



International Space Station Robotics Group Robotics Book - Flight Specific

ISS-ULF5

Mission Operations Directorate
Operations Division

16 JUN 10

This publication replaces
all previous publications.
These procedures are available
electronically on the SODF Homepage
at <http://mod.jsc.nasa.gov/do3>

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United Space Alliance

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**INTERNATIONAL SPACE STATION
ROBOTICS GROUP
ROBOTICS BOOK - FLIGHT SPECIFIC
ISS-ULF5**

16 JUN 10

APPROVED BY:



Meghan E. Labounty
Book Manager



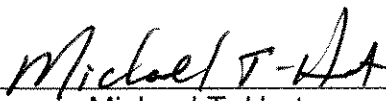
Manager, Flight Procedures

Case



SODF Coordinator

ACCEPTED BY:



Michael T. Hurt
SODF Manager

Incorporates the following:	
CR: Robotics_FS-00982A	Robotics_FS-00984
Robotics_FS-00983A	Robotics_FS-00987

Uplinked Messages (or Approved Flight Notes) replaced by this revision,
remove from Book:

None

**INTERNATIONAL SPACE STATION
ROBOTICS GROUP
ROBOTICS BOOK - FLIGHT SPECIFIC
ISS-ULF5**

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NOMINAL

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1.110 BERTHED ELC4 GRAPPLE SETUP

(RBT FS/ULF5/FIN/HC/SPN)

Verify SRMS is at Docking position.

SY	SP	EP	WP	WY	WR
0.0	+25.0	-25.0	+5.0	0.0	0.0

THC/
RHC

1. HAND CONTROLLER CALIBRATION

Deflect each axis to positive and negative hard stops.

2. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
07: P1 Lower Inboard (+150, +35)	09: P1 Lower Outboard (+120, +25)	03: S1 Lower Outboard (+60, +20)



Figure 1.- Docking Park Position
(07: P1 Lower Inboard: +150, +35).

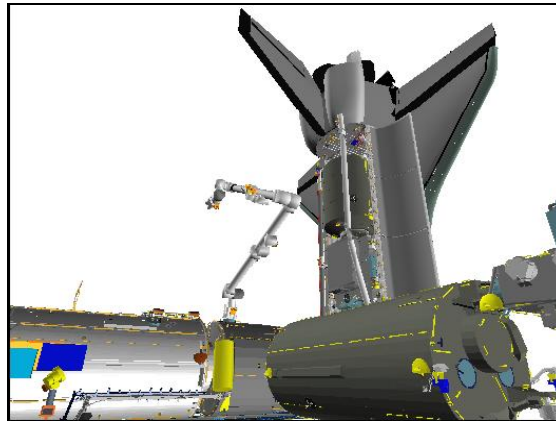


Figure 2.- Docking Park Position
(09: P1 Lower Outboard: +120, +25).

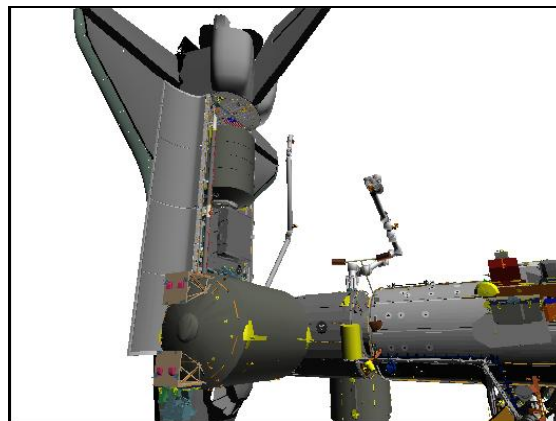


Figure 3.- Docking Park Position
(03: S1 Lower Outboard: +60, +20).

1.110 BERTHED ELC4 GRAPPLE SETUP

(RBT FS/ULF5/FIN/HC/SPN) Page 2 of 3 pages

PCS MSS: SSRMS:

Change Loaded Parameters ► ELC ► ELC4 Unberth SYH
Verify 'Loaded Parameters' (three) – ELC4 Unberth, SSRMS, SY Held

Change Unloaded Parameters ► Unloaded ► LEE Tip SYH
Verify 'Unloaded Parameters' (two) – LEE Tip, SY Held

Change Display ► Orbiter ► ELC4 FRGF (Verify Orbiter>ELC4 FRGF)

Change Command ► SSRMS ► Internal (Verify SSRMS>Internal)

Verify SSRMS at Docking Park position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+180.0	-180.0	-120.0	-130.0	-209.0	-180.0	+177.2
X	Y	Z	Pitch	Yaw	Roll	
-976	-3	-439	+56.5*	-89.8	-154.6*	
FOR	Unloaded – LEE Tip, SY Held					
Disp	Orbiter>ELC4 FRGF					

*Display Singularity

3. JOCAS TO ELC4 PRE-GRAPPLE (2 MINUTES)

MSS: SSRMS: MSS Safing:

cmd SSRMS: Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → VERNIER (Verify Vernier on PCS)

PCS MSS: SSRMS:

Enter Mode – Joint OCAS (Verify blue)

pick File ► ELC4 ► Berthed Pre-Grapple

Verify 'Joint Angles' 'Destination' for JEF Pre-Grapple position.

SR	SY	SP	EP	WP	WY	WR
+74.5	-173.6	-189.1	-131.7	-128.6	-164.6	+177.2

cmd Load (Verify Sequence Status – Confirm or Cancel)

MON Verify joint angles and errors are correct on Joint Angle Position overlay.

	SR	SY	SP	EP	WP	WY	WR
(current)	+180.0	-180.0	-120.0	-130.0	-209.0	-180.0	+177.2
TGT	+74.5	-173.6	-189.1	-131.7	-128.6	-164.6	+177.2
ERR	+105.5	-6.4	+69.1	+1.7	-80.4	-15.4	0.0

1.110 BERTHED ELC4 GRAPPLE SETUP

(RBT FS/ULF5/FIN/HC/SPN) Page 3 of 3 pages

PCS **cmd** Confirm (Verify Sequence Status – Auto Seq sw - Hot)

DCP AUTO SEQ → PROC

PCS MSS: SSRMS:

Verify Posn Hold – orange

Verify SSRMS at ELC4 Pre-Grapple position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+74.5	-173.6	-189.2	-131.7	-128.6	-164.5	+177.1
X	Y	Z	Pitch	Yaw	Roll	
-150	0	0	0.0	0.0	0.0	
FOR	Unloaded – LEE Tip, SY Held					
Disp	Orbiter>ELC4 FRGF					

NOTE

Expect the following message when safing is commanded:

'R3Z - MSS OCS SSRMS Prime(Redun) ACU SRT Cat-1 Brk Stat Fail' (SCR 17495)

This message should return to Norm.

DCP SAFING → SAFE (Verify ON)

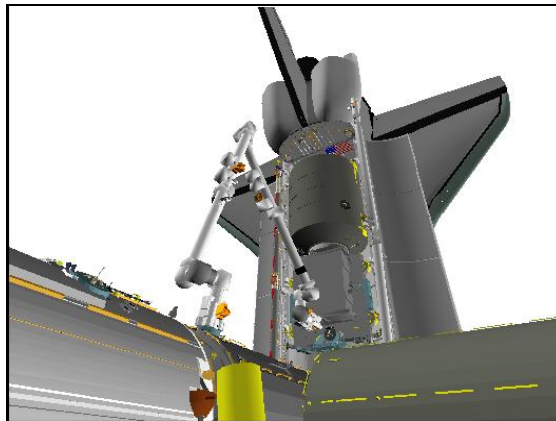


Figure 4.- Berthed ELC4 Pre-Grapple
(07: P1 Lower Inboard: +150, +35).

4. SETUP FOR GRAPPLE

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
07: P1 Lower Inboard (+145, +35)	25: Tip LEE (Full Zoom Out)	72

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1.120 ELC4 UNBERTH AND INSTALL

(RBT FS/ULF5/FIN/HC/SPN)

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NOTE

Callouts in gray are for shuttle crew.

1. ELC4 FRGF GRAPPLE

Review [SSRMS LEE CUE CARD \(SSRMS IS LOADED AND LEE CAUTION IS ANNUNCIATED\)](#), all (SODF: RBT GEN: REFERENCE: CUE CARD).

1.1 Setup

Verify SRMS is at ELC4 Unberth Viewing position.

SY	SP	EP	WP	WY	WR
+15.2	+71.3	-103.8	-77.1	-50.9	-184.9

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
07: P1 Lower Inboard (+145, +35)	25: Tip LEE (Full Zoom Out)	72 (DNLK): Camera A (-15, +10) Zoom = 25	Camera D (+25, +10)	SRMS Elbow (-65, -15)

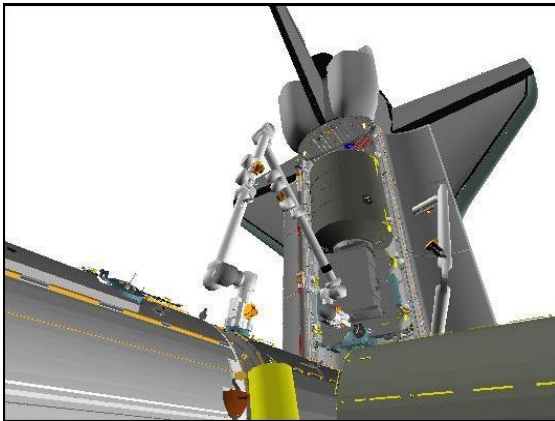


Figure 1.- Berthed ELC4 Pre-Grapple (07: P1 Lower Inboard: +145, +35).

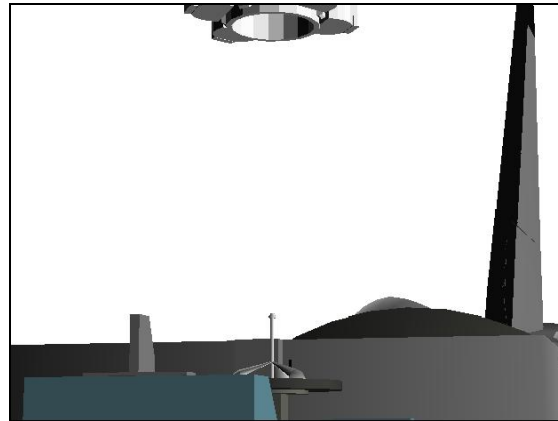


Figure 2.- Berthed ELC4 Pre-Grapple (72: Camera A: -15, +10: Zoom = 25).

1.120 ELC4 UNBERTH AND INSTALL

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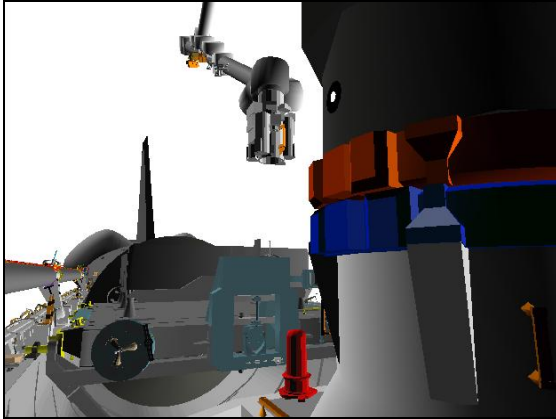


Figure 3.- Berthed ELC4 Pre-Grapple
(Camera D: +25, +10).

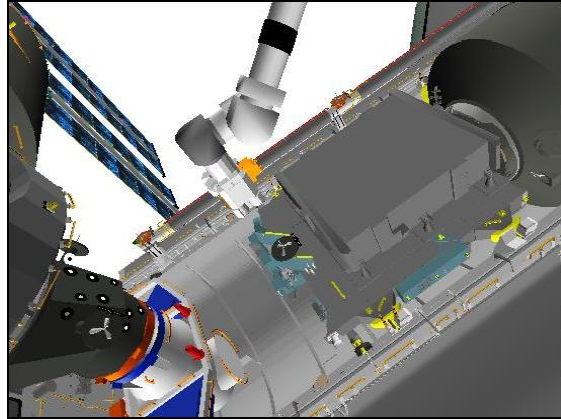


Figure 4.- Berthed ELC4 Pre-Grapple
(SRMS Elbow: -65, -15).

PCS

MSS: SSRMS:

Verify 'Loaded Parameters' (three) – ELC4 Unberth, SSRMS,
SY Held

Verify Unloaded Parameters – √

Verify 'Unloaded Parameters' (two) – LEE Tip, SY Held

Verify Display – Orbiter>ELC4 FRGF

Verify Command – SSRMS>Internal

MSS: SSRMS: MSS Safing:

cmd SSRMS: Remove (Verify Not Safed)

DCP

BRAKES SSRMS → OFF (Verify OFF)

RHC

RATE → VERNIER (Verify Vernier on PCS)

PCS

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired

1.2 Maneuvering to Within Grapple Envelope

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Yaw (Verify SY – Locked)

1.120 ELC4 UNBERTH AND INSTALL

(RBT FS/ULF5/FIN/HC/SPN)

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THC/
RHC

Maneuver to within grapple envelope (THC In, +X).

1.3 Slowing Auto FRGF Capture

PCS

MSS: SSRMS: Tip LEE: SSRMS Tip LEE

cmd Capture ► Automatic ► Slow, Limp (Verify Speed – Slow)

Verify '**Confirm or Terminate**' prompt.

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Capture

RHC

TRIGGER → Press (momentarily)

PCS

Verify 'Snare' Close, Capture (two) – blue (12s max)

Verify Capture to Latch – No (SCR 19282)

Verify 'Carriage' Tension ~5500 N (90s max)

Verify 'Carriage' Retract – blue

Verify 'Carriage' Brakes – On (15s max)

Verify Loaded Parameters – √

Verify 'Loaded Parameters' (three) – ELC4 Unberth, SSRMS,
SY Held

DCP

BRAKES SSRMS → ON (Verify ON)

2. ELC4 UNBERTH SETUP

NOTE

This maneuver has the following clearance concerns:

- a) ELC4 Trunnion Pin to OBSS Boom, minimum of 13 cm (5 in) at Z = -78. Monitor with Camera D and Tip Elbow.
- b) ELC4 Trunnion Pin to OBSS FRGF, minimum of 9 cm (3 in) at Z = -99. Monitor with Camera C, Tip Elbow, and LAB Stbd Zenith.
- c) ELC4 PVGF to PMM CBM, minimum of 16 cm (6 in) at Z = -144. Monitor with SRMS EE and Tip Elbow.

1.120 ELC4 UNBERTH AND INSTALL

(RBT FS/ULF5/FIN/HC/SPN)

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
71 (MON2): Mux D/A D (-4, -4) Zoom = 20 A (+4, -4) Zoom = 20	24: Tip Elbow (+35, +25) 07: P1 Lower Inboard (+145, +35)	72 (DNLK): Camera C (0, 0) Zoom = 15	Camera B (0, 0) Zoom = 15	SRMS EE Zoom = 25 SRMS Elbow (-45, -20)

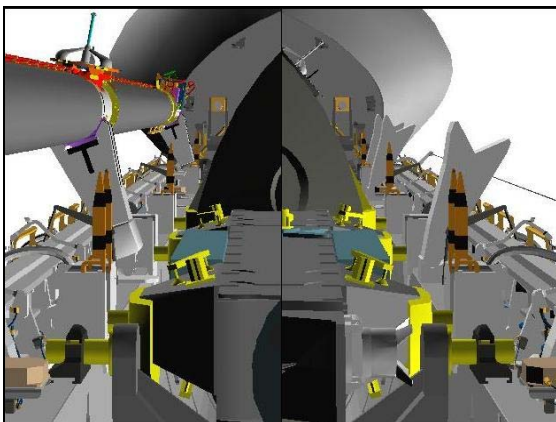


Figure 5.- Berthed ELC4 Grappled
(71: Mux D/A: -4, -4/+4, -4: Zoom = 20).

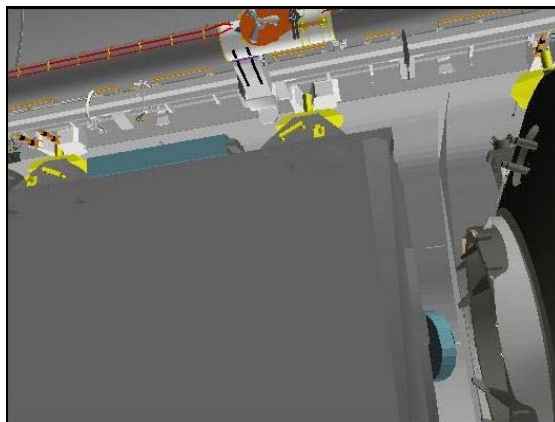


Figure 6.- Berthed ELC4 Grappled
(24: Tip Elbow: +35, +25).

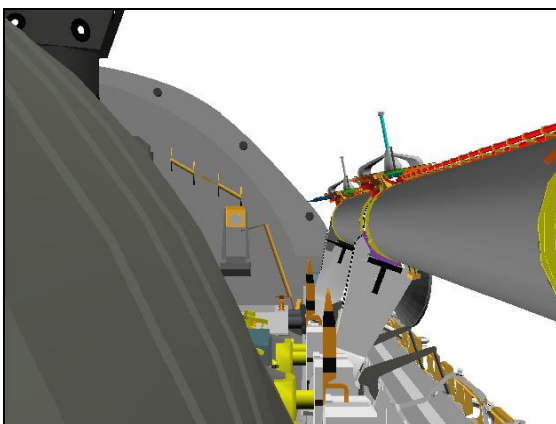


Figure 7.- Berthed ELC4 Grappled
(Camera C: 0, 0: Zoom = 15).

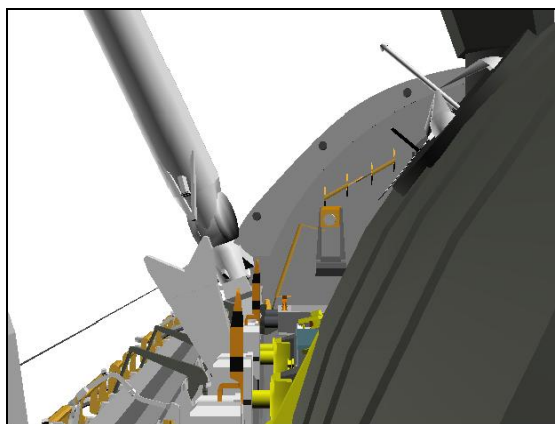


Figure 8.- Berthed ELC4 Grappled
(Camera B: 0, 0: Zoom = 15).

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Figure 9.- Berthed ELC4 Grappled (SRMS EE).

PCS

MSS: SSRMS:

Change Display ► Orbiter ► ELC4 Unberth (Verify Orbiter>ELC4 Unberth)

Change Command ► ISS ► OBAS (Verify ISS>OBAS)

Verify SSRMS at ELC4 Grapple position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+78.1	-173.6	-199.5	-117.9	-132.5	-168.1	+177.1
X	Y	Z	Pitch	Yaw	Roll	
0	0	0	0.0	0.0	0.0	
FOR	Loaded – ELC4 Unberth, SY Held					
Disp	Orbiter>ELC4 Unberth					

 * If using shuttle attitude control
 * Verify in attitude, then DAP: FREE.

On MCC-H GO, “GO for ELC4 Unberth.”

Notify PRLA operator, “GO for PRLA Ops.”

NOTE
PRLA operator will perform steps 3 to 5.

1.120 ELC4 UNBERTH AND INSTALL

(RBT FS/ULF5/FIN/HC/SPN)

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3. ACTIVATING LATCHES

On SSRMS operator, "GO for PRLA Ops."

NOTE

When MCA LOGIC switches taken OFF, KU will mode to standby.

MPM and MRL tbs – bp

MA73C:A MCA LOGIC MNC MID 2 – OFF
MA73C:B MCA LOGIC MNB MID 4 – OFF

A6U √PL RETEN LAT (five) – OFF
PL RETEN PL SEL – 3
R13L PL BAY MECH PWR SYS 1,2 (two) – ON
A6U PL RETEN LOGIC PWR SYS 1,2 (two) – ON

SM 97 PL RETENTION

CRT √PL SEL 3 RDY-FOR-LAT 1,2,3,4 (eight): 1
√LAT 1,2,3,4 (eight): 1

* If any rel msw shows '1'
* Expect single motor time (60 seconds).

4. PRLA RELEASE

A6U √PL RETEN LAT 1,2,3,4 (four) tb – LAT
√RDY 1,2,3,4 (four) tb – gray

Note single motor times (> 30 seconds).

PL RETEN LAT 1,2 (two) – REL (tb-REL), 60 seconds max
PL RETEN LAT 1,2 (two) – OFF
PL RETEN LAT 3,4 (two) – REL (tb-REL), 60 seconds max
PL RETEN LAT 3,4 (two) – OFF

5. DEACTIVATING LATCHES

R13L PL RETEN LOGIC PWR SYS 1,2 (two) – OFF
PL BAY MECH PWR SYS 1,2 (two) – OFF

MA73C:A MCA LOGIC MNC MID 2 – ON
MA73C:B MCA LOGIC MNB MID 4 – ON

Notify SSRMS operator, "GO for ELC4 Unberth."

6. MANUALLY MANEUVER ELC4 TO PAYLOAD BAY HOVER

* If 'R3Q - SSRMS LEE Uncommanded Derigidize' Caution was annunciated
* during PRLA release or Carriage tension < 4400 N
*

PCS

* MSS: SSRMS: Tip LEE:
*
* **cmd** 'Carriage' Rigidize ► Slow (Verify Speed – Slow)
*
* Verify '**Confirm or Terminate**' prompt.
*
* **cmd** Confirm (Verify RHC Trigger Hot icon)
*
* Verify LEE Mode – Rigidize
*

RHC

* TRIGGER → Press (momentarily) (SCR 19064)
*

PCS

* Verify 'Carriage' Tension ~5500 N (90s max)
* Verify 'Carriage' Retract – blue
*

On PRLA operator, "GO for ELC4 Unberth."

DCP

BRAKES SSRMS → OFF (Verify OFF)

√Vernier

PCS

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Yaw (Verify SY – Locked)

1.120 ELC4 UNBERTH AND INSTALL

(RBT FS/ULF5/FIN/HC/SPN)

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THC/ RHC Maneuver ELC4 to Hover position (within 5 cm/1 deg).
(THC Up, -Z)

		Locked						
		SR	SY	SP	EP	WP	WY	WR
		+78.1	-173.6	-199.5	-117.9	-132.5	-168.1	+177.1
		X	Y	Z	Pitch	Yaw	Roll	
Berthed		0	0	0	0.0	0.0	0.0	
1: Z	-			-50				
2: Y	-		-5					
3: Z	-			-400				
Hover		0	-5	-400	0.0	0.0	0.0	
		SR	SY	SP	EP	WP	WY	WR
		+57.0	-173.6	-163.6	-154.1	-129.5	-147.1	+177.7
		FOR	Loaded – ELC4 Unberth, SY Held					
		Disp	Orbiter>ELC4 Unberth					

PCS MSS: SSRMS:

Enter Mode – Standby (Verify blue)

* If using shuttle attitude control

* Perform **ROBOTICS ATTITUDE MAINTENANCE**, steps 1 to 3

* (ORB OPS, REBOOST/DAP), then:

7. FOR OCAS TO ELC4 HANDOFF (7 MINUTES)

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (+50, +20)	07: P1 Lower Inboard (+145, +35) 09: P1 Lower Outboard (+115, +20)	72 (DNLK): Camera C (0, +35)	Camera D (-5, +20)	SRMS Elbow (-65, +10)

1.120 ELC4 UNBERTH AND INSTALL

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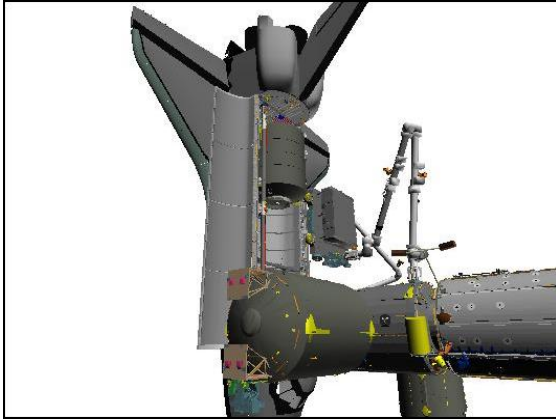


Figure 10.- ELC4 Hover
(03: S1 Lower Outboard: +50, +20).

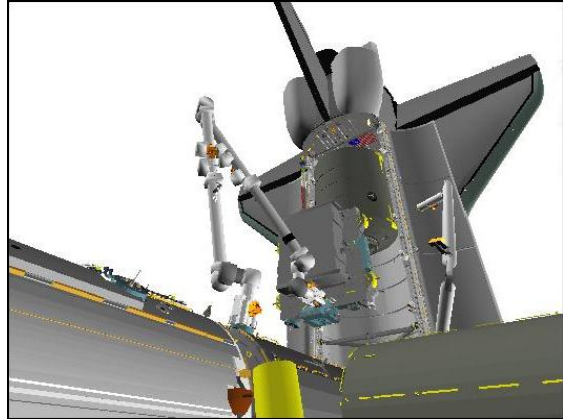


Figure 11.- ELC4 Hover
(07: P1 Lower Inboard: +145, +35).

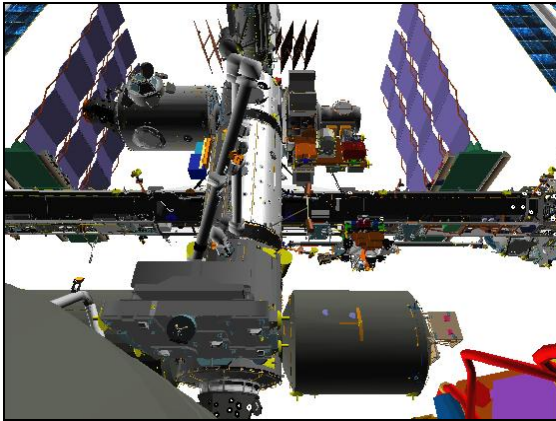


Figure 12.- ELC4 Hover
(72: Camera C: 0, +35).

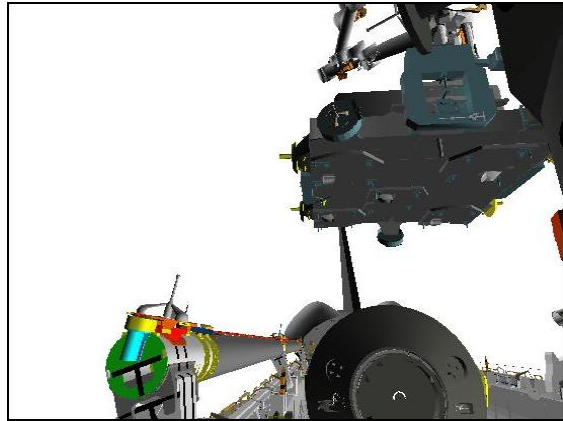


Figure 13.- ELC4 Hover
(Camera D: -5, +20).

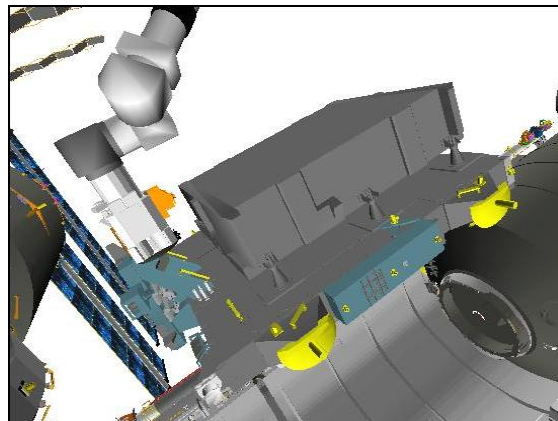


Figure 14.- ELC4 Hover
(SRMS Elbow: -65, +10).

1.120 ELC4 UNBERTH AND INSTALL

(RBT FS/ULF5/FIN/HC/SPN)

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NOTE

During this maneuver, expect the cross-cluster self collision warning to annunciate and return to norm (once).

RHC RATE → COARSE (Verify Coarse on PCS)

PCS MSS: SSRMS: SSRMS

Change Display ► Node2 ► PDGF (Verify Node2>PDGF)

Enter Mode – FOR OCAS (Verify blue)

MSS: SSRMS: SSRMS FOR OCAS: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

SSRMS FOR OCAS

pick File ► ELC4 ► Handoff

Verify 'FOR' 'Destination' for ELC4 Handoff position.

X	Y	Z	Pitch	Yaw	Roll
-520	-418	+1165	+129.1	-0.7	+89.0

cmd Load (Verify Sequence Status – Confirm or Cancel)

MON Verify FOR and errors are correct on FOR Position overlay.

	X	Y	Z	Pitch	Yaw	Roll
FOR	-403	-514	+99	+9.2	+1.1	+89.9
TGT	-520	-418	+1165	+129.1	-0.7	+89.0
ERR	+117	+96	-1066	-119.9	+1.8	+0.9

PCS **cmd** Confirm (Verify Sequence Status – Auto Seq sw - Hot)

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at ELC4 Handoff position (within 5 cm/1 deg).

Locked	SR	SY	SP	EP	WP	WY	WR
	+57.0	-128.4	-131.0	-62.8	-230.0	-159.3	+107.0
	X	Y	Z	Pitch	Yaw	Roll	
	-520	-418	+1165	+129.1	-0.7	+89.0	
FOR	Loaded – ELC4 Unberth, SR Held						
Disp	Node2>PDGF						

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(RBT FS/ULF5/FIN/HC/SPN)

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DCP BRAKES SSRMS → ON (Verify ON)

RHC RATE → VERNIER (Verify Vernier on PCS)

```
*****
* If using shuttle attitude control
* | Perform ROBOTICS ATTITUDE MAINTENANCE, steps 1 and 2
* | (ORB OPS, REBOOST/DAP), then:
*****
```

Notify SRMS operator, "SSRMS at ELC4 Handoff with brakes ON. SRMS GO for ELC4 grapple."

8. SSRMS RELEASE OF ELC4 FRGF AT HANDOFF

8.1 Setup

On SRMS operator, "ELC4 grapple complete and Brakes ON, SSRMS GO for ELC4 release."

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (+50, +30)	25: Tip LEE (Full Zoom Out)	13: LAB Stbd Zenith (-20, 0)	Camera D (-30, +25)	SRMS Elbow (0, +5) Zoom = 35



Figure 15.- ELC4 Port Hover (03: S1 Lower Outboard: +50, +30).



Figure 16.- ELC4 Port Hover (13: LAB Stbd Zenith: -20, 0).

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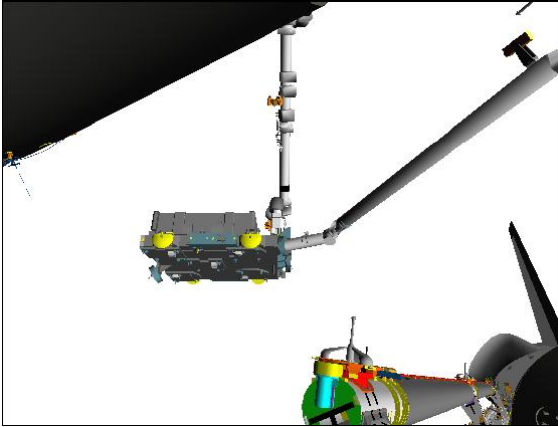


Figure 17.- ELC4 Port Hover
(Camera D: -30, +25).

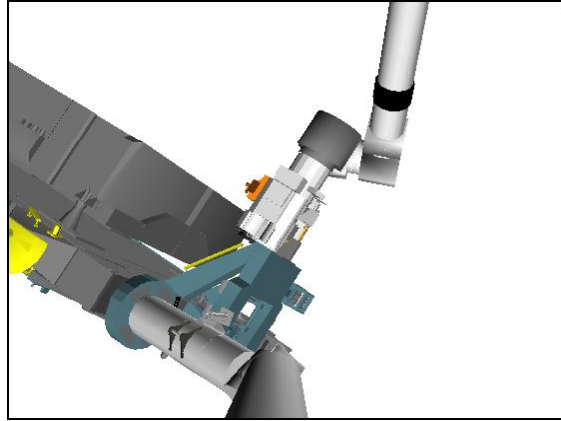


Figure 18.- ELC4 Port Hover
(SRMS Elbow: 0, +5: Zoom = 35).

PCS

MSS: SSRMS:

Change Command ► SSRMS ► Internal (Verify SSRMS>Internal)

Change Display ► ISS ► ISSACS (Verify ISS>ISSACS)

DCP

BRAKES SSRMS → OFF (Verify OFF)

√Vernier

PCS

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired

8.2 SSRMS Limping

MSS: SSRMS: Limp:

cmd All Limp (Verify Limp – blue)

MSS: SSRMS:

Verify all joints – Limped

8.3 Slowing Auto FRGF Release

MSS: SSRMS: Tip LEE:

cmd Release ► Automatic ► Slow (Verify Speed – Slow)

Verify '**Confirm or Terminate**' prompt.

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Release

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RHC TRIGGER → Press (momentarily)

PCS
 Verify 'Carriage' Retract – gray (90s max)
 Verify 'Snare' Open – blue (12s max)
 Verify 'Carriage' Derigidize – blue
 Verify 'Carriage' Extend – blue (90s max)

Verify Unloaded Parameters – √
 Verify 'Unloaded Parameters' (two) – LEE Tip, SY Held

8.4 Backing Off ELC4 at Handoff

MSS: SSRMS: Limp:

cmd None Limp (Verify Standby – blue)

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Roll (Verify SR – Locked)

THC/
RHC Maneuver SSRMS to Backoff position (within 5 cm/1 deg).
(THC Out, -X)

Locked						
SR	SY	SP	EP	WP	WY	WR
+57.0	-131.4	-122.8	-65.8	-236.3	-158.0	+104.2
X	Y	Z	Pitch	Yaw	Roll	
+923	+860	+1568	+1.1	+0.1	+60.2	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

PCS MSS: SSRMS:

Enter Mode – Standby (Verify blue)

9. JOINT OCAS MANEUVER TO INTERMEDIATE (2.5 MINUTES)

NOTE
 Expect singularity when: +15 > EP > -15.

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (+60, +30)	09: P1 Lower Outboard (+105, +15)	13: LAB Stbd Zenith (0, -10)	Camera C (+25, +40)	SRMS Elbow (0, +25)

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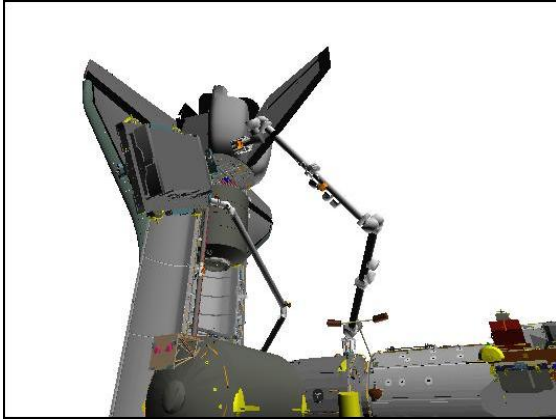


Figure 19.- ELC4 Handoff Released (03: S1 Lower Outboard: +60, +30).

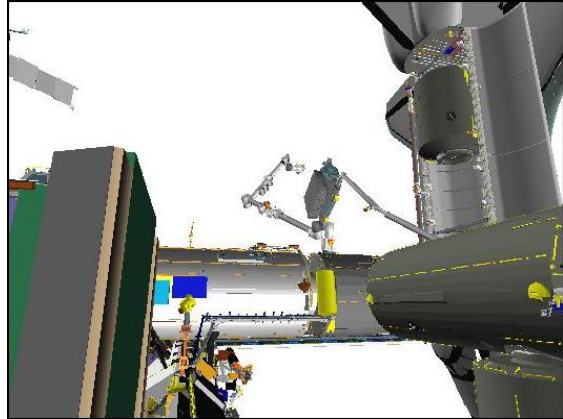


Figure 20.- ELC4 Handoff Released (09: P1 Lower Outboard: +105, +15).

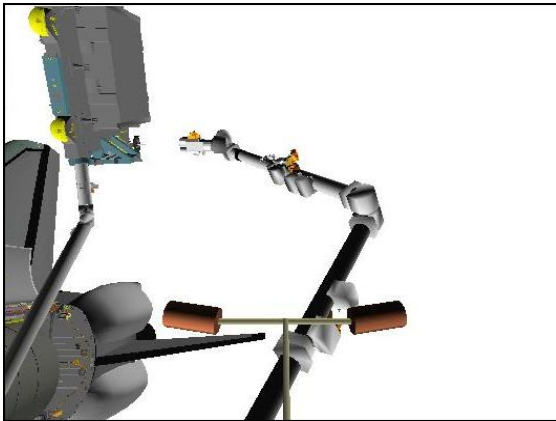


Figure 21.- ELC4 Handoff Released (13: LAB Stbd Zenith: 0, -10).

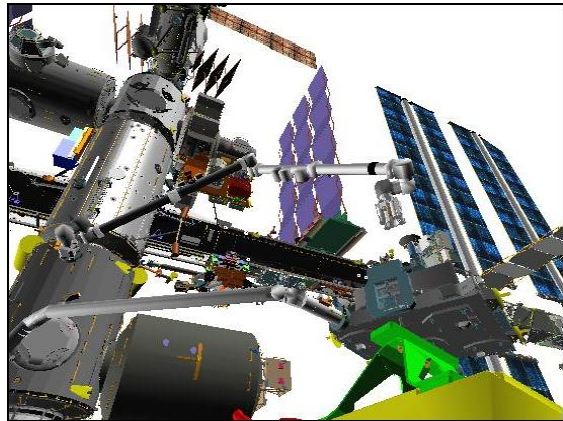


Figure 22.- ELC4 Handoff Released (Camera C: +25, +40).

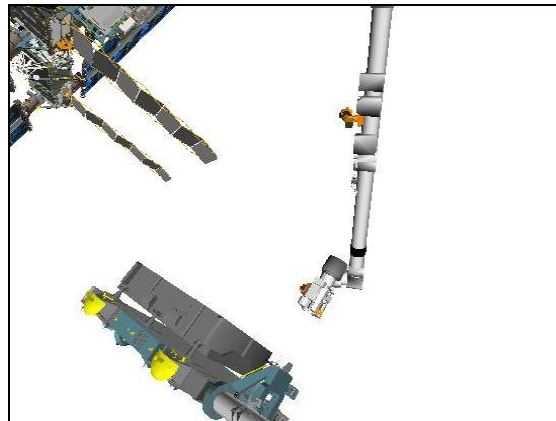


Figure 23.- ELC4 Handoff Released (SRMS Elbow: 0, +25).

RHC

RATE → COARSE (Verify Coarse on PCS)

PCS

MSS: SSRMS:

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Verify 'Unloaded Parameters' (two) – LEE Tip, SY Held

Change Loaded Parameters ► Walk Off ► MBS PDGF 1

Verify 'Loaded Parameters' (three) – MBS PDGF 1, SSRMS, SR Held

Change Display ► MBS ► PDGF 1 (Verify MBS>PDGF 1)

Verify Command – SSRMS>Internal

MSS: SSRMS:

Enter Mode – Joint OCAS (Verify blue)

pick File ► Walkoff ► Intermediate

Verify 'Joint Angles' 'Destination' for Intermediate position.

SR	SY	SP	EP	WP	WY	WR
+20.0	-144.9	-120.0	+77.9	-119.4	-211.3	+114.9

cmd Load (Verify Sequence Status – Confirm or Cancel)

MON

Verify joint angles and errors are correct on Joint Angle Position overlay.

	SR	SY	SP	EP	WP	WY	WR
(current)	+57.0	-131.4	-122.8	-65.8	-236.3	-158.0	+104.2
TGT	+20.0	-144.9	-120.0	+77.9	-119.4	-211.3	+114.9
ERR	+37.0	+13.5	-2.8	-143.7	-116.9	+53.3	-10.7

PCS

cmd Confirm (Verify Sequence Status – Auto Seq sw - Hot)

DCP

AUTO SEQ → PROC

PCS

MSS: SSRMS:

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
+20.0	-144.9	-120.0	+77.9	-119.4	-211.3	+114.9

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10. FOR OCAS MANEUVER TO PDGF 1 PRE-GRAPPLE (2.5 MINUTES)

NOTE

This maneuver has the following clearance concerns:

- a) SSRMS Tip Boom to Columbus Module, decreases to 60 cm (24 in). Monitor with SRMS Elb, MBS Mast, or LAB Stbd.
- b) SSRMS Base Boom to UHF Antenna, decreases to 73 cm (29 in). Monitor with MBS Mast or Tip Elbow.

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (+60, 0)	37: MBS Mast (+70, +20) 24: Tip Elbow (+120, -25)	13: LAB Stbd Zenith (-30, +5)	Camera C (+20, +25)	SRMS Elbow (-50, +50)

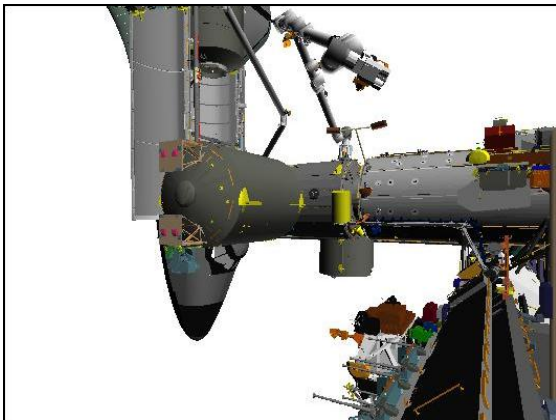


Figure 24.- Walkoff Intermediate (03: S1 Lower Outboard: +60, 0).

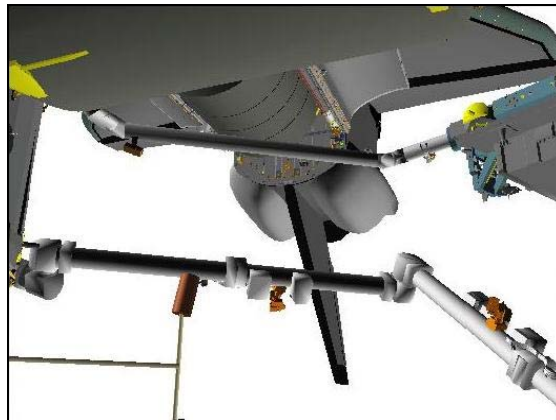


Figure 25.- Walkoff Intermediate (37: MBS Mast: +70, +20).

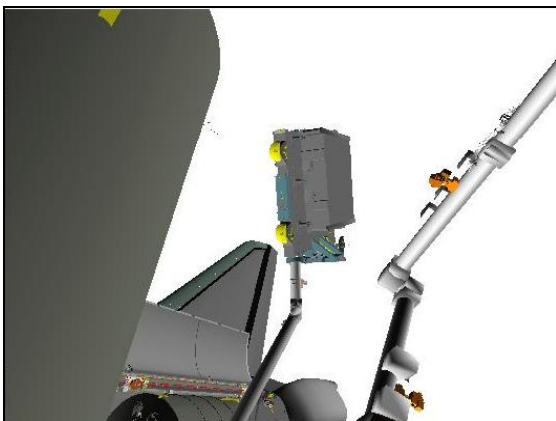


Figure 26.- Walkoff Intermediate (13: LAB Stbd Zenith: -30, +5).

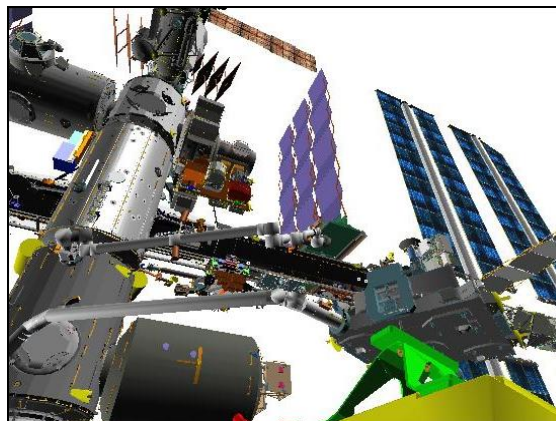


Figure 27.- Walkoff Intermediate (Camera C: +20, +25).

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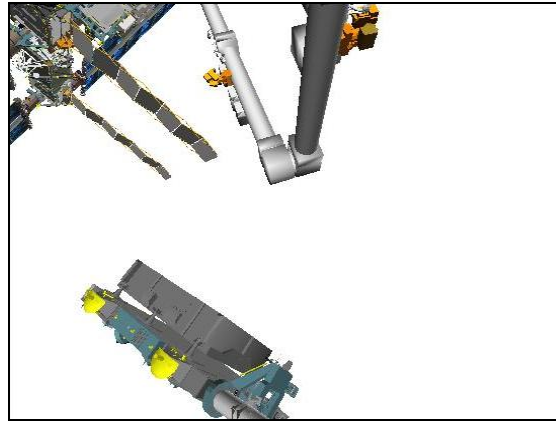


Figure 28.- Walkoff Intermediate (SRMS Elbow: -50, +50).

RHC RATE → VERNIER (Verify Vernier on PCS)

PCS MSS: SSRMS:

Enter Mode – FOR OCAS (Verify blue)

MSS: SSRMS: SSRMS FOR OCAS: Joint Lock:

cmd Shoulder Yaw (Verify SY – Locked)

pick File ► Walkoff ► Pre-Grapple

Verify 'FOR' 'Destination' for Pre-Grapple position.

X	Y	Z	Pitch	Yaw	Roll
-65	0	0	0.0	0.0	0.0

cmd Load (Verify Sequence Status – Confirm or Cancel)

MON Verify FOR and errors are correct on FOR Position overlay.

	X	Y	Z	Pitch	Yaw	Roll
FOR	-153	+408	+495	+5.8	-10.0	-20.8
TGT	-65	0	0	0.0	0.0	0.0
ERR	-88	+408	+495	+5.8	-10.0	-20.8

PCS **cmd** Confirm (Verify Sequence Status – Auto Seq sw - Hot)

DCP AUTO SEQ → PROC

PCS MSS: SSRMS:

Verify Posn Hold – orange

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Verify SSRMS at Pre-Grapple position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-11.0	-144.9	-73.8	+64.3	-116.2	-206.6	+109.8
X	Y	Z	Pitch	Yaw	Roll	
-65	0	0	0.0	0.0	0.0	
FOR	Unloaded – LEE Tip, SY Held					
Disp	MBS>PDGF 1					

11. GRAPPLING MBS PDGF 1

NOTE

This maneuver has the following clearance concerns:

- SSRMS Tip Boom to Columbus Module, increases to 91 cm (36 in). Monitor with SRMS Elbow or Camera C.
- SSRMS Base Boom to UHF Antenna, decreases to 60 cm (24 in). Monitor with Tip Elbow.

11.1 Setup

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
24: Tip Elbow (+135, -20)	25: Tip LEE (Full Zoom Out)	37: MBS Mast (+140, -25)	Camera C (+20, +25)	SRMS Elbow (-60, +50)

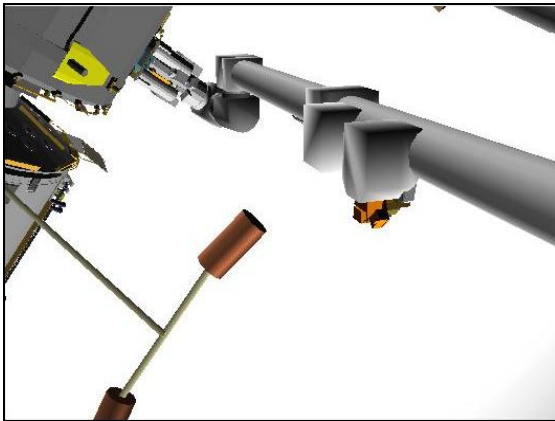


Figure 29.- PDGF 1 Pre-Grapple
(24: Tip Elbow: +135, -20).

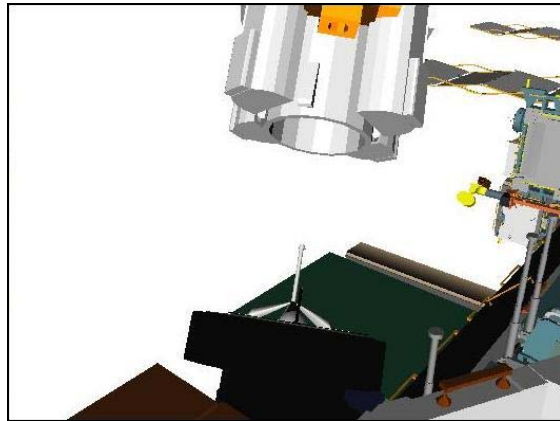


Figure 30.- PDGF 1 Pre-Grapple
(37: MBS Mast: +140, -25).

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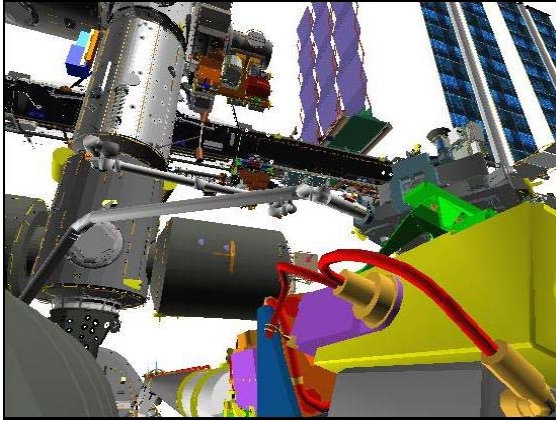


Figure 31.- PDGF 1 Pre-Grapple
(Camera C: +20, +25).

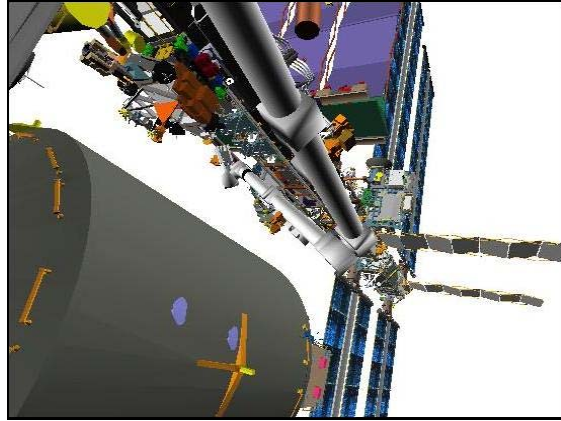


Figure 32.- PDGF 1 Pre-Grapple
(SRMS Elbow: -60, +50).

√Vernier

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as required

11.2 Maneuvering to Within Grapple Envelope

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Roll (Verify SR – Locked)

THC/
RHC

Maneuver to within grapple envelope (THC In, +X).

11.3 Slowing Auto FRGF Capture

PCS

MSS: SSRMS: Tip LEE:

cmd Capture ► Automatic ► Slow, Limp (Verify Speed – Slow)

Verify '**Confirm or Terminate**' prompt.

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Capture

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RHC TRIGGER → Press (momentarily)

PCS Verify 'Snare' Close, Capture (two) – blue (12s max)
 Verify Capture to Latch – Yes (SCR 19282)
 Verify 'Carriage' Tension ~5500 N (90s max)
 Verify 'Carriage' Retract – blue
 Verify 'Latch' Latch – blue (65s max)

Verify Loaded Parameters – √
 Verify 'Loaded Parameters' (three) – MBS PDGF 1, SSRMS,
 SR Held

11.4 Mating Umbilicals

Verify with **MCC-H** that payload and PDGF power inhibits have been confirmed.

NOTE

1. Expect '**R20 - MBS CRPCM 3P(R) Output Voltage 1 Stat Err**' Robotics Advisory message while umbilicals are mated. Message should return to norm.
2. Expect '**R3L - SSRMS Pwr Flags Fail**' Robotics Advisory message while Tip LEE is mated (SCR 19019).

MSS: SSRMS: Tip LEE: SSRMS Tip LEE

cmd 'Umbilical' Mate (Verify '**Confirm or Terminate**' prompt)

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Mate

RHC TRIGGER → Press (momentarily)

PCS Verify 'Umbilical' Mate – blue (10s max)
 Verify 'Connector Continuity' Prime, Redundant (two) – Yes

11.5 Grapple Cleanup

Verify Posn Hold – orange

Expected PDGF 1 Grapple position (within 5 cm/1 deg):

SR	SY	SP	EP	WP	WY	WR
-11.0	-143.2	-71.7	+65.5	-120.1	-205.5	+111.3
X	Y	Z	Pitch	Yaw	Roll	
0	0	0	0.0	0.0	0.0	
FOR	Loaded – MBS PDGF3, SR Held					
Disp	MBS> PDGF 3					

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NOTE

Expect the following message when safing is commanded:
**'R3Z - MSS OCS SSRMS Prime(Redun) ACU SRT Cat-1
 Brk Stat Fail'** (SCR 17495)
 This message should return to Norm.

DCP

SAFING → SAFE (Verify ON)

MCC-H will perform SSRMS Operating Base Change.

Notify SRMS operator, "GO for maneuver to ELC4 handback."

12. SETUP FOR NODE2 PDGF RELEASE

On MCC-H GO and SRMS operator, "GO for ELC4 Grapple."

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (+65, +5) 09: P1 Lower Outboard (+110, +10)	25: Tip LEE (Full Zoom Out)	37: MBS Mast (+70, +25) 22: Base Elbow (+140, -15)	Camera C (+5, +30)	SRMS Elbow (-60, +50)

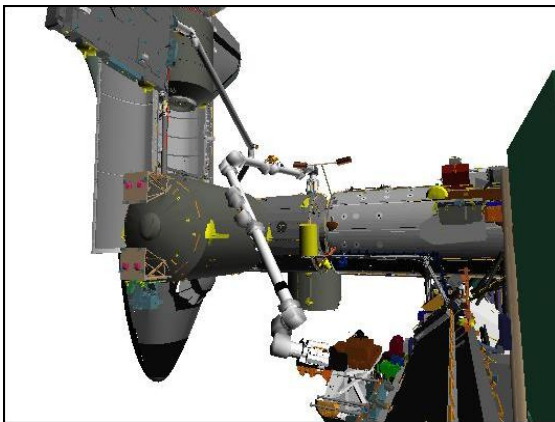


Figure 33.- PDGF 1 Pre-Grapple
(03: S1 Lower Outboard: +65, +5).

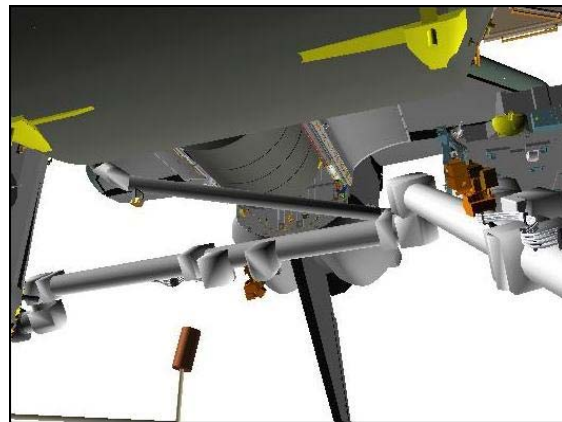


Figure 34.- PDGF 1 Pre-Grapple
(37: MBS Mast: +70, +25).

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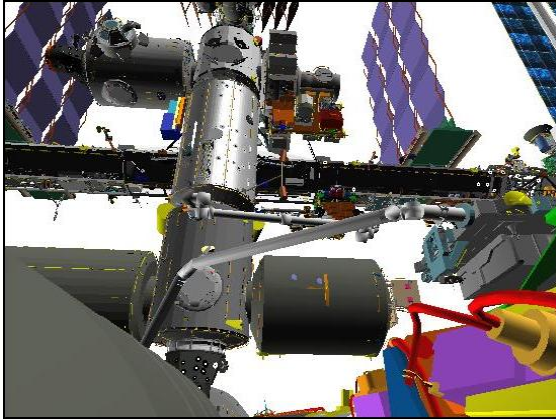


Figure 35.- PDGF 1 Pre-Grapple
(Camera C: +5, +30).

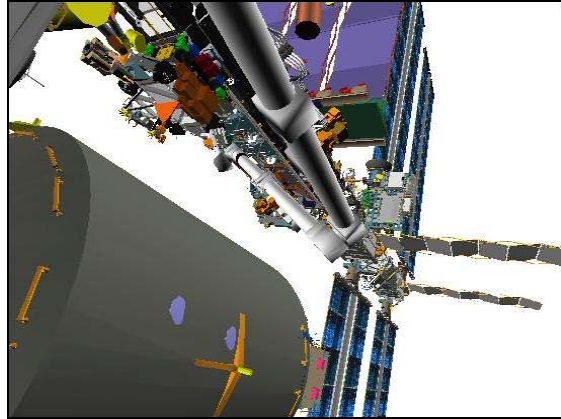


Figure 36.- PDGF 1 Pre-Grapple
(SRMS Elbow: -60, +50).

NOTE

The 'R3Q - SSRMS LEE Uncommanded Derigidize' Caution will annunciate when SSRMS Safing is removed (SCR 38011).

PCS

MSS: SSRMS: MSS Safing:

cmd 'SSRMS' Remove (Verify Not Safed)

DCP

BRAKES SSRMS → OFF (Verify OFF)

√Vernier

PCS

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired

MSS: SSRMS:

Verify 'Loaded Parameters' (three) – Node 2 PDGF, SSRMS, SR Held

Verify 'Unloaded Parameters' (two) – LEE Tip, SY Held

Change Display ► Node2 ► PDGF (Verify Node2>PDGF)

Verify Command – SSRMS>Internal

13. NODE 2 PDGF RELEASE

NOTE

This maneuver has the following clearance concerns:

- a) SSRMS Tip Boom to Columbus Module, increases from 91 cm (36 in) to 109 cm (43 in). Monitor with SRMS Elbow.
- b) SSRMS Base Boom to UHF Antenna, decreases to 48 cm (19 in). Monitor with Base Elbow, MBS Mast, Camera C, or S1 LOOB.

13.1 Limping SSRMS

MSS: SSRMS: Limp:

cmd All Limp (Verify Limp – blue)

MSS: SSRMS:

Verify all joints – Limped

13.2 Rigidizing Carriage

MSS: SSRMS: Tip LEE:

cmd 'Carriage' Rigidize ► Slow (Verify Speed – Slow)

Verify '**Confirm or Terminate**' prompt.

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Rigidize

RHC

TRIGGER → Press (momentarily) (SCR 19064)

PCS

Verify 'Carriage' Tension ~5500 N (90s max)

Verify 'Carriage' Retract – blue

Verify 'Carriage' Brakes – On (15s max)

13.3 Slowing Auto PDGF Release

Verify with **MCC-H** - Payload and PDGF power inhibits have been confirmed.

MSS: SSRMS: Tip LEE:

cmd Release ► Automatic ► Slow (Verify Speed – Slow)

Verify '**Confirm or Terminate**' prompt.

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Release

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RHC TRIGGER → Press (momentarily)

PCS
 Verify 'Umbilical' Demate – blue (10s max)
 Verify 'Latch' Unlatch – blue (65s max)
 Verify 'Carriage' Retract – gray (90s max)
 Verify 'Snare' Open – blue (12s max)
 Verify 'Carriage' Derigidize – blue
 Verify 'Carriage' Extend – blue (90s max)

13.4 Backing Off Node 2 PDGF

MSS: SSRMS: Limp:

cmd None Limp (Verify Standby – blue)

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Yaw (Verify SY – Locked)

THC/
RHC Maneuver to Modified Backoff position (within 5 cm/1 deg).
(THC Out, -X)

		Locked					
SR	SY	SP	EP	WP	WY	WR	
+109.5	+205.5	-117.2	+58.2	-65.8	+144.5	-12.3	
X	Y	Z	Pitch	Yaw	Roll		
-65	0	0	0.0	0.0	0.0		
FOR	Unloaded – LEE Tip, SY Held						
Disp	Node2>PDGF						

PCS MSS: SSRMS:

Enter Mode – Standby (Verify blue)

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14. FOR OCAS MANEUVER TO ELC4 HANDBACK PRE-GRAPPLE (3 MINUTES)

NOTE

This maneuver has the following clearance concerns:

- a) SSRMS Base Boom to Columbus Module, increases from 109 cm (43 in) to greater than 150 cm (60 in). Monitor with SRMS Elbow.
- b) SSRMS Tip Boom to UHF Antenna, increases from 48 cm (19 in) to greater than 150 cm (60 in). Monitor with P1 LOOB, MBS Mast, or Base Elbow.
- c) SSRMS Wrist Cluster to ELC4, minimum of 86 cm (34 in). Monitor with P1 LOOB, MBS Mast, LAB Stbd, Base Elbow, or SRMS Elb.

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (+55, +5)	09: P1 Lower Outboard (+110, +15) 13: LAB Stbd Zenith (-20, -5)	37: MBS Mast (+60, +15) 22: Base Elbow (+140, -15)	Camera C (+5, +30)	SRMS Elbow (-50, +50)

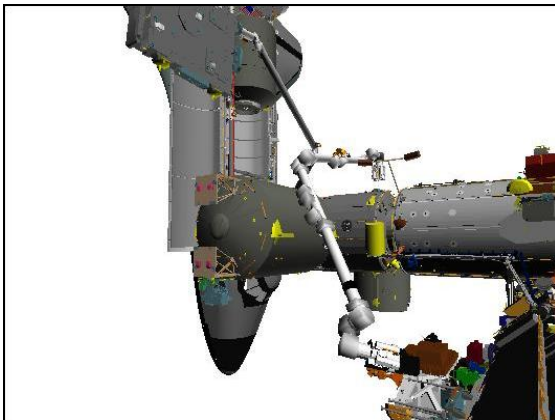


Figure 37.- Node 2 Backed Off (03: S1 Lower Outboard: +55, +5).

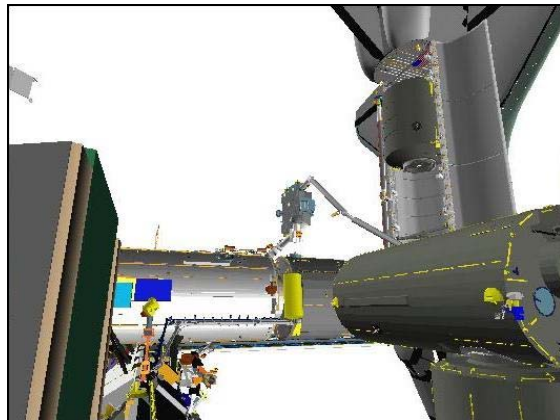


Figure 38.- Node 2 Backed Off (09: P1 Lower Outboard: +110, +15).

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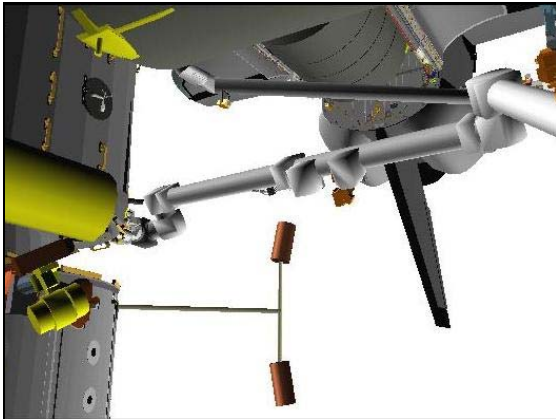


Figure 39.- Node 2 Backed Off
(37: MBS Mast: +60, +15).

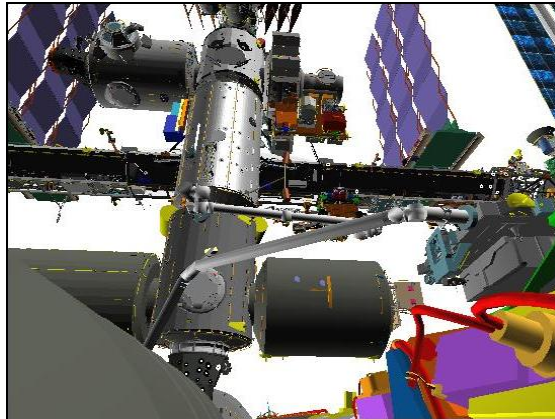


Figure 40.- Node 2 Backed Off
(Camera C: +5, +30).

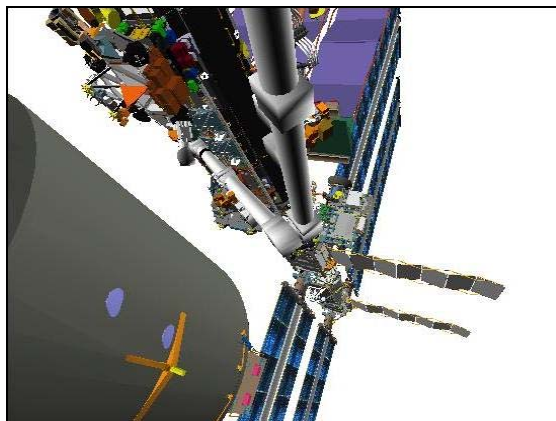


Figure 41.- Node 2 Backed Off
(SRMS Elbow: -50, +50).

MSS: SSRMS:

Change Loaded Parameters ► ELC4 ► ELC4 Install SYH
Verify 'Loaded Parameters' (two) – ELC4 Install, SY Held

Change Display ► ISS ► ISSACS (Verify ISS>ISSACS)

√Vernier

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: 1.0 (Verify 1.0)

MSS: SSRMS:

Enter Mode – FOR OCAS (Verify blue)

MSS: SSRMS: SSRMS FOR OCAS: Joint Lock:

cmd Shoulder Yaw (Verify SY – Locked)

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SSRMS FOR OCAS

pick File ► ELC4 Handback ► Pre-Grapple

Verify 'FOR' 'Destination' for ELC4 Pre-Grapple at Handback position.

X	Y	Z	Pitch	Yaw	Roll
+952	+1384	+1335	0.0	-53.2	-65.1

cmd Load (Verify Sequence Status – Confirm or Cancel)

MON

Verify FOR and errors are correct on FOR Position overlay.

	X	Y	Z	Pitch	Yaw	Roll
FOR	+757	-49	+758	+89.9	+9.3	-90.0
TGT	+952	+1384	+1335	0.0	-53.2	-65.1
ERR	-195	-1433	-577	+89.9	+62.5	-24.9

PCS

cmd Confirm (Verify Sequence Status – Auto Seq sw - Hot)

DCP

AUTO SEQ → PROC

PCS

MSS: SSRMS: **SSRMS**

Verify Posn Hold – orange

Verify SSRMS at ELC4 Pre-Grapple position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+81.8	+205.5	-175.2	+59.1	-115.7	+125.0	+144.8
X	Y	Z	Pitch	Yaw	Roll	
+952	+1384	+1335	0.0	-53.2	-65.1	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

 * If using shuttle attitude control
 * Verify in attitude, then DAP: FREE.

15. ELC4 PVGF GRAPPLE AT HANDBACK SETUP

15.1 Setup

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON1)	SSC R (DTV)
03: S1 Lower Outboard (+40, +25)	25: Tip LEE (Full Zoom Out)	37: MBS Mast (+110, +20)	Camera D (-40, +30)	SRMS Elbow (-20, +25)

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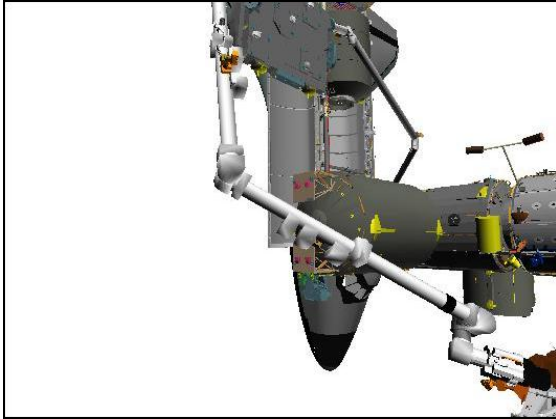


Figure 42.- ELC4 Handback Pre-Grapple
(03: S1 Lower Outboard: +40, +25).

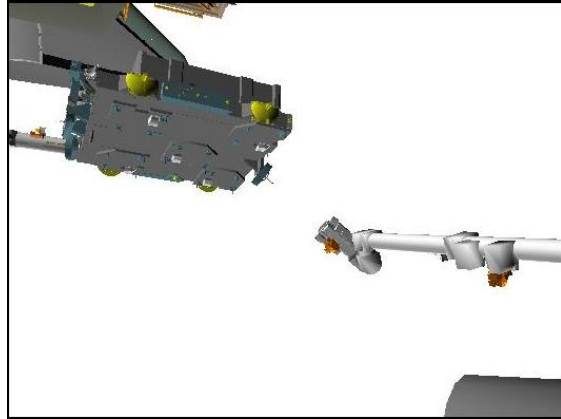


Figure 43.- ELC4 Handback Pre-Grapple
(37: MBS Mast: +110, +20).

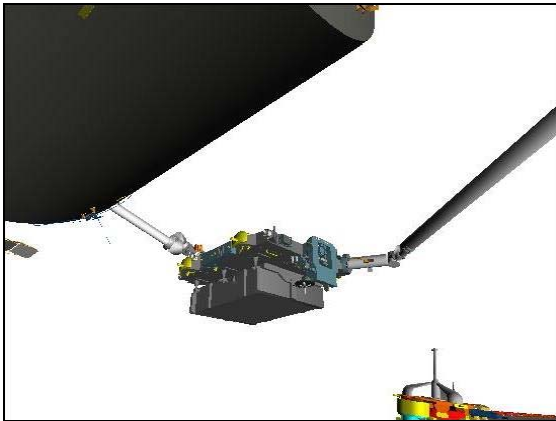


Figure 44.- ELC4 Handback Pre-Grapple
(Camera D: -40, +30).

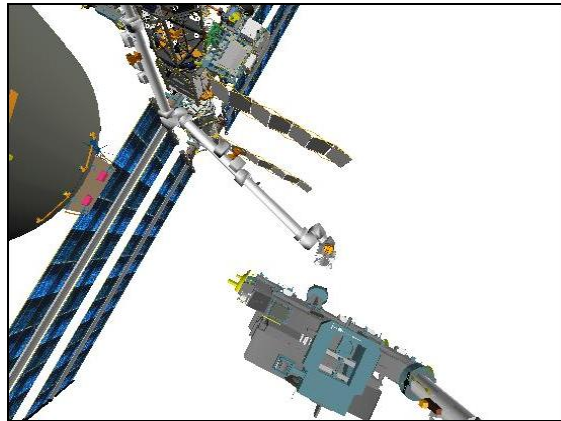


Figure 45.- ELC4 Handback Pre-Grapple
(SRMS Elbow: -20, +25).

√Vernier

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired

15.2 Maneuvering to Grapple Envelope

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Yaw (Verify SY – Locked)

THC/
RHC

Maneuver to within grapple envelope (THC In, +X).

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15.3 Slowing Auto PVGF Capture

PCS

MSS: SSRMS: Tip LEE: SSRMS Tip LEE

cmd Capture ► Automatic ► Slow, Limp (Verify Speed – Slow)

Verify '**Confirm or Terminate**' prompt.

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Capture

RHC

TRIGGER → Press (momentarily)

PCS

Verify 'Snare' Close, Capture (two) – blue (12s max)

Verify Capture to Latch – Yes (SCR 19282)

Verify 'Carriage' Tension ~5500 N (90s max)

Verify 'Carriage' Retract – blue

Verify 'Latch' Latch – blue (80s max)

Verify Loaded Parameters – ✓

Verify 'Loaded Parameters' (three) – ELC4 Install, SSRMS, SY Held

15.4 Mating Umbilicals

Verify with **MCC-H** - Payload and PDGF power inhibits have been confirmed.

cmd 'Umbilical' Mate (Verify '**Confirm or Terminate**' prompt)

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Mate

RHC

TRIGGER → Press (momentarily)

PCS

Verify 'Umbilical' Mate – blue (10s max)

Verify 'Connector Continuity' Prime, Redundant (two) – Yes

15.5 Grapple Cleanup

DCP

BRAKES SSRMS → ON (Verify ON)

PCS

MSS: SSRMS: Power: SSRMS Power

cmd 'Payload' Prime On (Verify On)

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Verify SSRMS at ELC4 Handback position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+94.1	+205.5	-176.0	+60.0	-128.2	+134.4	+154.0
X	Y	Z	Pitch	Yaw	Roll	
+1201	+746	+1287	+60.0	-80.7	+162.3	
FOR	Loaded – ELC4 Install, SY Held					
Disp	ISS>ISSACS					

Notify SRMS operator, “SSRMS Grappled to ELC4, SRMS is GO to release ELC4.”

16. JOINT OCAS MANEUVER TO ELC4 PRE-INSTALL POSITION (14 MINUTES)

On SRMS operator, “SSRMS GO for ELC4 install.”

```
*****
* If using shuttle attitude control
* | Perform ROBOTICS ATTITUDE MAINTENANCE, steps 1 to 3
* | (ORB OPS, REBOOST/DAP), then:
*****
```

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (+40, +25)	13: LAB Stbd Zenith (-40, +40)	37: MBS Mast (+95, +30) 22: Base Elbow (+130, -15)	Camera C (+30, +35)	SRMS Elbow (-40, +30)

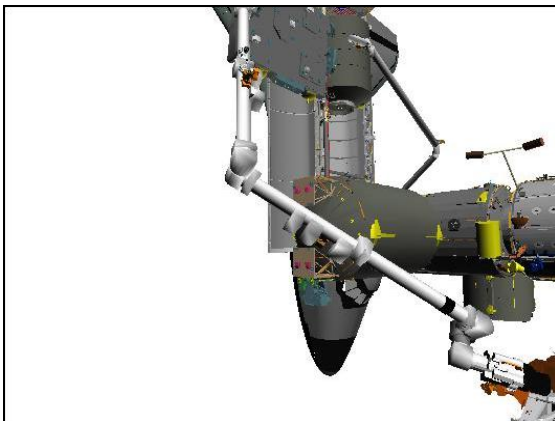


Figure 46.- ELC4 Handback Grappled (03: S1 Lower Outboard: +40, +25).

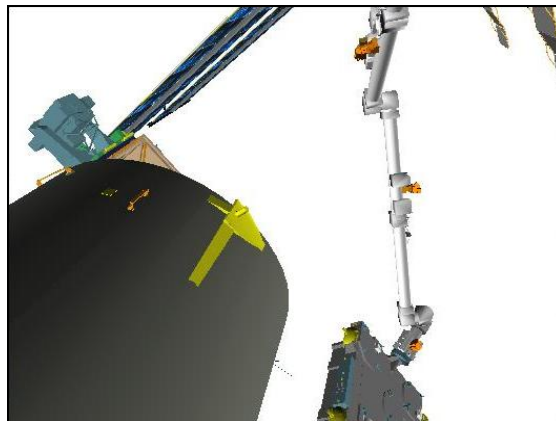


Figure 47.- ELC4 Handback Grappled (13: LAB Stbd Zenith: -40, +40).

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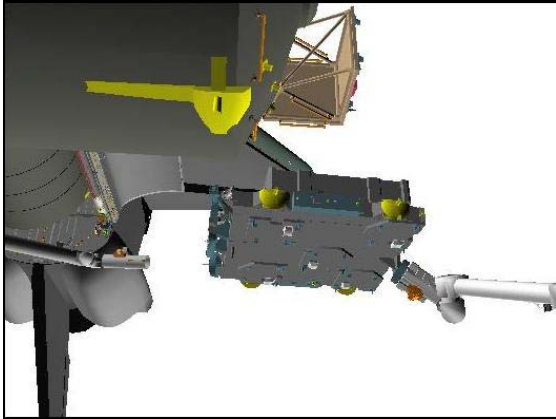


Figure 48.- ELC4 Handback Grappled
(37: MBS Mast: +95, +30).

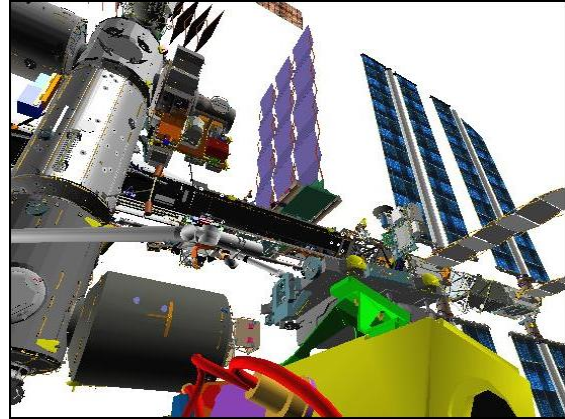


Figure 49.- ELC4 Handback Grappled
(Camera C: +30, +35).

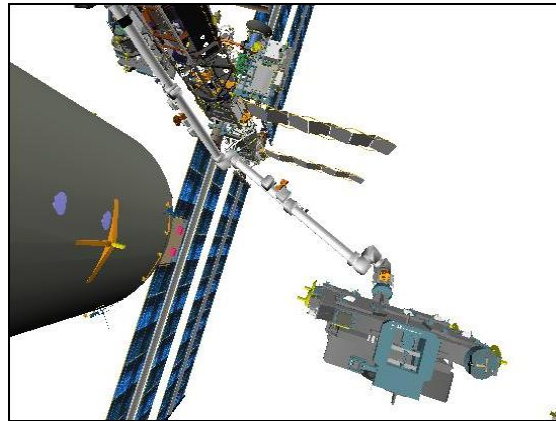


Figure 50.- ELC4 Handback Grappled
(SRMS Elbow: -40, +30).

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → COARSE (Verify Coarse on PCS)

PCS MSS: SSRMS:

Enter Mode – Joint OCAS (Verify blue)

pick File ► ELC4 ► Pre-Install

Verify 'Joint Angles' 'Destination' for ELC4 Pre-Install position.

SR	SY	SP	EP	WP	WY	WR
-17.8	+108.0	-133.9	+30.7	-86.4	+202.2	+224.5

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cmd Load (Verify Sequence Status – Confirm or Cancel)

MON Verify joint angles and errors are correct on Joint Angle Position overlay.

	SR	SY	SP	EP	WP	WY	WR
(current)	+94.1	+205.5	-176.0	+60.0	-128.2	+134.4	+154.0
TGT	-17.8	+108.0	-133.9	+30.7	-86.4	+202.2	+224.5
ERR	+111.9	+97.5	-42.1	+29.3	-41.8	-67.8	-70.5

PCS **cmd** Confirm (Verify Sequence Status – Auto Seq sw - Hot)

DCP AUTO SEQ → PROC

PCS MSS: SSRMS:

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-17.8	+108.0	-133.9	+30.7	-86.4	+202.2	+224.5

 * If using shuttle attitude control
 * | Perform **ROBOTICS ATTITUDE MAINTENANCE**, steps 1 to 3
 * | (**ORB OPS**, **REBOOST/DAP**), then:

17. MANUAL MANEUVER TO ELC4 INSTALL

17.1 Install Setup

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (-120, +40) 13: LAB Stbd Zenith (+50, +60)	28: EBCS	24: Tip Elbow (+65, +10) 22: Base Elbow (+95, -15)	Camera C (+45, +30)	SRMS Elbow (-50, +55)

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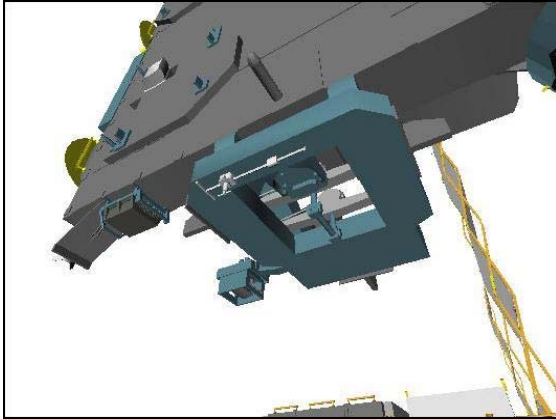


Figure 51.- ELC4 Pre-Install
(03: S1 Lower Outboard: -120, +40).

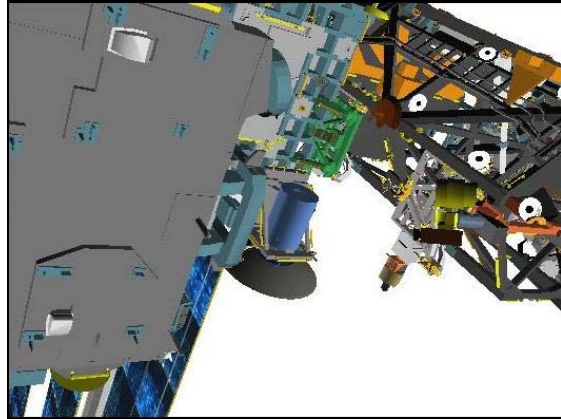


Figure 52.- ELC4 Pre-Install
(24: Tip Elbow: +65, +10).

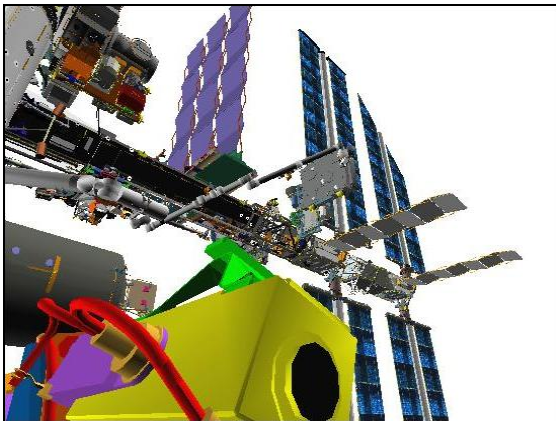


Figure 53.- ELC4 Pre-Install
(Camera C: -45, +30).

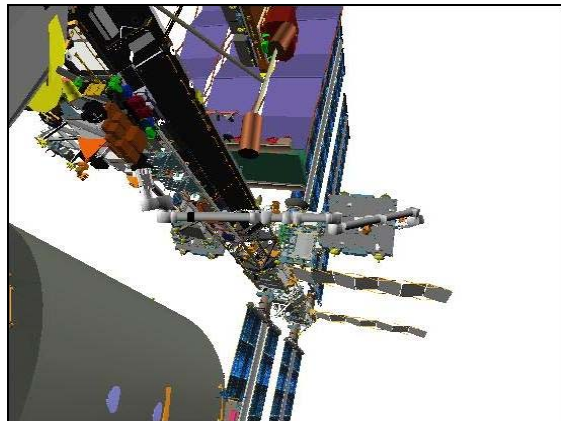


Figure 54.- ELC4 Pre-Install
(SRMS Elbow: -50, +55).

NOTE

Clearance between ELC4 and S1 LOOB decreases to 35 cm (14 in) at install. Monitor with the Tip Elbow Camera.

Change Display ► S3 ► Lower Inboard PAS (Verify S3>Lower Inboard PAS)

RHC

RATE → VERNIER (Verify Vernier on PCS)

PCS

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired

17.2 Manual Maneuver to Alignment Position

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

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cmd Shoulder Yaw (Verify SY – Locked)

THC/
RHC

Maneuver ELC4 to Alignment position (within 5 cm/1 deg).
(THC In, +X)

	Locked					
SR	SY	SP	EP	WP	WY	WR
-19.0	+108.0	-143.4	+64.8	-112.3	+202.1	+224.1
X	Y	Z	Pitch	Yaw	Roll	
-90	0	0	0.0	0.0	0.0	
FOR	Loaded – ELC4 Install, SY Held					
Disp	S3>ELC4 Install S3LI					

Make alignment corrections as needed.

17.3 ELC4 Install on S3LI

Maneuver ELC4 2cm +X past last RTL indication (THC In, +X).

Expected ELC4 Ready-to-Latch position:

	Locked					
SR	SY	SP	EP	WP	WY	WR
-19.4	+108.0	-143.9	+71.7	-119.1	+202.1	+224.0
X	Y	Z	Pitch	Yaw	Roll	
-6	0	0	0.0	0.0	0.0	
FOR	Loaded – ELC4 Install, SY Held					
Disp	S3>ELC4 Install S3LI					

PCS

MSS: SSRMS:

Enter Mode – Standby (Verify blue)

17.4 SSRMS PAS Coordination

Notify PAS operator, “Maneuver to RTL complete - GO for First Phase Capture.”

MSS: SSRMS: Power:

cmd ‘Payload’ Prime(Redundant) Off (Verify two Off)

On PAS operator, “First Stage Capture complete - GO to limp SSRMS.”

MSS: SSRMS: Limp:

cmd All Limp (Verify Limp – blue)

MSS: SSRMS:

Verify all joints – Limped

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Notify PAS operator, "GO for Second Stage Capture - All joints limped."

On PAS operator, "Capture complete - GO for SSRMS Brakes On."

DCP

BRAKES SSRMS → ON (Verify ON)

Expected ELC4 Install position:

SR	SY	SP	EP	WP	WY	WR
-19.4	+108.0	-143.9	+72.1	-119.6	+202.1	+223.9
X	Y	Z	Pitch	Yaw	Roll	
0	0	0	0.0	0.0	0.0	
FOR	Loaded – ELC4 Install, SY Held					
Disp	S3>ELC4 Install S3LI					

 * If using shuttle attitude control
 * | Perform **ROBOTICS ATTITUDE MAINTENANCE**, steps 1 and 2
 * | (**ORB OPS, REBOOST/DAP**), then:

18. ELC4 RELEASE SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
13: LAB Stbd Zenith (+50, +60)	25: Tip LEE (Zoom Full Out)	22: Base Elbow (+115, -15)	Camera C (+45, +35)	SRMS Elbow (-50, +55)

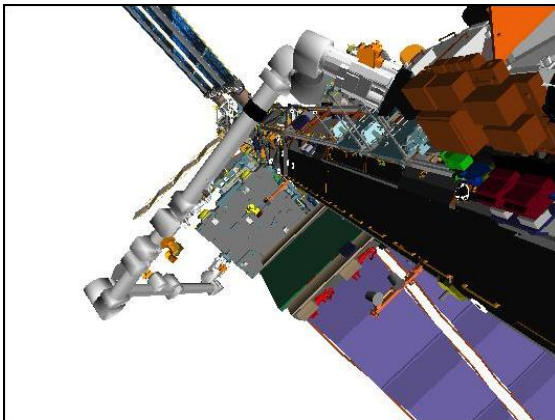


Figure 55.- ELC4 Installed
(13: LAB Stbd Zenith: +50, +60).

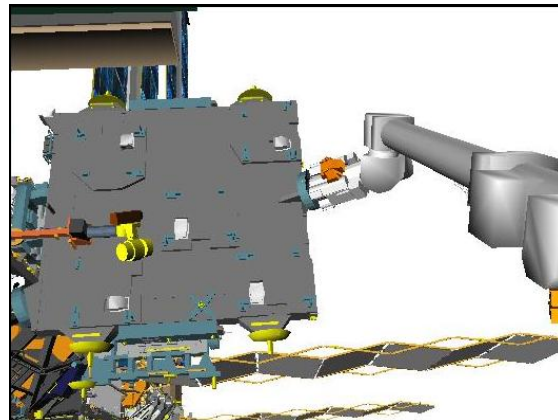


Figure 56.- ELC4 Installed
(22: Base Elbow: +115, -15).

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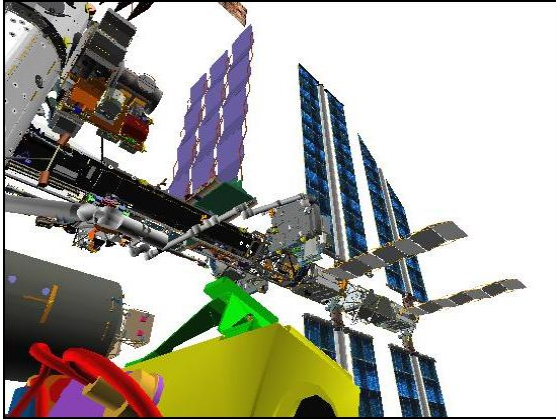


Figure 57.- ELC4 Installed
(Camera C: +45, +35).

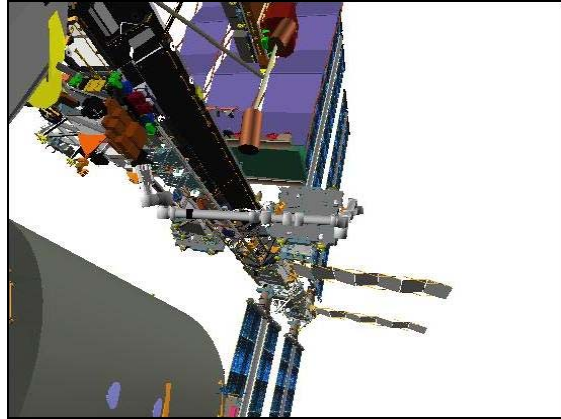


Figure 58.- ELC4 Installed
(SRMS Elbow: -50, +55).

Verify 'Unloaded Parameters' (two) – LEE Tip, SY Held

Change Display ► S3 ► ELC4 PVGF S3LI (Verify S3>ELC4 PVGF S3LI)
Verify Command – SSRMS>Internal

√Vernier

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired.

19. ELC4 RELEASE AND BACKOFF

19.1 Limping SSRMS

PCS

MSS: SSRMS: Limp:

cmd All Limp (Verify Limp – blue)

MSS: SSRMS:

Verify all joints – Limped

19.2 PVGF Release

Verify with **MCC-H** - Payload and PDGF power inhibits have been confirmed.

MSS: SSRMS: Tip LEE:

cmd Release ► Automatic ► Slow (Verify Speed – Slow)

Verify '**Confirm or Terminate**' prompt.

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Release

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- RHC TRIGGER → Press (momentarily)
- PCS
 - Verify 'Umbilical' Demate – blue (10s max)
 - Verify 'Latch' Unlatch – blue (65s max)
 - Verify 'Carriage' Retract – gray (90s max)
 - Verify 'Snare' Open – blue (12s max)
 - Verify 'Carriage' Derigidize – blue
 - Verify 'Carriage' Extend – blue (90s max)
 - Verify Unloaded Parameters – √

19.3 Backing Off PVGF

MSS: SSRMS: Limp:

cmd None Limp (Verify Standby – blue)

√Vernier

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Yaw (Verify SY – Locked)

THC/
RHC

Maneuver to Modified Backoff position (within 5 cm/1 deg).
(THC Out, -X)

	Locked					
SR	SY	SP	EP	WP	WY	WR
-9.0	+108.0	-140.5	+69.2	-108.9	+202.4	+227.4
X	Y	Z	Pitch	Yaw	Roll	
-185	0	0	0.0	0.0	0.0	
FOR	Unloaded – LEE Tip, SY Held					
Disp	S3>ELC4 PVGF S3LI					

NOTE

Expect the following message when safing is commanded:

'R3Z - MSS OCS SSRMS Prime(Redun) ACU SRT Cat-1 Brk Stat Fail' (SCR 17495)

This message should return to Norm.

DCP SAFING → SAFE (Verify ON)

Notify SRMS operator, "GO for maneuver to Pre-Cradle."

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1.210 SSRMS OBSS UNBERTH AND HANDOFF

(RBT FS/ULF5/FIN/HC/SPN)

1. SETUP

Verify SRMS is at Pre-Cradle position.

SY	SP	EP	WP	WY	WR
+24.0	+64.8	-34.4	-99.4	+11.3	-99.0

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (+60, +30)	25: Tip LEE (Full Zoom Out)	13: LAB Stbd Zenith (-40, -20)	Camera C (0, +5)	SRMS Elbow (-105, +15)

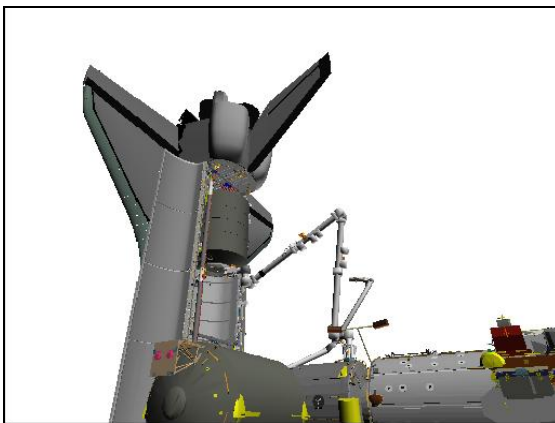


Figure 1.- OBSS Pre-Grapple (03: S1 Lower Outboard: +60, +30).

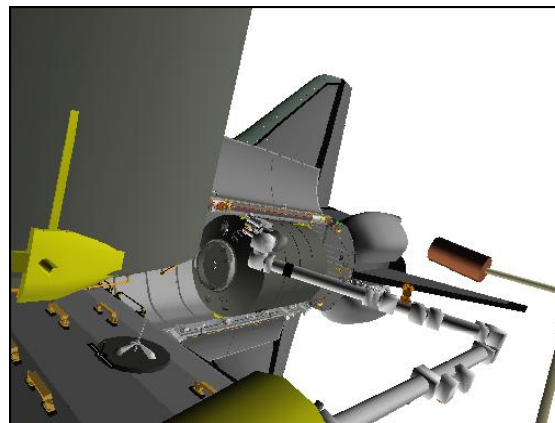


Figure 2.- OBSS Pre-Grapple (13: LAB Stbd Zenith: -40, -20).

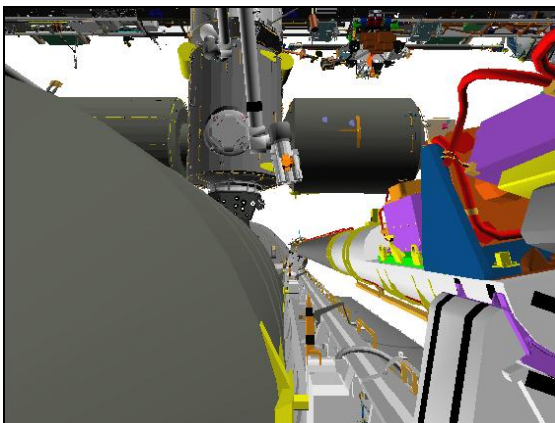


Figure 3.- OBSS Pre-Grapple (Camera C: 0, +5).

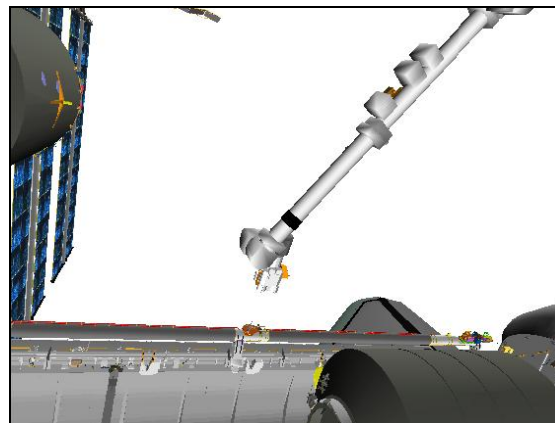


Figure 4.- OBSS Pre-Grapple (SRMS Elbow: -105, +15).

PCS

MSS: SSRMS:

Change Loaded Parameters ► OBSS ► OBSS Mid MPM SRH
 Verify 'Loaded Parameters' (two) – OBSS Mid MPM, SR Held

1.210 SSRMS OBSS UNBERTH AND HANDOFF

(RBT FS/ULF5/FIN/HC/SPN)

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Verify Unloaded Parameters – √

Change Unloaded Parameters ► Unloaded ► LEE Tip SRH

Verify 'Unloaded Parameters' (two) – LEE Tip, SR Held

Change Display ► Orbiter ► OBSS FRGF (Verify Orbiter>OBSS FRGF)

Verify Command – SSRMS>Internal

Verify SSRMS at OBSS Pre-Grapple position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-82.2	-15.2	+8.5	-129.9	+29.4	-3.2	+6.3
X	Y	Z	Pitch	Yaw	Roll	
-150	0	0	0.0	0.0	0.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	Orbiter>OBSS FRGF					

MSS: SSRMS: MSS Safing:

cmd 'SSRMS' Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

√Vernier

PCS MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired

2. OBSS GRAPPLE

2.1 Maneuvering to Grapple Envelope

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Roll (Verify SR – Locked)

THC/
RHC Maneuver to within grapple envelope (THC In, +X).

2.2 Grapple

PCS MSS: SSRMS: Tip LEE:

cmd Capture ► Automatic ► Slow, Limp (Verify Speed – Slow)

Verify '**Confirm or Terminate**' prompt.

1.210 SSRMS OBSS UNBERTH AND HANDOFF

(RBT FS/ULF5/FIN/HC/SPN)

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cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Capture

RHC TRIGGER → Press (momentarily)

PCS
 Verify 'Snare' Close, Capture (two) – blue (12s max)
 Verify Capture to Latch – No (SCR 19282)
 Verify 'Carriage' Tension ~5500 N (90s max)
 Verify 'Carriage' Retract – blue
 Verify Motors – Inh

2.3 Grapple Cleanup

Verify Posn Hold – orange

DCP BRAKES SSRMS → ON (Verify ON)

PCS MSS: SSRMS:

Verify Loaded Parameters – √

Verify 'Loaded Parameters' (three) – OBSS Mid MPM, SSRMS, SR Held

Change Display ► Orbiter ► OBSS Mid MPM
 (Verify Orbiter>OBSS Mid MPM)

Change Command ► Orbiter ► OBSS Mid MPM
 (Verify Orbiter>OBSS Mid MPM)

Expected OBSS Grappled position:

Locked						
SR	SY	SP	EP	WP	WY	WR
-82.2	-16.4	-4.0	-118.2	+30.2	-3.2	+7.5
X	Y	Z	Pitch	Yaw	Roll	
0	0	0	0.0	0.0	0.0	
FOR	Loaded – OBSS Mid MPM, SR Held					
Disp	Orbiter>OBSS Mid MPM					

Review [SSRMS LEE CUE CARD \(SSRMS IS LOADED AND LEE CAUTION IS ANNUNCIATED\)](#), all (SODF: RBT GEN: REFERENCE: CUE CARD).

3. OBSS UNBERTH

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (+60, +30)	24: Tip Elbow (-30, +5)	72 (DNLK): Mux D/C (D: -25, 0) (C: +30, 0)	Camera B (+80, +10)	SRMS Elbow (-135, +15)

1.210 SSRMS OBSS UNBERTH AND HANDOFF

(RBT FS/ULF5/FIN/HC/SPN)

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NOTE

Clearance between OBSS and Columbus decreases to 112 cm (44 in).
Monitor using SRMS Elbow and Tip Elbow Cameras.

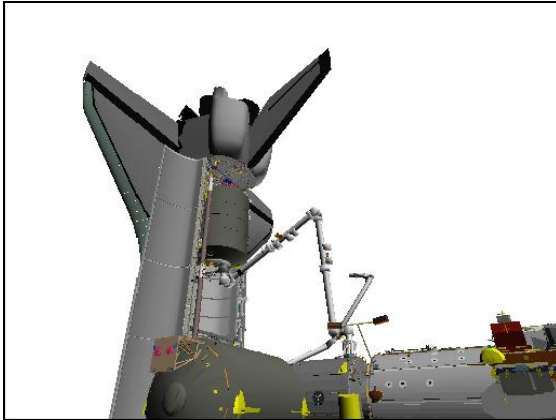


Figure 5.- OBSS Grappled
(03: S1 Lower Outboard: +60, +30).

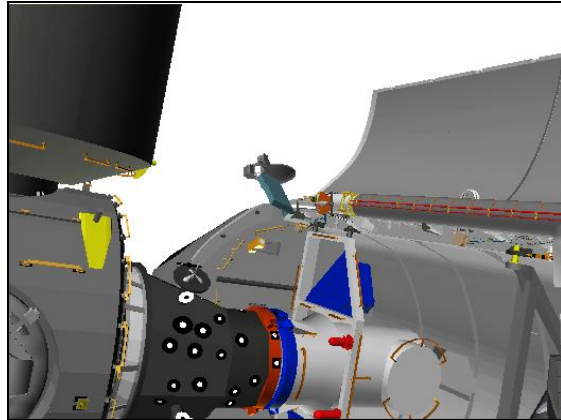


Figure 6.- OBSS Grappled
(24: Tip Elbow: -30, +5).

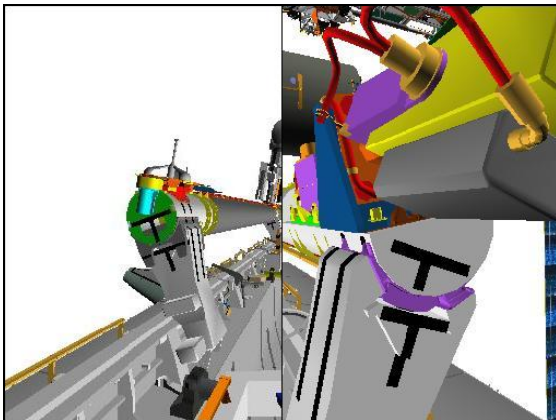


Figure 7.- OBSS Grappled
(72: Mux D/C).

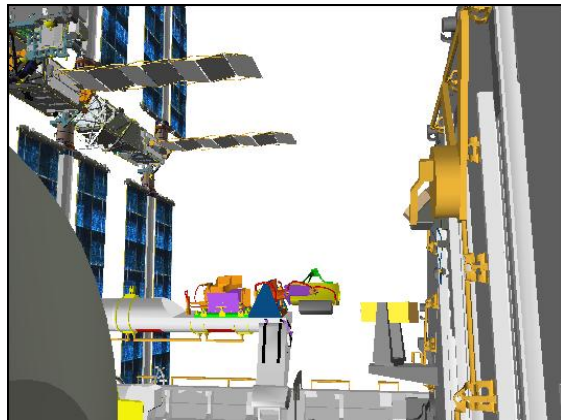


Figure 8.- OBSS Grappled
(Camera B: +80, +10).

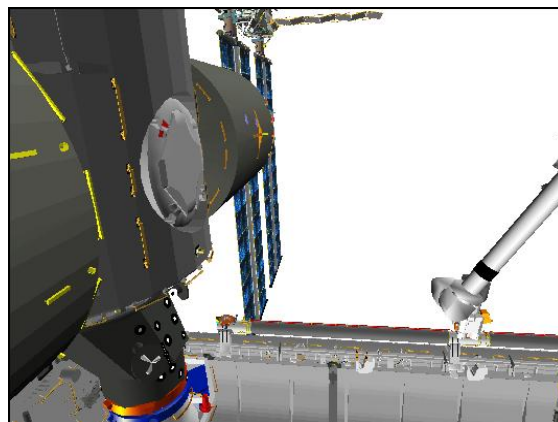


Figure 9.- OBSS Grappled
(SRMS Elbow: -135, +15).

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(RBT FS/ULF5/FIN/HC/SPN)

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3.1 MRL Release

 * If using shuttle attitude control
 * Verify in attitude, then DAP: FREE.

On MCC-H GO, "GO for OBSS Unberth."

Notify shuttle crew, "GO to release stbd MRLs."

<u>NOTE</u>
SRMS SPEE power must be applied within 90 minutes to prevent sensor damage.

 * If '**R3Q - SSRMS LEE Uncommanded Derigidize**' Caution is
 * annunciated during MRL release
 * MSS: SSRMS: Tip LEE:
 *
 * **cmd** 'Carriage' Rigidize ► Slow (Verify Speed – Slow)
 *
 * Verify '**Confirm or Terminate**' prompt.
 *
 * **cmd** Confirm (Verify RHC Trigger Hot icon)
 *
 * Verify LEE Mode – Rigidize
 *
 * TRIGGER → Press (momentarily) (SCR 19064)
 *
 * Verify 'Carriage' Tension ~5500 N (90s max)
 * Verify 'Carriage' Retract – blue

RHC

PCS

3.2 Maneuvering to Low Hover

On shuttle crew, "GO for OBSS Unberth."

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired

DCP

BRAKES SSRMS → OFF (Verify OFF)

PCS

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Roll (Verify SR – Locked)

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THC/
RHC

Maneuver OBSS to Low Hover position (within 5 cm/1 deg).
(THC Up, -Z)

Locked						
SR	SY	SP	EP	WP	WY	WR
-82.2	-25.3	+9.1	-126.5	+25.9	-3.5	+16.4
X	Y	Z	Pitch	Yaw	Roll	
0	0	-150	0.0	0.0	0.0	
FOR	Loaded – OBSS Mid MPM, SR Held					
Disp	Orbiter>OBSS Mid MPM					

PCS

MSS: SSRMS:

Enter Mode – Standby (Verify blue)

* If using shuttle attitude control

* | Perform **ROBOTICS ATTITUDE MAINTENANCE**, steps 1

* | and 2 (ORB OPS, **REBOOST/DAP**), then:

4. FOR OCAS TO UNBERTH INTERMEDIATE (2 MINUTES)

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (+60, +30)	24: Tip Elbow (-30, +5)	72 (DNLK): Camera D (-20, +20)	Camera C (+50, +50)	SRMS Elbow (-135, +15)

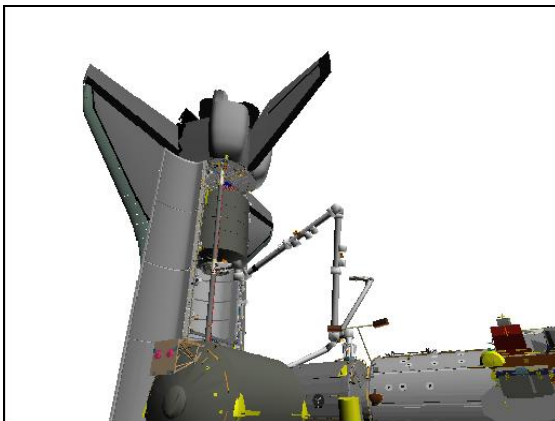


Figure 10.- Low Hover
(03: S1 Lower Outboard: +60, +30).

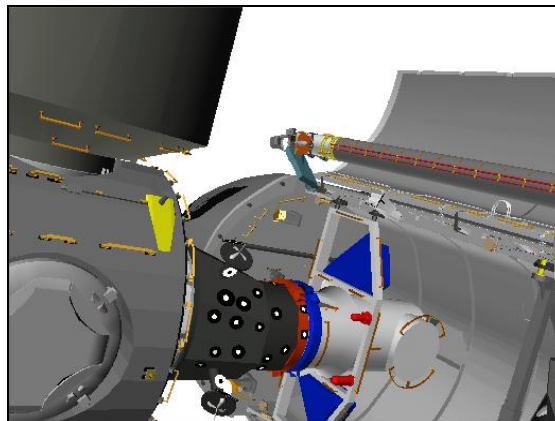


Figure 11.- Low Hover
(24: Tip Elbow: -30, +5).

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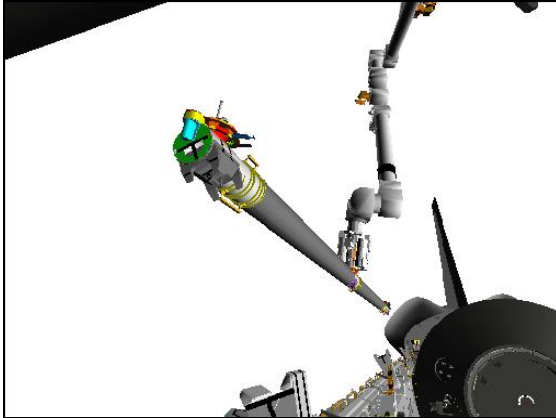


Figure 12.- Low Hover
(72: Camera D: -20, +20).

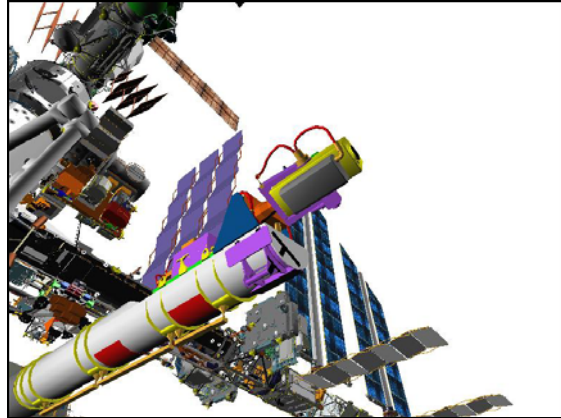


Figure 13.- Low Hover
(Camera C: +50, +50).

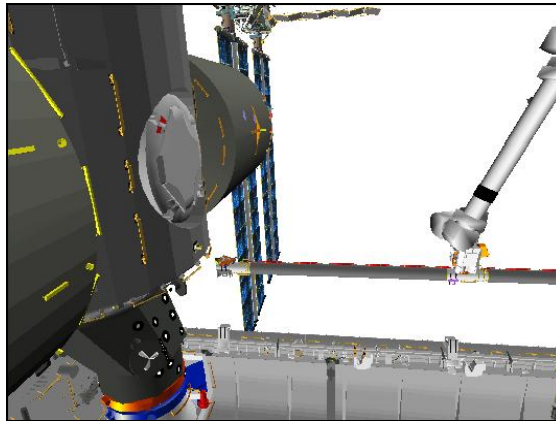


Figure 14.- Low Hover
(SRMS Elbow: -135, +15).

√Vernier

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: 1.0 (Verify 1.0)

MSS: SSRMS:

Enter Mode – FOR OCAS (Verify blue)

MSS: SSRMS: SSRMS FOR OCAS: Joint Lock:

cmd Shoulder Roll (Verify SR – Locked)

pick File ► OBSS ► Unberth Intermed

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Verify 'FOR' 'Destination' for Unberth Intermediate position.

X	Y	Z	Pitch	Yaw	Roll
+250	-200	-300	+5.0	-5.0	0.0

cmd Load (Verify Sequence Status – Confirm or Cancel)

MON

Verify FOR and errors are correct on FOR Position overlay.

	X	Y	Z	Pitch	Yaw	Roll
FOR	0	0	-150	0.0	0.0	0.0
TGT	+250	-200	-300	+5.0	-5.0	0.0
ERR	-250	+200	+150	-5.0	+5.0	0.0

PCS

cmd Confirm (Verify Sequence Status – Auto Seq sw - Hot)

DCP

AUTO SEQ → PROC

PCS

MSS: SSRMS:

Verify Posn Hold – orange

Verify SSRMS at Unberth Intermediate position (within 5 cm/1 deg).

Locked	SR	SY	SP	EP	WP	WY	WR
	-82.2	-37.8	+18.1	-103.4	-3.8	-2.7	+22.2
	X	Y	Z	Pitch	Yaw	Roll	
	+250	-200	-300	+5.0	-5.0	0.0	
FOR	Loaded – OBSS Mid MPM, SR Held						
Disp	Orbiter>OBSS Mid MPM						

5. FOR OCAS TO OBSS HANDOFF (4 MINUTES)

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (+60, +30)	09: P1 Lower Outboard (+120, +20)	72 (DNLK): Camera D (-20, +20) Camera A (+10, +20)	Camera C (+45, +30)	SRMS Elbow (-105, +10)



Figure 15.- Intermediate
(03: S1 Lower Outboard: +60, +30).

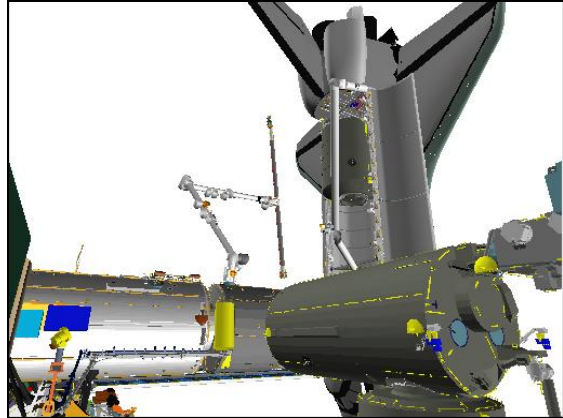


Figure 16.- Intermediate
(09: P1 Lower Outboard: +120, +20).



Figure 17.- Intermediate
(72: Camera D: -20, +20).

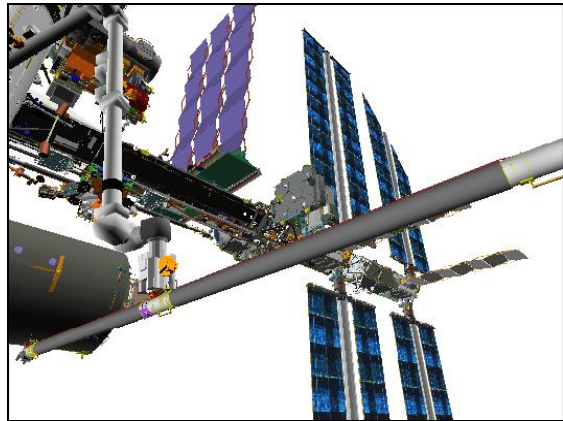


Figure 18.- Intermediate
(Camera C: +45, +30).

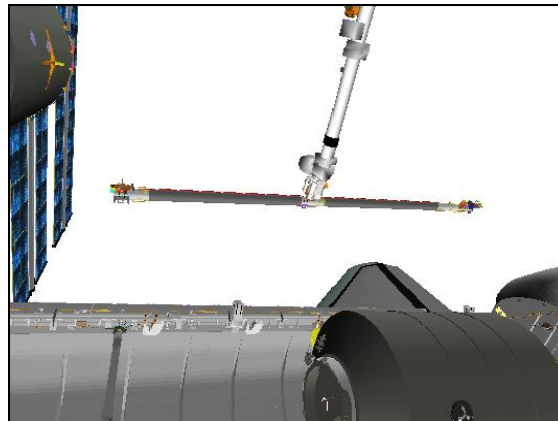


Figure 19.- Intermediate
(SRMS Elbow: -105, +10).

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√Vernier

SSRMS FOR OCAS

pick File ► OBSS ► Handoff

Verify 'FOR' 'Destination' for OBSS Handoff position.

X	Y	Z	Pitch	Yaw	Roll
+325	+705	-198	+91.2	-70.6	+47.3

cmd Load (Verify Sequence Status – Confirm or Cancel)

MON

Verify FOR and errors are correct on FOR Position overlay.

	X	Y	Z	Pitch	Yaw	Roll
FOR	+250	-200	-300	+5.0	-5.0	0.0
TGT	+325	+705	-198	+91.2	-70.6	+47.3
ERR	-75	-905	-102	-86.2	+65.6	-47.3

PCS

cmd Confirm (Verify Sequence Status – Auto Seq sw - Hot)

DCP

AUTO SEQ → PROC

PCS

MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at OBSS Handoff position (within 5 cm/1 deg).

Locked	SR	SY	SP	EP	WP	WY	WR
	-82.2	+28.1	+45.2	-125.9	+4.4	-1.0	-128.4
	X	Y	Z	Pitch	Yaw	Roll	
	+325	+705	-198	+91.2	-70.6	+47.3	
FOR	Loaded – OBSS Mid MPM, SR Held						
Disp	Orbiter>OBSS Mid MPM						

DCP

BRAKES SSRMS → ON (Verify ON)

 * If using shuttle attitude control
 * Verify in attitude, then DAP: FREE.

On MCC-H GO, "GO for SRMS OBSS Grapple."

Notify SRMS operator, "GO for SRMS OBSS Grapple."

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6. SETUP FOR UNGRAPPLE

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
03: S1 Lower Outboard (+60, +30)	25: Tip LEE (Full Zoom Out)	72 (DNLK): Camera A (+10, +20)	Camera C (-30, +40)	SRMS Elbow (-50, +20)

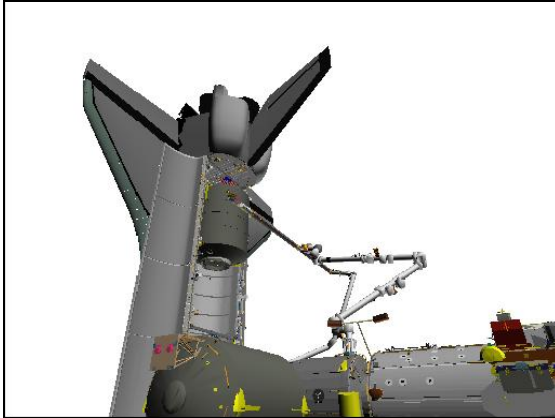


Figure 20.- OBSS Handoff
(03: S1 Lower Outboard: +60, +30).

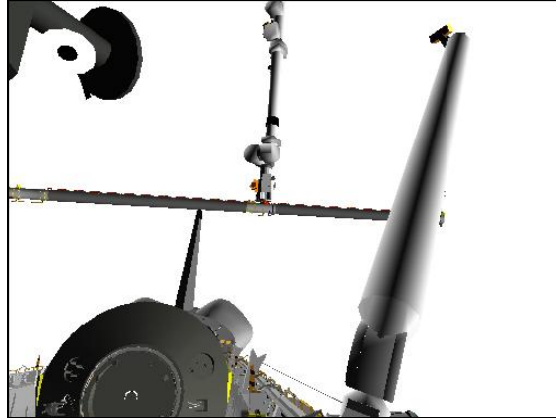


Figure 21.- OBSS Handoff
(72: Camera A: +10, +20).

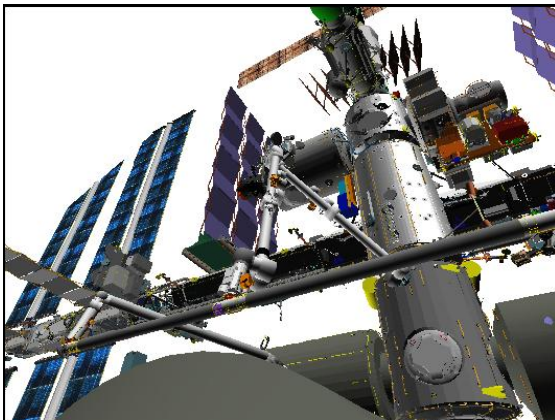


Figure 22.- OBSS Handoff
(Camera C: -30, +40).

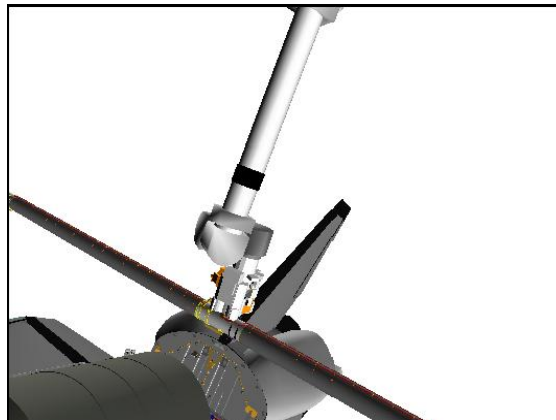


Figure 23.- OBSS Handoff
(SRMS Elbow: -50, +20).

PCS

MSS: SSRMS:

Verify 'Unloaded Parameters' (two) – LEE Tip, SR Held

Change Display ► ISS ► ISSACS (Verify ISS>ISSACS)

Change Command ► SSRMS ► Internal (Verify SSRMS>Internal)

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired

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(RBT FS/ULF5/FIN/HC/SPN)

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7. OBSS RELEASE

7.1 SSRMS Limp

On SRMS operator, "GO for OBSS Ungrapple."

DCP BRAKES SSRMS → OFF (Verify OFF)

√Vernier

PCS MSS: SSRMS: Limp:

cmd All Limp (Verify Limp – blue)

MSS: SSRMS:

Verify all joints – Limped

7.2 Auto Release

MSS: SSRMS: Tip LEE:

cmd Release ► Automatic ► Slow (Verify Speed – Slow)

Verify '**Confirm or Terminate**' prompt.

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Release

RHC TRIGGER → Press (momentarily)

PCS Verify 'Carriage' Retract – gray (90s max)
Verify 'Snare' Open – blue (12s max)
Verify 'Carriage' Derigidize – blue (90s max)
Verify 'Carriage' Extend – blue (90s max)

Verify Unloaded Parameters – √

7.3 SSRMS Backoff

MSS: SSRMS: Limp:

cmd None Limp (Verify Standby – blue)

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Roll (Verify SR – Locked)

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THC/
RHC

Maneuver to OBSS Backoff position (within 5 cm/1 deg).
(THC Pull, -X)

Locked						
SR	SY	SP	EP	WP	WY	WR
-82.2	+28.3	+60.8	-131.7	-5.4	-1.1	-128.6
X	Y	Z	Pitch	Yaw	Roll	
+1014	-313	+1499	-12.8	+0.1	+89.8	
FOR	Unloaded – LEE Tip, SR Held					
Disp	ISS>ISSACS					

DCP

BRAKES SSRMS → ON (Verify ON)

```
*****
* If using shuttle attitude control
* | Perform ROBOTICS ATTITUDE MAINTENANCE, steps 1
* | and 2 (ORB OPS, REBOOST/DAP), then:
*****
```

Notify SRMS operator, "GO for maneuver to PMM Viewing position."

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1.310 SSRMS PMM UNBERTH AND INSTALL TO NODE 1 NADIR
 (RBT FS/ULF5/FIN/HC/SPN) Page 1 of 21 pages

1. JOINT OCAS TO PMM PRE-GRAPPLE (2 MINUTES)

Verify SRMS is grappled to OBSS and at PMM Install Viewing position.

SY	SP	EP	WP	WY	WR
+35.0	+38.7	-22.8	-0.5	-0.3	-40.0

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
07: P1 Lower Inboard (+155, +40)	03: S1 Lower Outboard (+65, +20)	72 (DNLK): Camera B (0, +40)	SRMS Elbow (-90, +55)	OBSS ITVC (+120, -45)

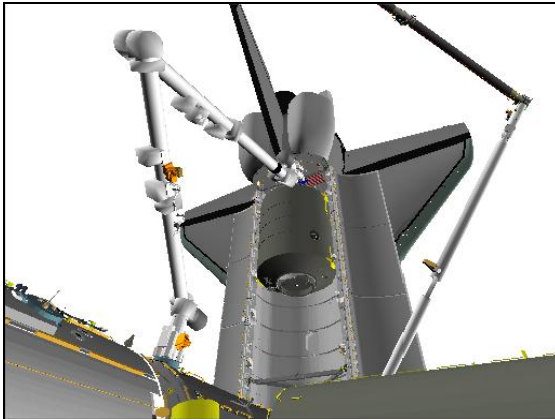


Figure 1.- OBSS Backoff
 (07: P1 Lower Inboard: +155, +40).

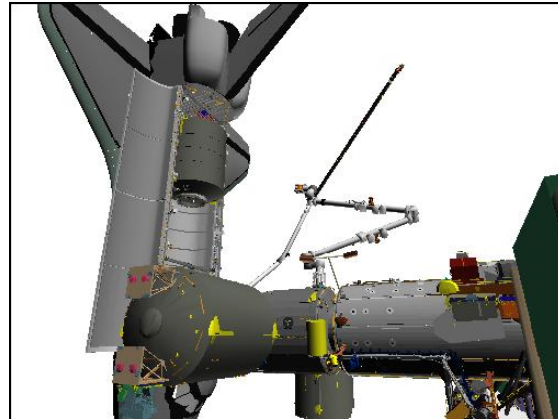


Figure 2.- OBSS Backoff
 (03: S1 Lower Outboard: +65, +20).

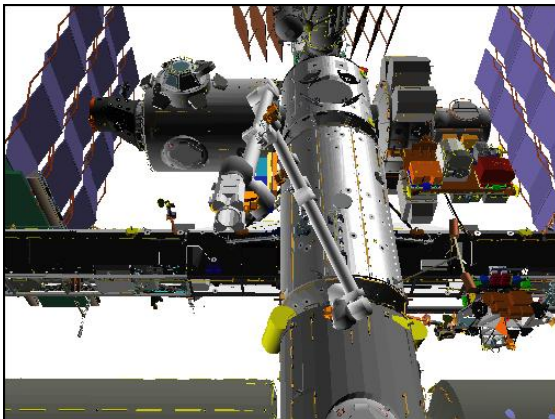


Figure 3.- OBSS Backoff
 (72: Camera B: 0, +40).

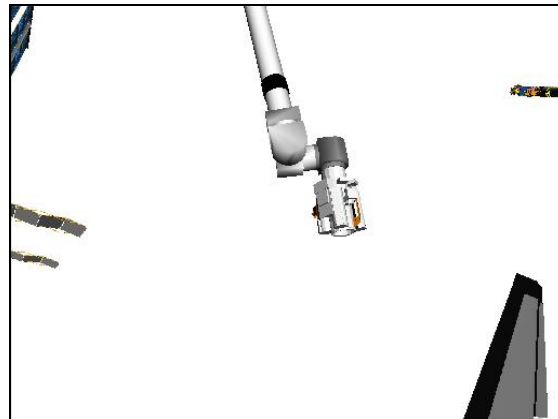


Figure 4.- OBSS Backoff
 (SRMS Elbow: -90, +55).

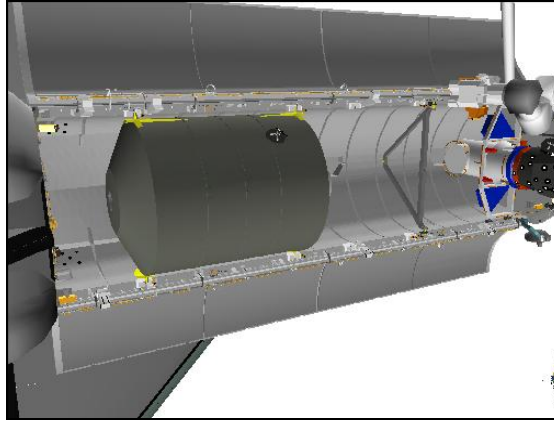


Figure 5.- OBSS Backoff
 (OBSS ITVC: +120, -45).

PCS

MSS: SSRMS:

Verify Unloaded Parameters – √

Change Unloaded Parameters ► Unloaded ► LEE Tip SRH

Verify 'Unloaded Parameters' (two) – LEE Tip, SR Held

Change Loaded Parameters ► PMM ► PMM Unberth SRH

Verify 'Loaded Parameters' (three) – PMM Unberth, SSRMS, SR Held

Change Display ► Orbiter ► PMM GF (Verify Orbiter>PMM GF)

Change Command ► SSRMS ► Internal (Verify SSRMS>Internal)

Verify SSRMS at OBSS Backoff position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-82.2	+28.3	+60.8	-131.7	-5.4	-1.1	-128.6
X	Y	Z	Pitch	Yaw	Roll	
-459	+351	+65	+14.8	-49.8	+120.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	Orbiter>PMM GF					

DCP

BRAKES SSRMS → OFF (Verify OFF)

RHC

RATE → COARSE (Verify Coarse on PCS)

PCS

MSS: SSRMS:

Enter Mode – Joint OCAS (Verify blue)

pick File ► PMM ► Pre-Grapple

1.310 SSRMS PMM UNBERTH AND INSTALL TO NODE 1 NADIR

(RBT FS/ULF5/FIN/HC/SPN)

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Verify 'Joint Angles' 'Destination' for PMM Pre-Grapple position.

SR	SY	SP	EP	WP	WY	WR
-90.1	+25.8	+7.4	-84.2	-228.3	-141.2	-77.1

cmd Load (Verify Sequence Status – Confirm or Cancel)

MON

Verify joint angles and errors are correct on Joint Angle Position overlay.

	SR	SY	SP	EP	WP	WY	WR
(current)	-82.2	+28.3	+60.8	-131.7	-5.4	-1.1	-128.6
TGT	-90.1	+25.8	+7.4	-84.2	-228.3	-141.2	-77.1
ERR	+7.9	+2.5	+53.4	-47.5	+222.9	+140.1	-51.5

PCS

cmd Confirm (Verify Sequence Status – Auto Seq sw - Hot)

DCP

AUTO SEQ → PROC

PCS

MSS: SSRMS:

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-90.1	+25.8	+7.4	-84.2	-228.3	-141.2	-77.1

2. PMM GRAPPLE

2.1 Setup

RHC

RATE → VERNIER (Verify Vernier on PCS)

PCS

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
07: P1 Lower Inboard (+155, +40)	25: Tip LEE (Full Zoom Out)	72 (DNLK): Camera B (0, +10)	SRMS Elbow (-90, +10)	OBSS ITVC (+120, -45)



Figure 6.- PMM Pre-Grapple
(07: P1 Lower Inboard: +155, +40).

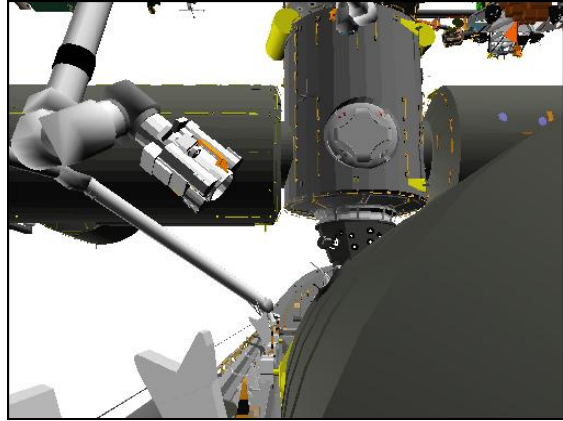


Figure 7.- PMM Pre-Grapple
(72: Camera B: 0, +10).

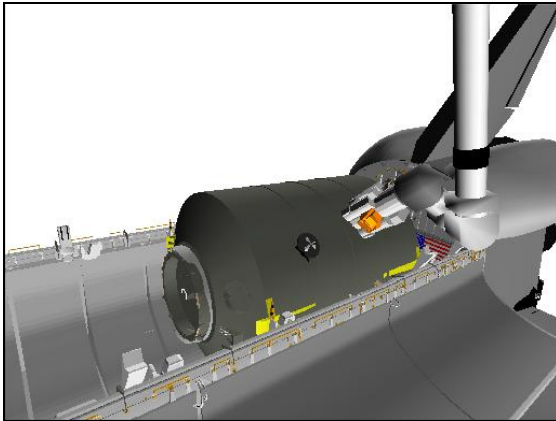


Figure 8.- PMM Pre-Grapple
(SRMS Elbow: -90, +10).

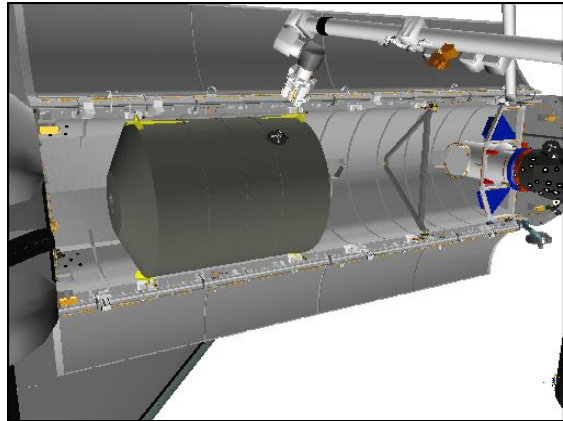


Figure 9.- PMM Pre-Grapple
(OBSS ITVC: +120, -45).

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Roll (Verify SR – Locked)

2.2 Maneuvering to Grapple

NOTE

Clearance between Tip LEE and orbiter decreases to 90 cm (35 in). Monitor using Camera B.

THC/
RHC

Maneuver to within grapple envelope (THC In, +X).

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(RBT FS/ULF5/FIN/HC/SPN)

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2.3 Slowing FRGF Capture Commands

PCS

MSS: SSRMS: Tip LEE:

cmd Capture ► Automatic ► Slow, Limp (Verify Speed – Slow)

Verify '**Confirm or Terminate**' prompt.

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Capture

2.4 FRGF Grapple

RHC

TRIGGER → Press (momentarily)

PCS

Verify 'Snare' Close, Capture (two) – blue (12s max)

Verify Capture to Latch – No (SCR 19282)

Verify 'Carriage' Tension ~5500 N (90s max)

Verify 'Carriage' Retract – blue

Verify Motors – Inh

2.5 Grapple Cleanup

DCP

BRAKES SSRMS → ON (Verify ON)

PCS

MSS: SSRMS:

Verify Loaded Parameters – √

Verify 'Loaded Parameters' (three) – PMM Unberth, SSRMS, SR Held

3. PMM UNBERTH SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
07: P1 Lower Inboard (+155, +40)	13: LAB Stbd Zenith (-40, -20) 22: Base Elbow (-110, -15)	72 (DNLK): Mux B/C B (0, -10) C (0, -10)	SRMS Elbow (-90, +10)	OBSS ITVC (+120, -45)

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Figure 10.- PMM Grappled
(07: P1 Lower Inboard: +155, +40).

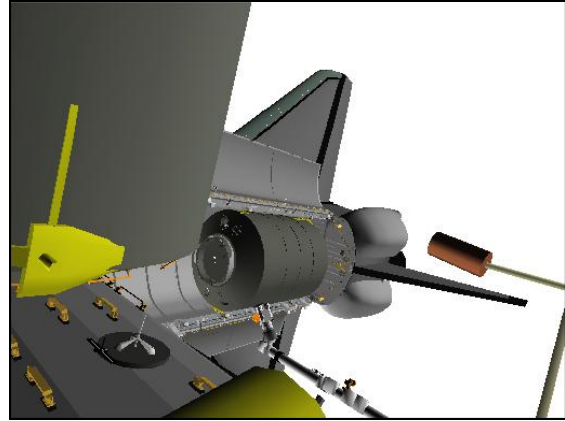


Figure 11.- PMM Grappled
(13: LAB Stbd Zenith: -40, -20).

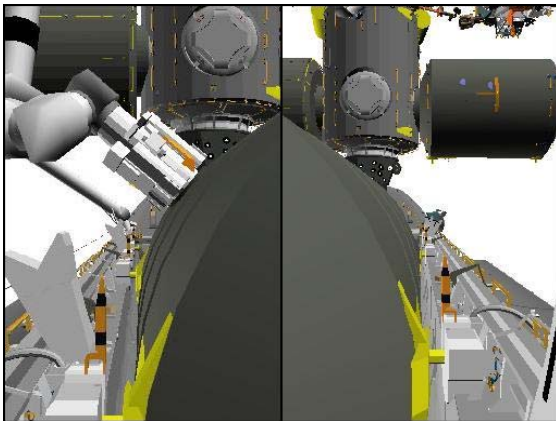


Figure 12.- PMM Grappled
(72: Mux B/C).

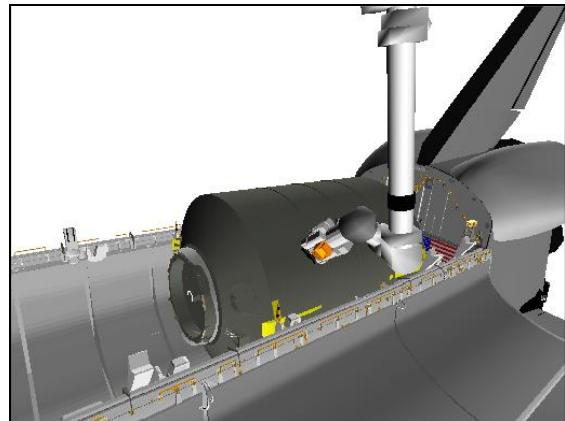


Figure 13.- PMM Grappled
(SRMS Elbow: -90, +10).

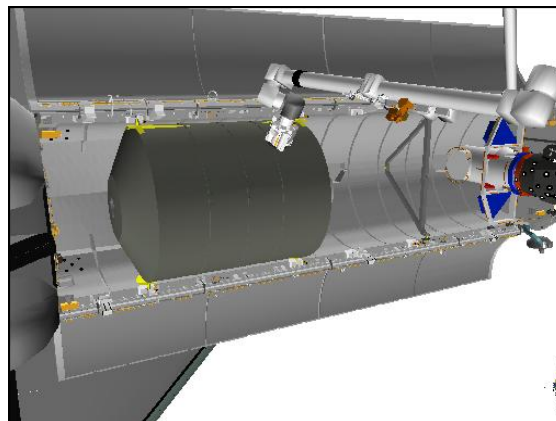


Figure 14.- PMM Grappled
(OBSS ITVC: +120, -45).

1.310 SSRMS PMM UNBERTH AND INSTALL TO NODE 1 NADIR

(RBT FS/ULF5/FIN/HC/SPN)

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MSS: SSRMS:

Change Display ► Orbiter ► PMM Unberth (Verify Orbiter>PMM Unberth)

Change Command ► ISS ► OBAS (Verify ISS>OBAS)

Verify SSRMS at Berthed PMM Grappled position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-90.1	+18.7	+0.8	-81.1	-219.7	-137.6	-69.2
X	Y	Z	Pitch	Yaw	Roll	
0	0	0	0.0	0.0	0.0	
FOR	Loaded – PMM Unberth, SR Held					
Disp	Orbiter>PMM Unberth					

Review [SSRMS LEE CUE CARD \(SSRMS IS LOADED AND LEE CAUTION IS ANNUNCIATED\)](#), all (SODF: RBT GEN: REFERENCE: CUE CARD).

 * If using shuttle attitude control
 * Verify in attitude, then DAP: FREE.

On MCC-H GO, “GO for PRLA Ops.”

Notify PRLA operator, “GO for ROEU and PRLA Ops.”

NOTE
Steps 4 to 8 will be performed by the shuttle crew to open PMM PRLAs.

4. [ROEU DEMATE](#)

4.1 [Setup](#)

On SSRMS operator, “GO for ROEU and PRLA ops.”

CCTV – Config for ROEU demate

4.2 [Deadfacing ROEU](#)

SSP 1 √PMM CH 1,2 HTR – OFF (tb–bp)

A15 √APCU 1 OUTPUT – OFF

A6U Install ROEU A6U PANEL OVERLAY.

√PL RETEN LAT (five) – OFF
PL SEL – 2

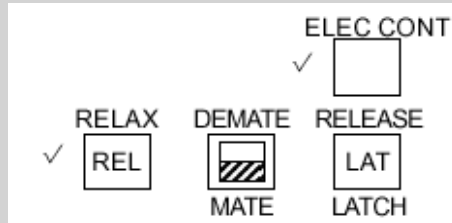
√REL 2,3 (four): 0

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 * If LATCH 2,3 REL msw shows 1, drive latch for single motor time.



4.3 Activating ROEU

R13L

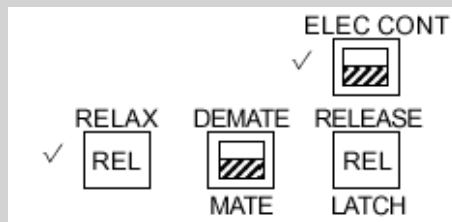
PL RETEN LOGIC PWR SYS 1,2 (two) – ON
 BAY MECH PWR SYS 1,2 (two) – ON

4.4 Releasing Latches

Note single motor time (> 20 seconds).

A6U

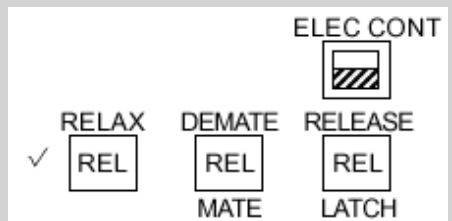
RELEASE/LATCH – REL (tb–REL), 40s max
 – OFF



4.5 Demating ROEU

Note single motor time (> 18 seconds).

DEMATE/MATE – DEMATE (tb–REL), 36s max
 – OFF



4.6 Deactivating ROEU

R13L

PL RETEN LOGIC PWR SYS 1,2 (two) – OFF
 BAY MECH PWR SYS 1,2 (two) – OFF

A6U

Remove ROEU A6U PANEL OVERLAY.

CCTV – Config for SSRMS Ops

DTV | OBSS ITVC

5. ACTIVATING LATCHES

- √PL RETEN LAT (five) – OFF
- PL SEL – 1
- LOGIC PWR SYS 1,2 (two) – ON
- R13L PL BAY MECH PWR SYS 1,2 (two) – ON

SM 97 PL RETENTION

- √RDY-FOR-LAT 1,2,3,4,5 (ten): 1
- √LAT 1,2,3,4,5 (ten): 1

 * If any REL msw shows 1, expect single motor time
 * (60 seconds).

6. AKA RELEASE

- A6U √PL RETEN LAT 5 tb – LAT
- √RDY 5 tb – gray

Note single motor drive times (> 30 seconds).

- PL RETEN LAT 5 – REL (tb-REL), 60s max
- OFF

7. PRLA RELEASE

- √PL RETEN LAT 1,2,3,4 tb (four) – LAT
- √RDY 1,2,3,4 tb (four) – gray

Note single motor drive times (> 30 seconds).

- PL RETEN LAT 1,2 (two) – REL (tb-REL), 60s max
- OFF
- 3,4 (two) – REL (tb-REL), 60s max
- OFF

8. DEACTIVATING LATCHES

- R13L PL RETEN LOGIC PWR SYS 1,2 (two) – OFF
- BAY MECH PWR SYS 1,2 (two) – OFF

Notify SSRMS operator, "PRLAs released, GO for PMM unberth."

9. MANEUVERING PMM TO HOVER

```

*****
* If 'R3Q - SSRMS LEE Uncommanded Derigidize' Caution was announced
* during PRLA release or Carriage tension < 4400 N
*
PCS *   MSS: SSRMS: Tip LEE: 
*
*   cmd 'Carriage' Rigidize ► Slow (Verify Speed – Slow)
*
*   Verify 'Confirm or Terminate' prompt.
*
*   cmd Confirm (Verify RHC Trigger Hot icon)
*
*   Verify LEE Mode – Rigidize
RHC *   TRIGGER → Press (momentarily) (SCR 19064)
*
PCS *   Verify 'Carriage' Tension ~5500 N (90s max)
*   Verify 'Carriage' Retract – blue
*****
  
```

On PRLA operator, "GO for PMM Unberth."

DCP BRAKES SSRMS → OFF (Verify – OFF)

√Vernier

PCS MSS: SSRMS: Rate:
 Set 'Scale' 'Vernier' Rate Scale: as desired

MSS: SSRMS:

Enter Mode – Manual (Verify – blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Roll (Verify SR – Locked)

THC/
RHC Maneuver PMM to Hover position (within 5 cm/1 deg).
(THC Up, -Z)

Locked						
SR	SY	SP	EP	WP	WY	WR
-90.1	+18.5	+36.1	-104.2	-231.7	-137.5	-69.0
X	Y	Z	Pitch	Yaw	Roll	
0	0	-550	0.0	0.0	0.0	
FOR	Loaded – PMM Unberth, SR Held					
Disp	Orbiter>PMM Unberth					

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PCS

MSS: SSRMS:

Enter Mode – Standby (Verify blue)

 * If using shuttle attitude control
 * | Perform [ROBOTICS ATTITUDE MAINTENANCE](#), steps 1 to 3
 * | (ORB OPS, [REBOOST/DAP](#)), then:

10. JOINT OCAS MANEUVER TO PRE-INSTALL (18 MINUTES)

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON1)	SSC R (DTV)
09: P1 Lower Outboard (+105, +25)	03: S1 Lower Outboard (+65, +20)	72 (DNLK): Camera C (0, +20)	SRMS Elbow (-90, +35)	OBSS ITVC (+120, -45)

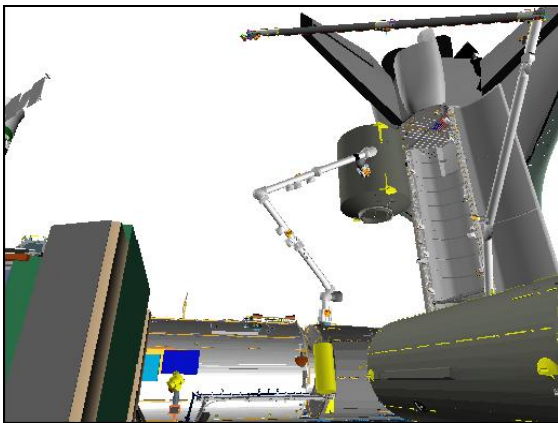


Figure 15.- PMM Hover (09: P1 Lower Outboard: +105, +25).

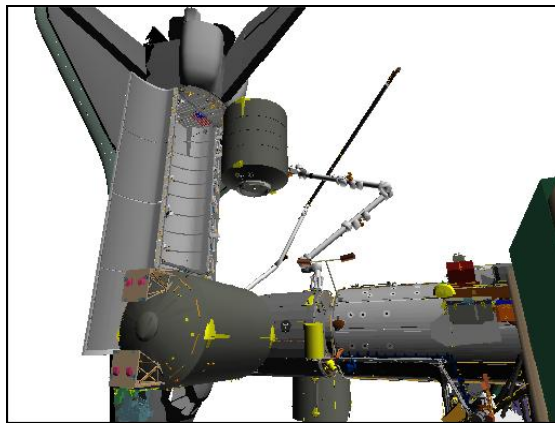


Figure 16.- PMM Hover (03: S1 Lower Outboard: +65, +20).

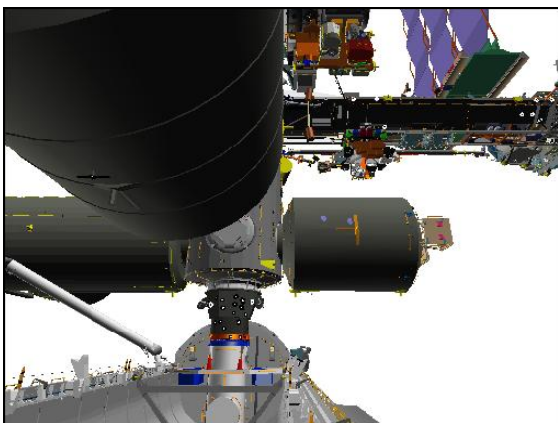


Figure 17.- PMM Hover (72: Camera C: 0, +20).

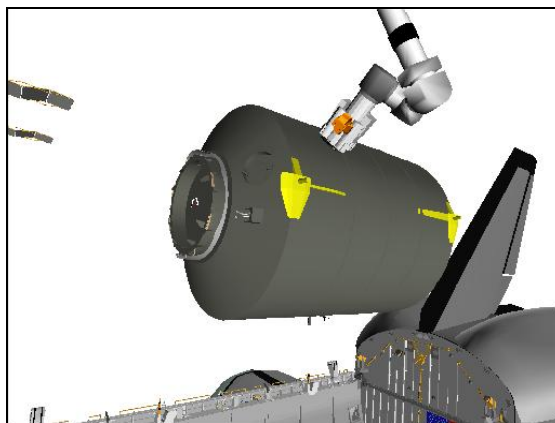


Figure 18.- PMM Hover (SRMS Elbow: -90, +35).

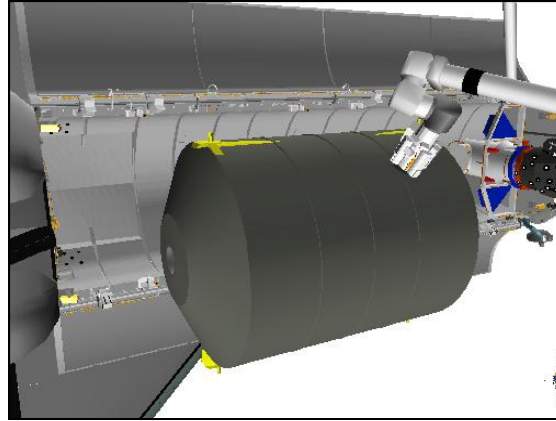


Figure 19.- PMM Hover
 (OBSS ITVC: +120, -45).

MSS: SSRMS:

Change Loaded Parameters ► PMM ► PMM CBCS Mate SYH
 Verify 'Loaded Parameters' (three) – PMM CBCS Mate, SSRMS, SY Held

Change Display ► Node1 ► PMM Mate CBCS (Verify Node1>PMM Mate CBCS)

Change Command ► SSRMS ► Internal (Verify SSRMS>Internal)

RHC RATE → COARSE (Verify Coarse on PCS)

PCS MSS: SSRMS:

Enter Mode – Joint OCAS (Verify blue)

pick File ► PMM ► Pre-Install

Verify 'Joint Angles' 'Destination' for Pre-Install position.

SR	SY	SP	EP	WP	WY	WR
+90.9	+9.9	-17.6	-98.3	-153.1	-220.9	-30.8

cmd Load (Verify Sequence Status – Confirm or Cancel)

MON Verify joint angles and errors are correct on Joint Angle Position overlay.

	SR	SY	SP	EP	WP	WY	WR
(current)	-90.1	+18.4	+43.6	-106.3	-237.1	-137.4	-68.9
TGT	+90.9	+9.9	-17.6	-98.3	-153.1	-220.9	-30.8
ERR	-181.0	+8.5	+61.2	-8.0	-84.0	+83.5	-38.1

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PCS **cmd** Confirm (Verify Sequence Status – Auto Seq sw - Hot)

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at PMM Pre-Install position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+90.9	+9.9	-17.6	-98.3	-153.1	-220.9	-30.8
X	Y	Z	Pitch	Yaw	Roll	
+250	0	0	0.0	0.0	0.0	
FOR	Loaded – PMM CBCS Mate, SY Held					
Disp	Node1>PMM Mate CBCS					

```
*****
* If using shuttle attitude control
* | Perform ROBOTICS ATTITUDE MAINTENANCE, steps 1 to 3
* | (ORB OPS, REBOOST/DAP), then:
*****
```

11. [MANEUVERING PMM TO READY-TO-LATCH POSITION](#)

NOTE

1. Clearance between the PMM and Airlock decreases to 44 cm (17 in) at RTLs. Monitor with Camera C.
2. Clearance between the PMM and N3 Ammonia Lines decreases to TBD cm (TBD in) at RTLs. Monitor with Base Elbow Camera.

Configure Cameras and CBCS PMM overlay as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON1)	SSC R (DTV)
09: P1 Lower Outboard (+85, +20)	17: CBCS	22: Base Elbow (-85, +10)	SRMS Elbow (+155, +45)	Camera C (0, +55)

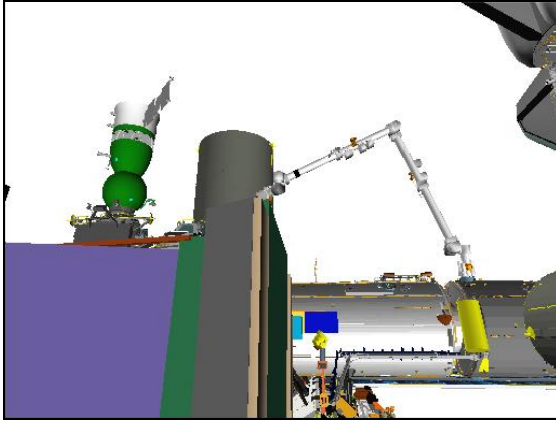


Figure 20.- PMM Pre-Install
(09: P1 Lower Outboard: +85, +20).

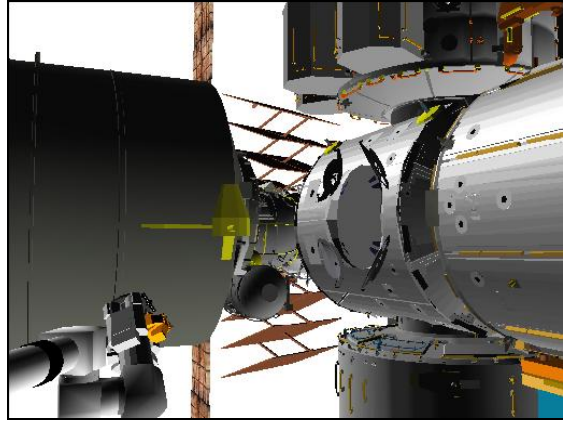


Figure 21.- PMM Pre-Install
(22: Base Elbow: -85, +10).

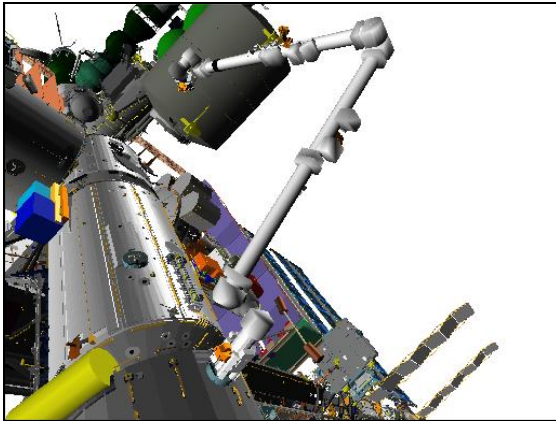


Figure 22.- PMM Pre-Install
(SRMS Elbow: +155, +45).

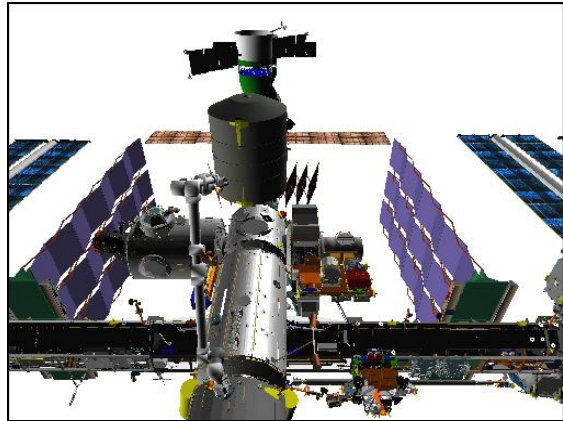


Figure 23.- PMM Pre-Install
(Camera C: 0, +55).

Verify [1.505 NODE 1 CBM VERIFY PRE-MATE STATUS](#), all
(SODF: S&M: NOMINAL: CBM), completed.

On CBM operator, "GO for maneuver to Ready-to-Latch position."

NODE1: S&M: Nadir CBM:

Monitor CBM RTLs using PCS.

RHC RATE → VERNIER (Verify Vernier on PCS)

PCS MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired

MSS: SSRMS:

Verify Command – SSRMS>Internal

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Enter Mode – Manual (Verify – blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Yaw (Verify SY – Locked)

THC/
RHC

Maneuver PMM to Ready-To-Latch position until RTL (four) – green (THC Out, -X)

Locked		SP	EP	WP	WY	WR
SR	SY					
+90.8	+9.9	-29.2	-105.1	-134.8	-220.7	-30.8
X	Y	Z	Pitch	Yaw	Roll	
+8	0	0	0.0	0.0	0.0	
FOR	Loaded – PMM CBCS Mate, SY Held					
Disp	Node1>PMM Mate CBCS					

PCS

MSS: SSRMS:

Verify Posn Hold – orange

NODE1: S&M: Nadir CBM:

Verify RTL (four) – green

MSS: SSRMS:

Enter Mode – Standby (Verify blue)

Notify CBM operator, “Maneuver to RTL complete. GO for First Stage Capture.”

12. SSRMS LIMPING

On CBM operator, “GO for SSRMS mode to limp.”

NOTE

Following SSRMS Mode to Limp, RTL indication may be lost due to RTL spring forces. RTL indication is not required prior to execution of Second Stage Capture.

MSS: SSRMS: Limp:

cmd All Limp (Verify Limp – blue)

MSS: SSRMS:

Verify all joints – Limped

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WARNING

If SSRMS fails to brakes-on from limp mode, continuation of Second Stage Capture may cause structural failure of SSRMS or primary structure. If CBM stops unexpectedly (and Cmd Code changes to 'Stop') or SSRMS safes during Second Stage Capture, $\sqrt{\text{MCC-H}}$ before proceeding.

Notify CBM operator, "SSRMS mode to limp complete. GO for Second Stage Capture."

13. PMM RELEASE SETUP

On CBM operator, "GO for SSRMS ungrapple."

MSS: SSRMS:

Expected PMM Install position:

SR	SY	SP	EP	WP	WY	WR
+90.8	+9.9	-29.7	-105.2	-134.2	-220.7	-30.8
X	Y	Z	Pitch	Yaw	Roll	
0	0	0	0.0	0.0	0.0	
FOR	Loaded – PMM CBCS Mate, SY Held					
Disp	Node1>PMM Mate CBCS					

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
09: P1 Lower Outboard (+85, +20)	25: Tip LEE (Zoom Full Out)	22: Base Elbow (-95, 0)	SRMS Elbow (-170, +65)	Camera C (0, +55)

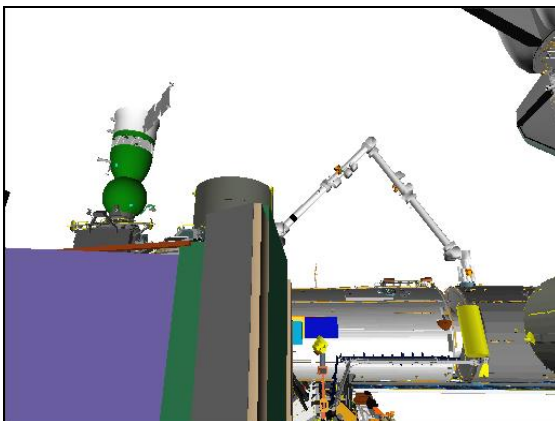


Figure 24.- PMM Installed (09: P1 Lower Outboard: +85, +20).

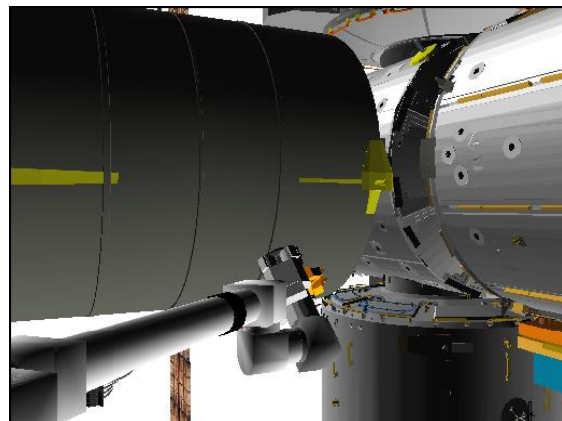


Figure 25.- PMM Installed (22: Base Elbow: -95, 0).

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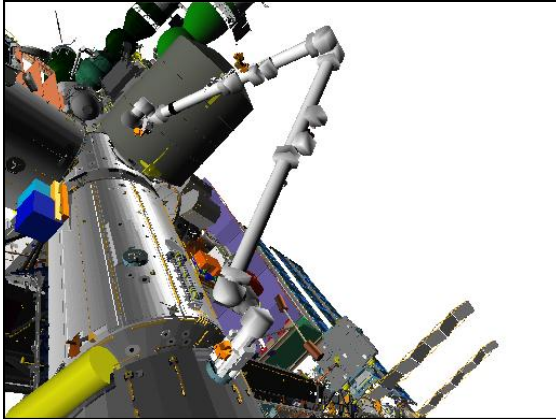


Figure 26.- PMM Installed
(SRMS Elbow: -170, +65).

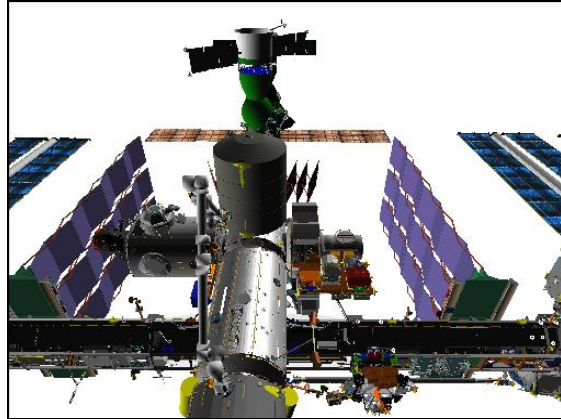


Figure 27.- PMM Installed
(Camera C: 0, +55).

Change Unloaded Parameters ► Unloaded ► LEE Tip SYH
Verify 'Unloaded Parameters' (two) – LEE Tip, SY Held

Change Display ► Node1 ► PMM Mated GF (Verify Node1>PMM Mated GF)

Verify Command – SSRMS>Internal

√Vernier

MSS: SSRMS: Rate:

Set 'Scale' 'Vernier' Rate Scale: as desired

14. PMM RELEASE AND BACKOFF

14.1 Auto Release

MSS: SSRMS: Tip LEE:

cmd Release ► Automatic ► Slow (Verify Speed – Slow)

Verify '**Confirm or Terminate**' prompt.

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Release

RHC TRIGGER → Press (momentarily)

PCS Verify 'Carriage' Retract – gray (90s max)
Verify 'Snare' Open – blue (12s max)
Verify 'Carriage' Derigidize – blue
Verify 'Carriage' Extend – blue (90s max)

Verify Unloaded Parameters – √

14.2 SSRMS Backoff

MSS: SSRMS: Limp:

cmd None Limp (Verify Standby – blue)

MSS: SSRMS:

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock:

cmd Shoulder Yaw (Verify SY – Locked)

THC/
RHC

Maneuver SSRMS to Backoff position (within 5 cm/1 deg).
(THC Out, -X)

SR	SY	SP	EP	WP	WY	WR
+100.3	+9.9	-21.4	-116.3	-129.5	-230.1	-31.2
X	Y	Z	Pitch	Yaw	Roll	
-200	0	0	0.0	0.0	0.0	
FOR	Unloaded – LEE Tip, SY Held					
Disp	Node1>PMM FRGF					

PCS

MSS: SSRMS:

Enter Mode – Standby (Verify blue)

15. JOINT OCAS MANEUVER TO INTERMEDIATE (1 MINUTE)

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	SSC L (MON 1)	SSC R (DTV)
09: P1 Lower Outboard (+105, +20)	03: S1 Lower Outboard (+80, +15)	22: Base Elbow (-80, -5)	SRMS Elbow (-160, +65)	Camera C (0, +40)

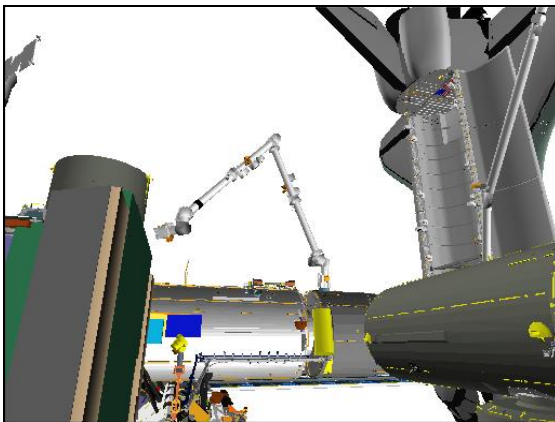


Figure 28.- PMM Released
(09: P1 Lower Outboard: +105, +20).

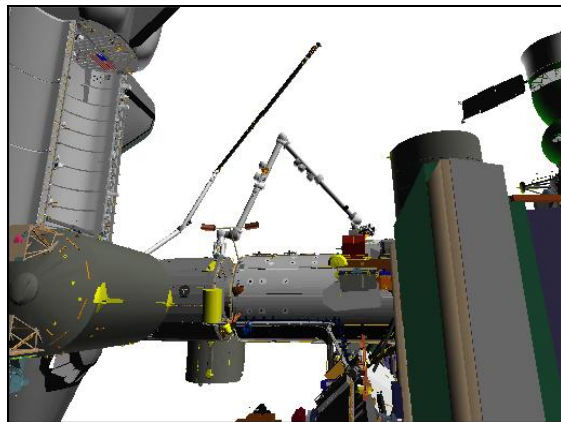


Figure 29.- PMM Released
(03: S1 Lower Outboard: +80, +15).

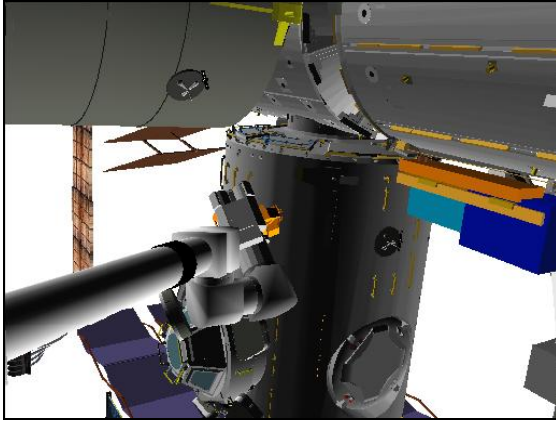


Figure 30.- PMM Released
 (22: Base Elbow: -85, -5).

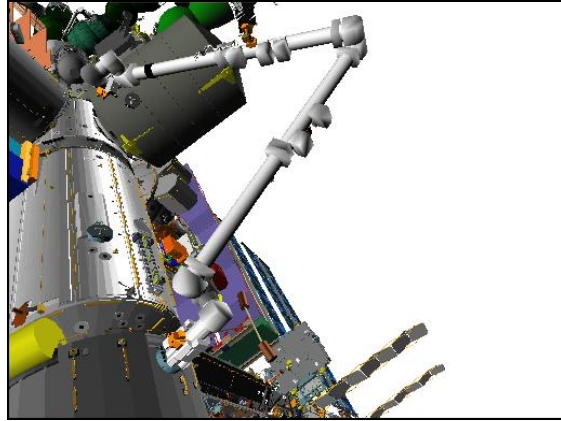


Figure 31.- PMM Released
 (SRMS Elbow: -160, +65).

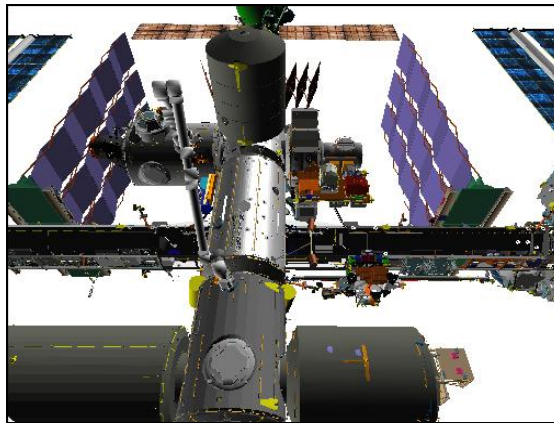


Figure 32.- PMM Released
 (Camera C: 0, +40).

NOTE
 Expect the SSRMS to be in cross-cluster self-collision approaching region.

RHC RATE – as desired

PCS MSS: SSRMS:

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

pick File ► Park ► Intermediate

Verify 'Joint Angles' 'Destination' for Intermediate position.

SR	SY	SP	EP	WP	WY	WR
+75.0	+9.9	+30.0	-150.0	-146.0	-200.0	-17.0

cmd Load (Verify Sequence Status – Confirm or Cancel)

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MON Verify joint angles and errors are correct on Joint Angle Position overlay.

	SR	SY	SP	EP	WP	WY	WR
(current)	+100.3	+9.9	-21.4	-116.3	-129.5	-230.1	-31.2
TGT	+75.0	+9.9	+30.0	-150.0	-146.0	-200.0	-17.0
ERR	+25.3	0.0	-51.4	+33.7	+16.5	-30.1	-14.2

PCS **cmd** Confirm (Verify Sequence Status – Auto Seq sw - Hot)

DCP AUTO SEQ → PROC

PCS MSS: SSRMS:

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
+75.0	+9.9	+30.0	-150.0	-146.0	-200.0	-17.0

16. JOINT OCAS MANEUVER TO UNDOCK (2 MINUTES)

pick File ► Park ► Undock

Verify 'Joint Angles' 'Destination' for Undock position.

SR	SY	SP	EP	WP	WY	WR
-30.0	-28.0	-58.0	-60.0	-146.0	-149.2	-17.0

cmd Load (Verify Sequence Status – Confirm or Cancel)

MON Verify joint angles and errors are correct on Joint Angle Position overlay.

	SR	SY	SP	EP	WP	WY	WR
(current)	+75.0	+9.9	+30.0	-150.0	-146.0	-200.0	-17.0
TGT	-30.0	-28.0	-58.0	-60.0	-146.0	-149.2	-17.0
ERR	+105	+37.9	+88.0	-90.0	0.0	-50.8	0.0

PCS **cmd** Confirm (Verify Sequence Status – Auto Seq sw - Hot)

DCP AUTO SEQ → PROC

PCS MSS: SSRMS:

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-30.0	-28.0	-58.0	-60.0	-146.0	-149.2	-17.0

NOTE

Expect the following message when safing is commanded:

'R3Z - MSS OCS SSRMS Prime(Redun) ACU SRT Cat-1 Brk Stat Fail' (SCR 17495)

This message should return to Norm.

DCP

SAFING → SAFE (Verify ON)

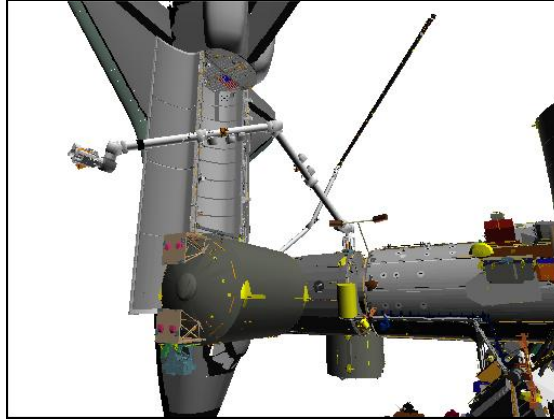


Figure 33.- Undock
(03: S1 Lower Outboard: +60, +15).

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