–3.0	0:27:00	A8/B8 AUTO/VERN (PRI)	If RDOT falls below value for next gate, THC: –Z (in) as reqd to maintain RDOT	1990 HHL Report	2015
1700	–2.6	0:29:00			1690	1698
1500	–2.3	0:30:00			1490	1498
1000	–1.5	0:35:00	LO Z	**Report to MCC: ISS solar array config** **MCC UPDATE: ✓Go to proceed within 400 ft**	990	985
800	↓			A1U KU OUTPUT – LO **IF U.S. SOLAR ARRAYS NOT FEATHERED:** Maintain TORVA and VBAR RNG > 400 ft (cg–cg) When in Rbar attitude, config DAP to A9,B9 Null ISS rates in centerline camera prior to TORVA	790 HHL Report	786
600 550 500	–0.8 –0.7 –0.5	0:40:00	A9/B9	TORVA GNC UNIV PTG P ITEM 15 +1 7 9 EXEC IF VERN FAIL, GNC 20 DAP CONFIG, ITEM 11 +2.0, ITEM 31 +2.0 DAP: A/AUTO/PRI TRK – ITEM 19 EXEC (CUR – *) THC: +X (up) as reqd to null tgt motion in C/L camera and initiate flyaround (approx 22 pulses) DAP: A(B)/AUTO/VERN(PRI) Maintain ISS within C/L camera FOV	590 540 490 HHL Report	586 536 486
400	0.0 to –0.1			**MCC UPDATE: GO for Docking** If reqd, PET reset per GROUND STATION COVERAGE APPROACH Maintain RNG > 330 ft (cg–cg) until VBAR arrival Maintain ISS CG within 10° of centerline camera Start video recorders	390 HHL Report	343
When Pitch Error < 20°	–0.1			RPOP POR – Orb DP to Tgt DP	**HHL RNG (to LAB)**	**TCS Refl 1**
When Pitch Error < 2°		0:51:30	IF VERN FAIL Reconfig A9/B9	ESTABLISH VBAR THC: –X (down) as reqd to null ISS in centerline camera, then THC: as reqd to maintain ISS in camera FOV		
430–330 (350–250 DP–DP)	–0.2	0:52:00		Perform CONFIGURE FOR DOCKING Perform VBAR APPROACH (Cue Card)	357–257 HHL Report	355–255
330 (250 DP–DP)	–0.2	0:57:00	✓A9,B9 ✓LO Z	Maintain ISS docking target within 8 deg Corridor	257 HHL Report	255

***** Raw TCS Range assumes ISS in docking attitude

GROUND STATION COVERAGE APPROACH

PRIME GROUND STATION PASS

Approach PET 0:00 = ☐☐/☐☐:☐☐:☐☐

BACKUP GROUND STATION PASS

Approach PET 0:00 = ☐☐/☐☐:☐☐:☐☐

170 ft STATIONKEEPING	Prime	Backup
Estimated duration of 170 ft SK =	☐☐ min	☐☐ min

CONFIGURE FOR DOCKING

Perform DOCKING MECHANISM PWRUP (APDS), 8–5
Perform DOCKING PREP (APDS), 8–7
Perform ODS VOLUME PREP FOR DOCKING (SODF: JOINT OPS, ARRIVAL)

(reduced copy)

TOP
BACK OF 'APPROACH'

HOOK VELCRO

VBAR APPROACH

RNDZ–3b/113/O/B

Interface RNG (ft)	RDOT (ft/s)	MC2 ET h:mm:ss (dock – PET)	DAP	EVENT	HHL RNG (to US Lab) (ft)	Raw TCS RNG* (Refl #1)
250	–0.20	0:57:00 (–34:00)	✓A9,B9 ✓LO Z	Maintain ISS docking target within 8 deg Corridor	257 HHL Report	255
(170 ± 10) 170	(0.00) –0.20	1:03:30 (–27:30)	DAP: B	NOTE: DAP A allowed for ±X and ±Z THC If reqd, THC: as reqd to null Rdot and perform VBAR stationkeeping	177 HHL Report	175
110	–0.15	1:08:30 (–22:30)		Perform CONFIGURE KU FOR COMM (Cue Card, KU OPS)	117	115
75	–0.10	1:12:30 (–18:30)	No LO Z A10,B10 ✓DAP: B	Note: DAP A allowed for ±X and –Z THC (in) GNC 23 RCS (Maintain through contact) ✓RCS FWD – ITEM 1 EXEC (*) JET DES F1F – ITEM 31 EXEC (*) F2F – ITEM 35 EXEC (*)	82 HHL Report	80
30 ± 5	0.0	1:20:00 (–11:00)	✓A10,B10 ✓DAP: B	5° Corridor If Flyout Reqd: THC: +Z (out) as reqd to null RDOT Perform AUTO ANGULAR FLYOUT (Cue Card) outside 25 ft Review FAILED CAPTURE, steps 1 thru 3, CAUTION (Cue Card, DOCKING SEQUENCE) ✓A7L Panel Config Set EVENT TIMER for CAPTURE (counting up from 00:00)	32–42 HHL Report	30–40
30	–0.07	1:25:00 (–06:00)		✓5° Corridor THC: –Z (in) as reqd to establish RDOT = –0:07 fps **Report to MCC and ISS: Initiating final approach**	37	35
25	↑	1:26:00 (–05:00)			32	30
10	–0.10 ±0.03	1:29:20 (–01:40)	✓No LO Z	ARM PCT F2(F4) SPDBK/THROT pb – AUTO – ✓lt on	17	15
3	–0.10 ±0.03	1:30:30 (–00:30)		Maintain 3–in lateral alignment cylinder	N/A	8
CONTACT or ~2 in	–0.10 ±0.03	1:31:00 (00:00)	PCT (SPARE pbi)	CAPTURE **IF NO CAPTURE (bounce–off)** Go to FAILED CAPTURE	N/A	5

***** Raw TCS Range assumes ISS in docking attitude

CAPTURE

✓CAPTURE lt – on
✓INITIAL CONTACT lt – off
Notify ISS: "Capture confirmed"
MS START EVENT TIMER = 00:00:00

Perform DOCKING SEQUENCE (Cue Card)

✓ISS in FREE DRIFT
If ISS indicator lights flashing:
ISS in free drift
If ISS indicator lights steady on:
ISS ACS active
If ISS indicator lights off:
Indicator light has failed
✓MCC
Confirm status with MCC and ISS Crew

IF ISS ACS STILL ACTIVE AT CAPTURE + 65 SEC:
Perform FAILED CAPTURE

When capture confirmed and ISS in FREE DRIFT:
DISARM PCT:
F4 SPDBK/THROT pb – AUTO
– ✓lt off
A6U FLT CNTLR PWR – OFF

When Docking Sequence complete:
Go to TERMINATE RNDZ OPS 22A, 4–22

FAILED CAPTURE

NOTE
There will be no spring–assisted separation from ISS. Opening rate of 0.1 fps must be achieved by THC inputs

1. APDS CIRC PROT OFF pb – push
✓OFF lt – on
OPEN LATCHES pb – push
✓LAT CL lt – off
✓OP lt – on
2. When petals clear:
IF VERN FAIL,
DAP: A/PRI/LVLH
DAP: A/VERN(PRI)/LVLH
✓DAP: NO LO Z
3. THC: +Z (out) to establish 0.1 fps opening rate
If ISS in FREE DRIFT:
Use ISS CG as corridor reference
Maintain 8 degree corridor
DAP: B
Inform MCC–H and ISS: Failed Capture
Maintain opening rate of at least 0.1 fps
4. Perform VBAR CORRIDOR BACKOUT, steps 2,3, CONTINGENCY OPS, 5–12
5. If second docking attempt desired:
Perform APDS FAILED CAPTURE RECONFIG (APDS), 8–29
If reqd, perform DOCKING MECHANISM POWERDOWN (APDS), 8–6
Go to VBAR APPROACH Cue Card, RNG = 170 ft

(reduced copy)

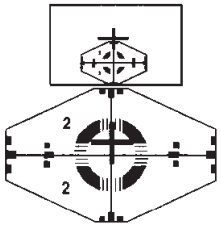
TOP

HOOK VELCRO

C/L CAMERA TARGET ALIGNMENT (+VBAR)

PITCH (P)
ITEM 15

Target Displaced DOWN
(Cross Displaced UP)

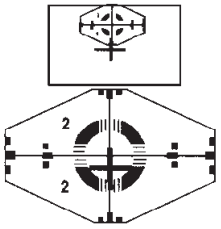


P = _____

P = _____

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

Target Displaced UP
(Cross Displaced DOWN)



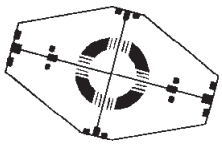
P = _____

P = _____

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

ROLL (R)
ITEM 16

Rotated CW

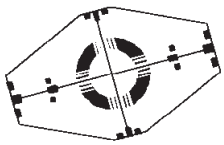


R = _____

R = _____

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

Rotated CCW



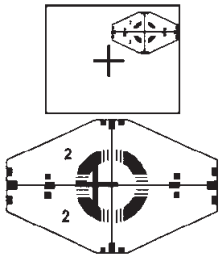
R = _____

R = _____

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

YAW (Y)
ITEM 17

Target Displaced RIGHT
(Cross Displaced LEFT)

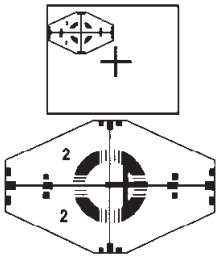


Y = _____

Y = _____

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

Target Displaced LEFT
(Cross Displaced RIGHT)



Y = _____

Y = _____

3. OM = 360 – Y =_____(C)
5. OM = OM – Y = _____(F)

RNDZ–4a/113/O/B

(reduced copy)

TOP
BACK OF 'C/L CAMERA TARGET ALIGNMENT'

HOOK
VELCRO

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 – *)

RNDZ–4b/113/O/B

(reduced copy)

HOOK VELCRO

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)

POWER Failed OFF (All STATUS lts ↓)	DAMPING tlm Failed ON
CAPTURE lt Failed ON	FIXERS tlm Failed ON

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

Event Time

Contact/Capture/Damping

SM 167 DOCKING STATUS

0:00 A7L 1. ✓CAPTURE lt – on (expect RING INIT POS lt off)
Inform MCC–H "CAPTURE lt on"
0:05 CRT 2. ✓DAMPING – ON

Disable and Release Dampers

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

4. When no relative motion [PETAL POS BASE (three) not changing for 60 sec]:
If RING ALIGNED lt off:
FIXER OFF pb – push (lt on)
0:00 A7L RING IN pb – push
CRT ✓DRV CMD – ON [PETAL POS BASE (three) – decr]

0:10 A7L 5. PWR ON pb – push
CRT ✓RING DRV CMD – OFF

NOTE
When dirving out, if RING INIT POS lt comes on and FIXERS OFF lt off, expect RING DRV CMD – OFF and CLUTCH – blank/SLIP

6. When no relative motion [PETAL POS BASE (three) not changing for 60 sec]:
If RING ALIGNED lt off:
FIXER OFF pb – push (lt on)
APDS CIRC PROT OFF pb – push (lt on)
0:00 A7L RING OUT pb – push
CRT ✓DRV CMD – ON [PETAL POS BASE (three) – incr]
0:05 A7L 7. PWR ON pb – push
CRT ✓RING DRV CMD – OFF
8. Wait for ring alignment
If RING ALIGNED lt remains off after 10:00, perform FORCE RING ALIGNMENT (DOCKING SEQUENCE Cue Card)

Retract Ring

9. If FIXERS OFF lt on:
PWR OFF pb – push
ON pb – push
✓FIXERS OFF lt off
10. On MCC GO (RING ALIGNED lt on and [PETAL POS BASE (three) not changing] for 60 sec):
0:00 A7L RING IN pb – push
CRT ✓DRV CMD – ON [PETAL POS BASE (three) – decr]
✓ FIXERS – ON
✓ CLUTCH – LOCK / <blank>

* If RING ALIGNED lt – off: *
* PWR ON pb – push *
* When RING ALIGNED lt – on and [PETAL POS BASE (three) *
* not changing] for 60 sec: *
* RING IN pb – push *

3:15 11. ✓RDY TO HK lt – on [PETAL POS BASE (three) ≤ 7 %]

HOOK VELCRO

Close Hooks

0:00		12. ✓HOOKS 1,HOOKS 2 OP lts (two) – off [HOOK 1,2 POS (two) ≥ 4% & incr]
	CRT	✓HK 1,2 DRV CMD (two) – ON
		* If no auto Hook drive, and HK 1(2) DRV CMD – OFF: *
	A7L	* CLOSE HOOKS pb – push *
0:20	CRT	13. ✓RING DRV CMD – OFF
		* If RING DRV CMD – ON 20 sec after RDY TO HK lt on: *
	A7L	* PWR ON pb – push *
≤ 1:30		14. ✓INTERF SEALED lt – on (expect intermittent lt initially)
2:30		15. ✓HOOKS 1, HOOKS 2 CL lts (two) – on [HOOK 1,2 POS (two) = 92%]
	CRT	✓HK 1,2 IND (two) – blank/CL
		✓ODS INDIV HK CL (twelve) – CL
		16. If PWR OFF/ON pb performed Post–Contact, go to MANUAL DOCKING SEQUENCE (DOCKING SEQUENCE Cue Card) >>

Load Relieve Capture Latches (Extend Ring)

2:30	CRT	17. ✓RING DRV CMD – ON [PETAL POS BASE (three) – incr]

Open Capture Latches/Retract Ring to FNL POS

2:40	A7L	18. ✓LAT CL lt – off
2:45		✓OP lt – on
	CRT	✓RING DRV CMD – ON [PETAL POS BASE (three) – decr]
		✓FIXERS – ON
2:50	A7L	19. ✓CAPTURE lt – off
		✓RING FNL POS lt – on [PETAL POS BASE (three) = 5%]
3:00	CRT	20. ✓DRV CMD – OFF

Power Off

	A7L	21. PWR OFF pb – push
		✓STATUS lts (eighteen) – off
		22. Return to CAPTURE (APPROACH Cue Card)

MANUAL DOCKING SEQUENCE

Load Relieve Capture Latches (Extend Ring) – MANUAL

	A7L	1. APDS CIRC PROT OFF pb – push (lt on)
0:00		2. RING OUT pb – push
0:10		3. PWR ON pb – push
	CRT	✓RING DRV CMD – OFF

Open Capture Latches – MANUAL

	A7L	4. ✓APDS CIRC PROT OFF lt – on
		✓PWR (three) – ON (A_{DS}, B_{DS}, C_{DS} lts on)
0:00		OPEN LATCHES pb – push
		✓LAT CL lt – off
0:05		✓OP lt – on

Retract Ring to FNL POS – MANUAL

0:00		5. RING IN pb – push
	CRT	✓RING DRV CMD – ON [PETAL POS BASE (three) = decr]
		✓FIXERS – ON
	A7L	✓CAPTURE lt – off
0:10		✓RING FNL POS lt – on [PETAL POS BASE (three) = 5%]
0:20	CRT	✓DRV CMD – OFF

Power Off

	A7L	6. PWR OFF pb – push
		✓STATUS lts (eighteen) – off
		7. Return to CAPTURE (APPROACH Cue Card)

FORCE RING ALIGNMENT

	A7L	1. ✓APDS CIRC PROT OFF pb – push (lt on)
		2. ✓FIXER OFF pb – push (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
~0:15	A7L	✓RING INIT POS lt – on (off at ~0:30)
	CRT	4. When [PETAL POS BASE (any) = 92%]:
	A7L	PWR ON pb – push
	CRT	5. Allow relative motion to damp
		6. When [PETAL POS BASE (three) not changing for 60 sec]:
	A7L	RING OUT pb – push
		7. ✓RING FWD POS lt – on [PETAL POS BASE (three) = 98%]
	CRT	8. ✓DRV CMD – OFF
	A7L	✓FIXERS OFF lt – off
		✓RING ALIGNED lt – on [PETAL POS RING (three) 50±1%] and [PETAL POS BASE (three) within 1%]
		9. Wait 10:00 for stack oscillations to damp (not detectable)
		10. Perform RETRACT RING (DOCKING SEQUENCE Cue Card, step 9) >>

(reduced copy)

TOP

HOOK VELCRO

STOPWATCH RDOT CONVERSION

TIME BETWEEN 1 FT MARKS (SEC)	RANGE RATE (FT/SEC)
2	0.50
3	0.33
4	0.25
5	0.20
5.5	0.18
6	0.17
6.5	0.15
7	0.14
7.5	0.13
8	0.125
8.5	0.12
9	0.11
10	0.10
11	0.09
12	0.08
13	0.075
14	0.07
15	0.067
16	0.063
18	0.056
20	0.050

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)

RNDZ–6a/113/O/A

TOP
BACK OF 'STOPWATCH RDOT CONVERSION'

HOOK
VELCRO

RDOT vs DELTA RNG/DELTA TIME

	Rdot (fps)													
ΔRng (ft) / ΔT (m:ss)	1000	800	700	600	500	400	300	250	200	150	100	50	25	10
0:45						8.9	6.7	5.6	4.4	3.3	2.2	1.1	0.56	0.22
0:50					10.0	8.0	6.0	5.0	4.0	3.0	2.0	1.0	0.50	0.20
0:55					9.1	7.3	5.5	4.5	3.6	2.7	1.8	0.91	0.45	0.18
1:00				10.0	8.3	6.7	5.0	4.2	3.3	2.5	1.7	0.83	0.42	0.17
1:10			10.0	8.6	7.1	5.7	4.3	3.6	2.9	2.1	1.4	0.71	0.36	0.14
1:20		10.0	8.8	7.5	6.3	5.0	3.8	3.1	2.5	1.9	1.3	0.63	0.31	0.13
1:30		8.9	7.8	6.7	5.6	4.4	3.3	2.8	2.2	1.7	1.1	0.56	0.28	0.11
1:40	10.0	8.0	7.0	6.0	5.0	4.0	3.0	2.5	2.0	1.5	1.0	0.50	0.25	0.10
1:50	9.1	7.3	6.4	5.5	4.5	3.6	2.7	2.3	1.8	1.4	0.91	0.45	0.23	0.09
2:00	8.3	6.7	5.8	5.0	4.2	3.3	2.5	2.1	1.7	1.3	0.83	0.42	0.21	0.08
2:20	7.1	5.7	5.0	4.3	3.6	2.9	2.1	1.8	1.4	1.1	0.71	0.36	0.18	0.07
2:40	6.3	5.0	4.4	3.8	3.1	2.5	1.9	1.6	1.3	0.9	0.63	0.31	0.16	0.06
3:00	5.6	4.4	3.9	3.3	2.8	2.2	1.7	1.4	1.1	0.8	0.56	0.28	0.14	0.06

NOTE
If RPOP is available, use RPOP subtended angle function

TIME	DELTA TIME	RANGE	DELTA RANGE

RNDZ–6b/113/O/B

HOOK VELCRO

GPC/MDM FAILURE RESPONSE DURING RNDZ

HOOK VELCRO

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)

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

* Expect this NBAT if GPC fail

MALFUNCTION	>>

RNDZ–7a/113/O/A

TOP
BACK OF 'GPC/MDM FAILURE RESPONSE DURING RNDZ'

HOOK VELCRO

RNDZ REF DATA

HOOK VELCRO

FF1
FRCS MANF **1** JETS
IMU 1
L OMS GMBL PRI SEL
F,A THC contacts 1
L,A RHC channel 1
–Z STRK
C3 DAP LTS
L,R,F RCS OX QTY
L,F RCS LOWEST QTY

FF2
FRCS MANF **2** JETS
IMU 2
L OMS GMBL SEC SEL
F,A THC contacts 2
L RHC channel 2
A RHC P,Y channel 2

FF3
FRCS MANF **4** JETS
IMU 3
R OMS GMBL SEC SEL
RR→NAV/RPOP
F,A THC contacts 3
L,A RHC channel 3
VERNS
–Y STRK
A6 DAP LTS
R RCS LOWEST QTY
L,R,F RCS FU QTY

FF4
FRCS MANF **3** JETS
R OMS GMBL PRI SEL
A RHC Roll channel 2

FA1
ARCS MANF **1** JETS
L OMS GMBL PRI
VERNS

FA2
ARCS MANF **3** JETS
L OMS GMBL SEC
VERNS

FA3
ARCS MANF **2** JETS
R OMS GMBL SEC

FA4
ARCS MANF **4** JETS
R OMS GMBL PRI

PL1
GPC KU PTG
KU self–test

MDM OA1
LOMS DEORB ONLY

MDM OA2
ROMS DEORB ONLY

DSC OF2
FRCS OX, FU QTY
VERNS

DSC OL1
LRCS OX QTY
VERNS

DSC OL2
LRCS OX, FU QTY

DSC OR1
RRCS OX QTY
VERNS

DSC OR2
RRCS OX, FU QTY

DSC OA2
VERNS

CNTL AB1
PLB LTS (F,P BHD)
L ADI ATT REF set cap

CNTL BC1
PLB LTS (FS, MID–P)
R ADI ATT REF set cap
VERNS

CNTL CA1
PLB LTS (AP, MID–S)
A ADI ATT REF set cap
OVHD DOCKING LIGHT

CNTL AB2
L ADI ATT REF set cap
L ADI: ATT,ERR,RATE set
F MANF **1** JETS

CNTL BC2
R ADI ATT REF set cap
R ADI: ATT,ERR,RATE set
A6 DAP ROT,TRANS pbs (PCT)
VERNS
F MANF **2** JETS

CNTL CA2
A ADI ATT REF set cap
A ADI: ATT,ERR,RATE set
F MANF **3** JETS
A6 DAP ROT,TRANS pbs (PCT)

CNTL AB3
C3 DAP ROT,TRANS pbs

CNTL BC3
C3 DAP ROT,TRANS pbs

CNTL CA3
F MANF **4** JETS

MAIN A
AC1B: RCS/OMS QTY gauges
FWD EVENT TIMER
APC1: L OMS GMBL PRI
R OMS GMBL SEC
VERNS
FLC1: F MANF **1** JETS
ALC1: VERNS
OMS QTY GAUGING
O14: –Z STRK
L INST PWR
AFT EVENT TIMER
MPC1: OVHD DOCKING LTS
AFT STB PLB LTS
FWD PORT PLB LTS

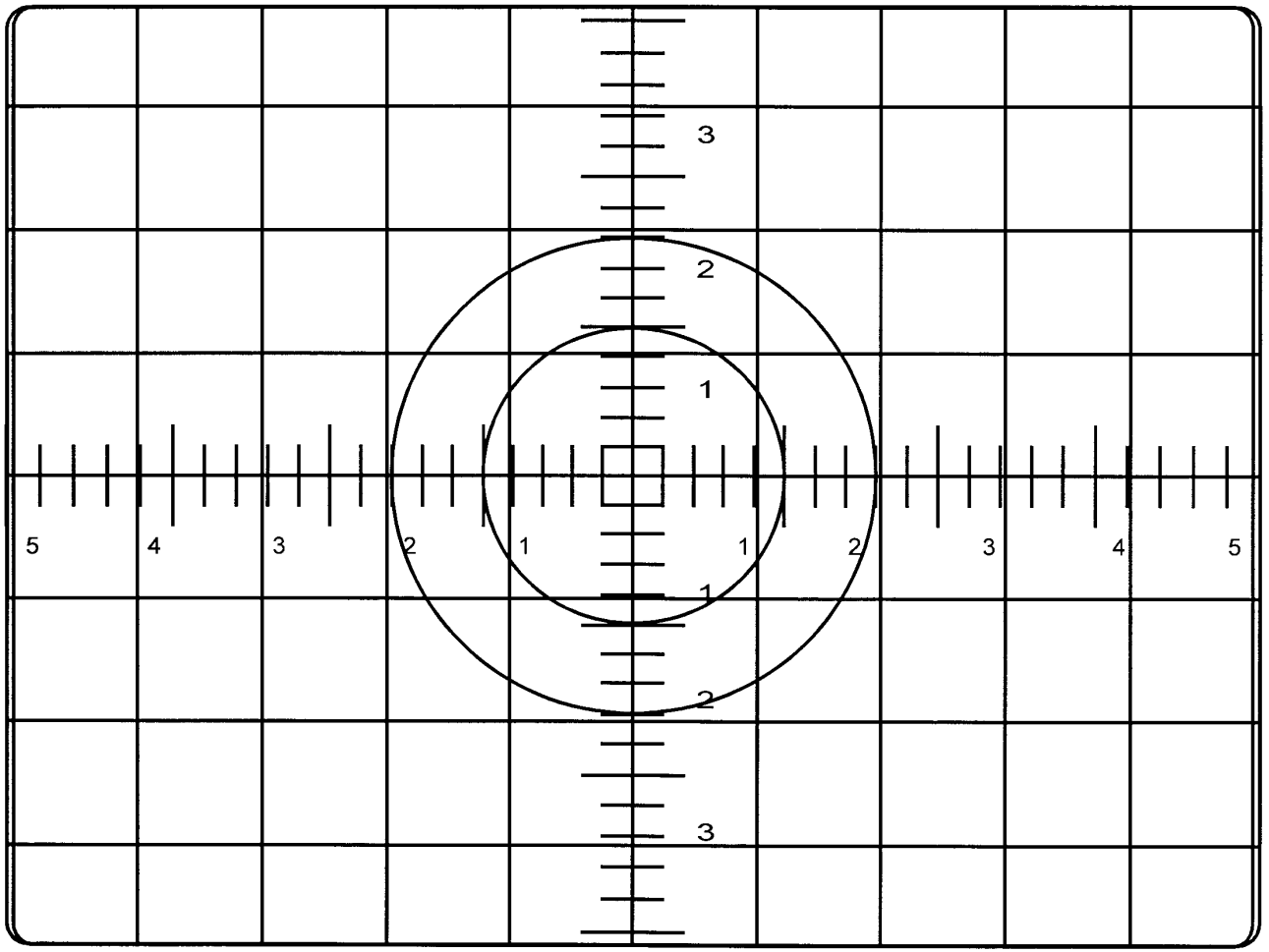
MAIN B
MPC2: KU ANT HTRS 1 & 2
FWD STB PLB LTS
TCS
MID–PORT PLB LTS
APC2: LOMS GMBL SEC
VERNS
ALC2: VERNS
L OMS QTY GAUGE
(single L OMS burns)
O15: –Y STRK
FWD EVENT TIMER
R14: CCTV CAM–A
CCTV MON–2
KU ANT ELEC 1 & 2
(loss of KU comm & RR)
FLC2: F MANF **2** JETS

MAIN C
AC3A: COAS PWR
FLC3: F MANF **4** JETS
VERNS
APC3: R OMS GMBL PRI
ALC3: R OMS QTY GAUGING
(single R OMS burns)
O16: PNL O3 OMS/RCS QTY
R14: CCTV CAM–B
CCTV KEEL CAMERA
KU SIG PROC
MPC3: AFT PORT PLB LTS
MID–STBD PLB LTS

RNDZ–7b/113/O/A

Note: Fabricate As Transparency

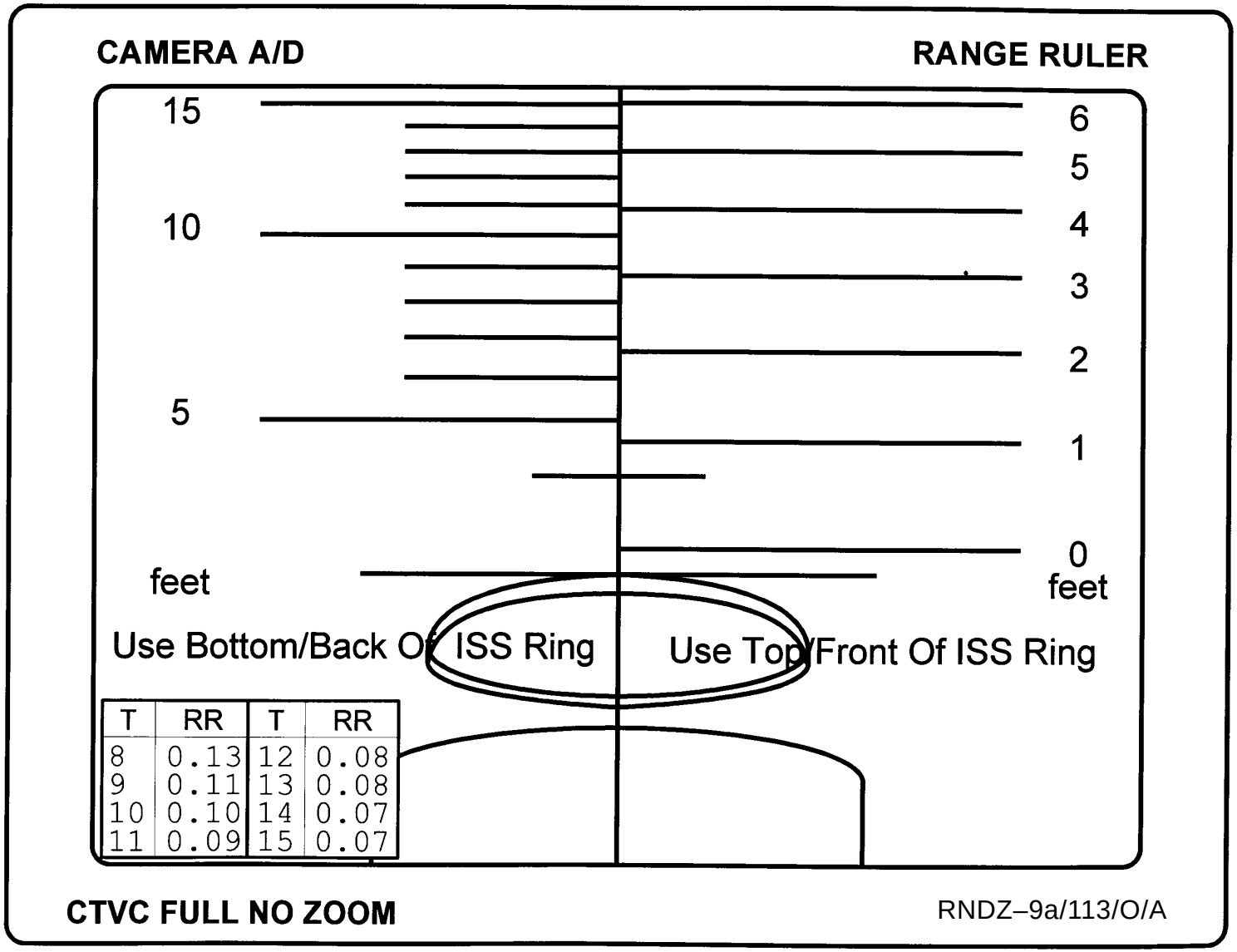
C/L CAMERA **CORRIDOR AND ALIGNMENT**



CTVC 40.0 DEG HFOV - CORRIDOR
CTVC FULL ZOOM - ALIGNMENT

RNDZ–8a/113/O/A

Note: Fabricate As Transparency



FAB USE ONLY

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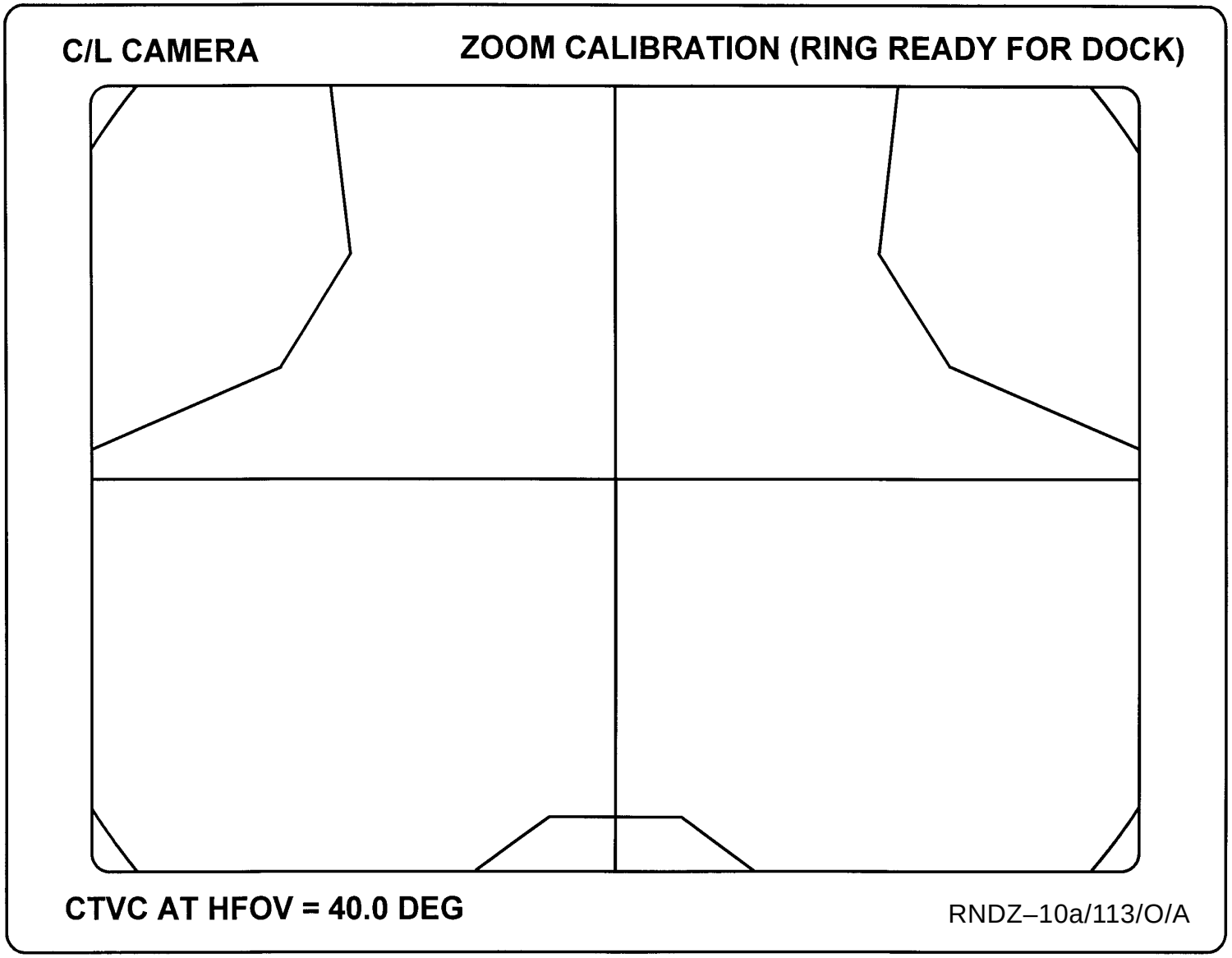
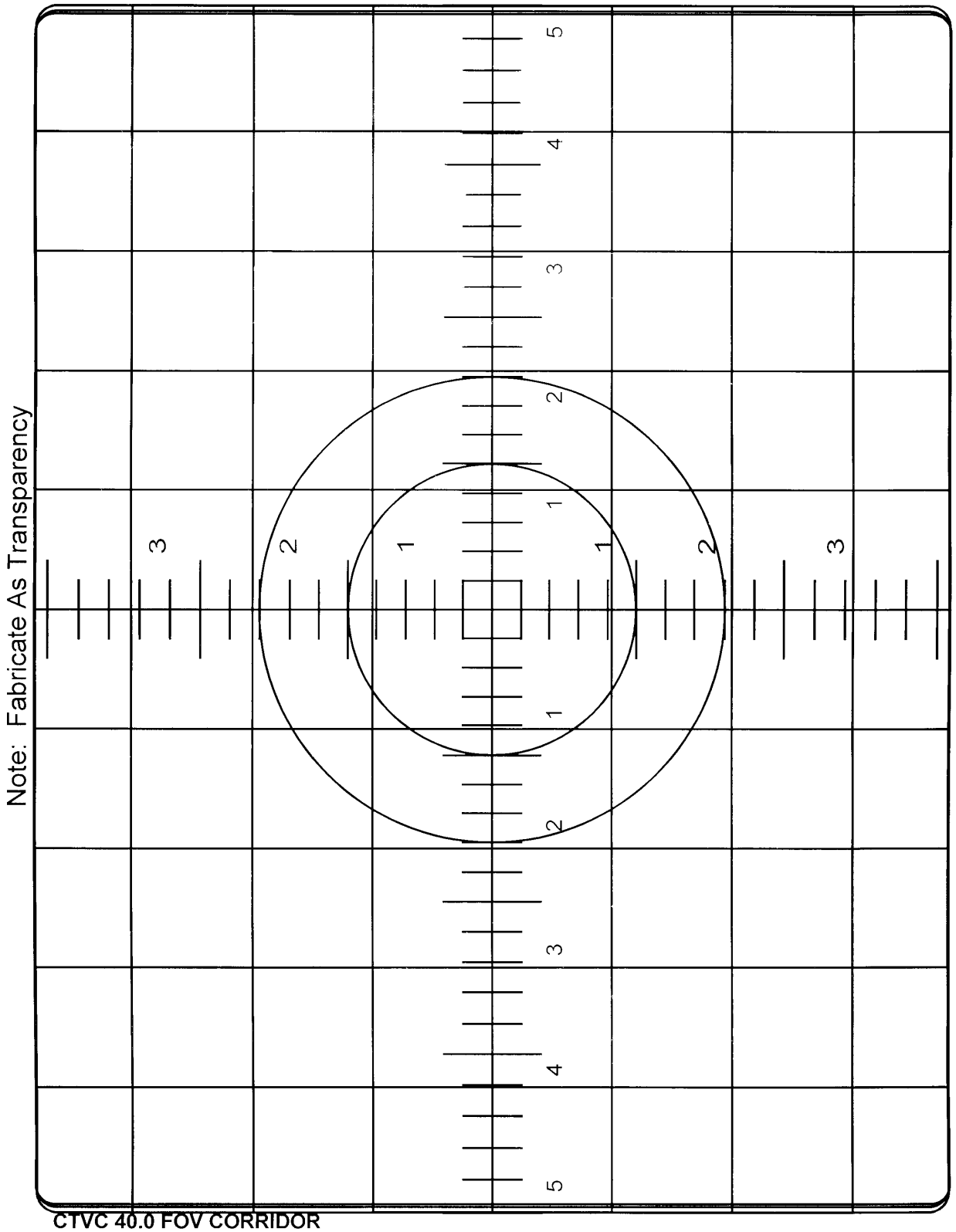
CC 9–19

RNDZ/113/FIN

Note: Fabricate As Transparency



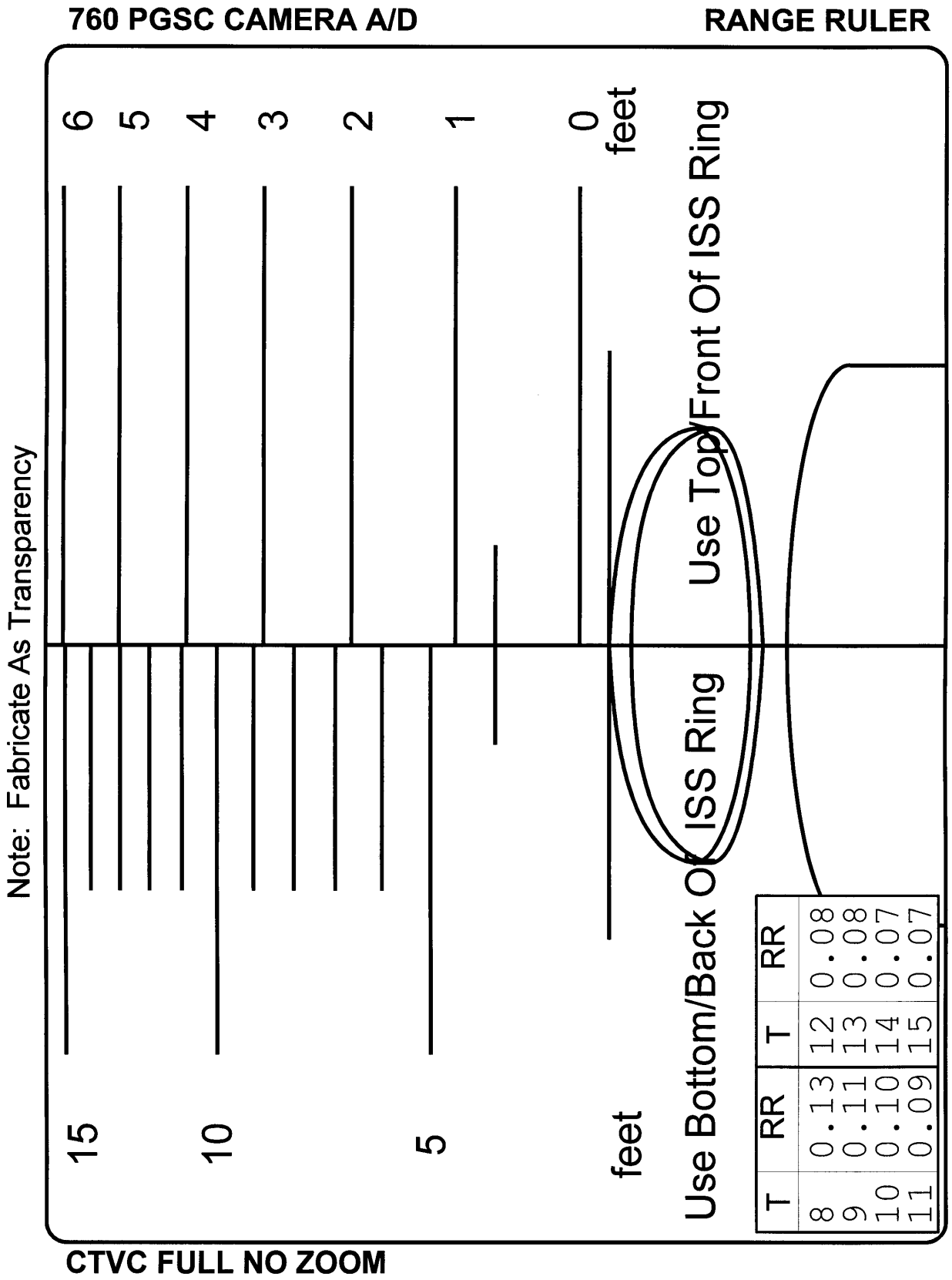
760 PGSC DISPLAY OF C/L CAMERA CORRIDOR AND ALIGNMENT



CTVC 40.0 FOV CORRIDOR
CTVC FULL ZOOM ALIGNMENT

RNDZ–11a/113/O/A

(reduced copy)



RNDZ–12a/113/O/A

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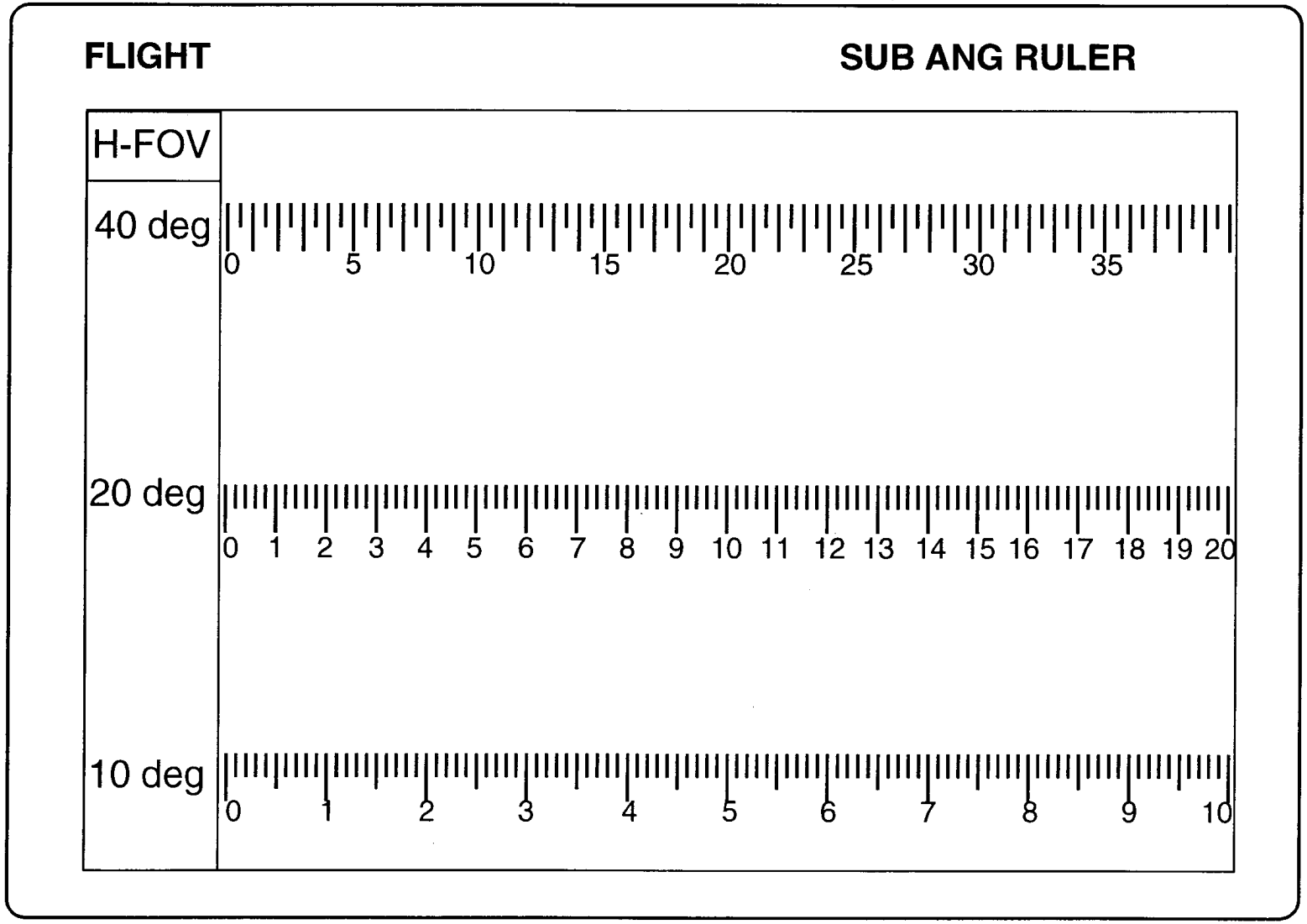
Note: Fabricate as Transparency



RNDZ-13a/113/O/A

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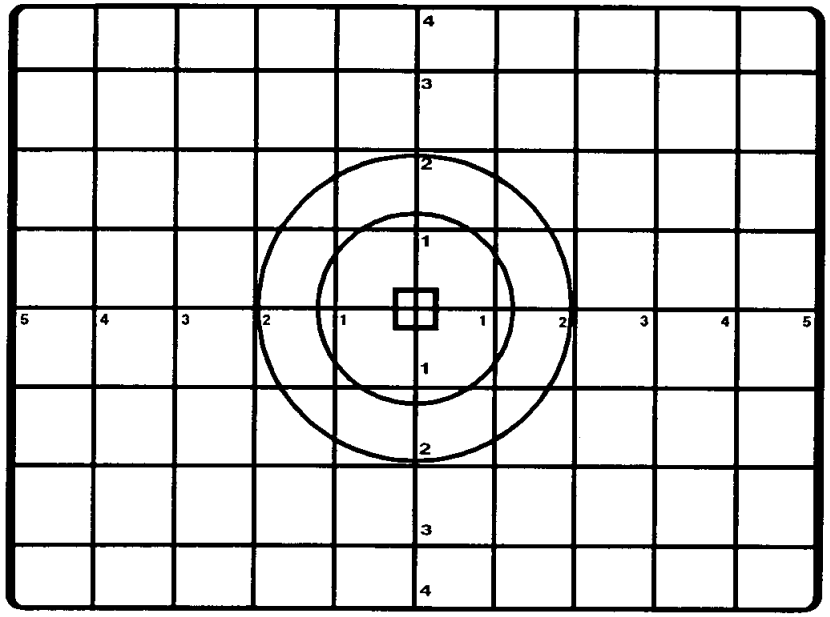
Note: Fabricate As Transparency

RNDZ-14a/113/O/A

V10 MONITOR **CORRIDOR**



CTVC 40.0 DEG HFOV - CORRIDOR
CTVC FULL ZOOM - ALIGNMENT

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Space Shuttle Program
FLIGHT DATA FILE

JSC–48072–113
FINAL

RENDEZVOUS

STS 113

Flight Cover (trim bottom to expose tabs)