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ISS-12A.1

Mission Operations Directorate
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17 NOV 06

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INTERNATIONAL SPACE STATION
ROBOTICS GROUP
ROBOTICS BOOK - FLIGHT SPECIFIC
ISS-12A.1

17 NOV 06

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None

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ISS-12A.1

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P5 HANDOFF

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1.101 P5 GRAPPLE

1. HAND CONTROLLER CALIBRATION

1.1 Translational Hand Controller (THC) Calibration

THC

Deflect [X] Axis to positive hard stop where [X] = [X] [Y] [Z]

Deflect [X] Axis to negative hard stop.

Repeat

1.2 Rotational Hand Controller (RHC) Calibration

RHC

Deflect [X] Axis to positive hard stop where [X] = [P] [Y] [R]

Deflect [X] Axis to negative hard stop.

Repeat

2. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
91: Camera A (+80, 0)	25: Tip LEE	92: Camera B (-30, 0)	SRMS Elbow (-20, 0)

PCS

MSS: SSRMS: [SSRMS]

Change Loaded Parameters ▶ P5 ▶ P5 Maneuver SYH
Verify 'Loaded Parameters' (two) – P5 Maneuver, SY Held

Verify Unloaded Parameters – √
Change Unloaded Parameters ▶ Unloaded ▶ LEE Tip SRH
Verify 'Unloaded Parameters' (two) – LEE Tip, SR Held

Change Display ▶ W8 ▶ ISSACS (Verify W8>ISSACS)

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

Verify SSRMS at P5 Pre-Grapple Setup position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+2.5	+103.3	-82.7	+68.7	-72.6	+175.0	-118.1
X	Y	Z	Pitch	Yaw	Roll	
+696	-1512	+730	+99.4	-1.3	-29.1	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W8>ISSACS					

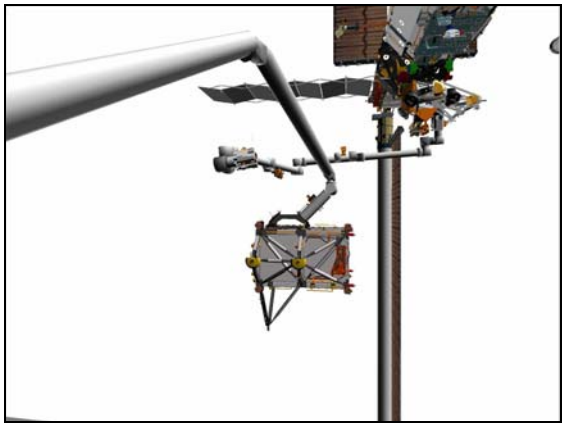

Figure 1.- SSRMS P5 Pre-Grapple Setup (91: Camera A: +80, 0).

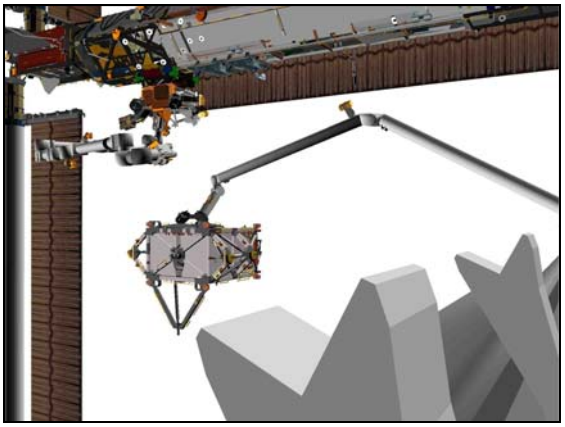

Figure 2.- SSRMS P5 Pre-Grapple Setup (92: Camera B: -30, 0).

3. P5 PRE-GRAPPLE
   Verify SRMS in P5 Handoff Position with brakes on.

PCS MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → VERNIER (Verify Vernier on PCS)

PCS MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → WRIST YAW (Verify WY – Selected on PCS)

THC Perform "+" Single Joint maneuver to WY: +229.3 (THC up).

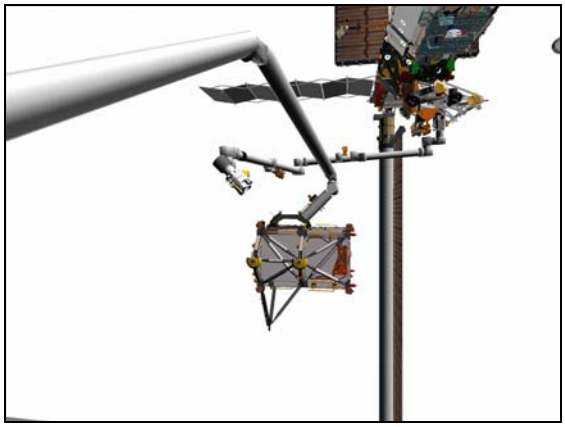

Figure 3.- SSRMS P5 Pre-Grapple
(91: Camera A: +80, 0).

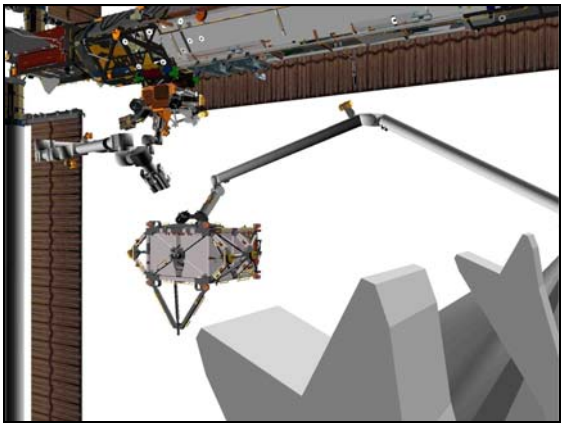

Figure 4.- SSRMS P5 Pre-Grapple
(92: Camera B: -30, 0).

4. SSRMS LEE CUE CARD REVIEW
   Review {SSRMS LEE CUE CARD}, all (SODF: RBT GEN: REFERENCE).

5. P5 GRAPPLE

5.1 Grapple Setup
Configure Cameras and overlays for grapple.

NOTE
The LEE Camera must be fully zoomed out to correspond to the target overlay.

PCS MSS: SSRMS: Rate: [SSRMS Rate]

Set ‘Scale’ ‘Vernier’ Rate Scale: as desired

5.2 Inhibiting Thrusters
MSS: SSRMS: Thrusters: [Thruster Controls for MSS Ops]

Verify ‘Desat Request:’ – Inh

5.3 SSRMS Mode
MSS: SSRMS: [SSRMS]

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: [Joint Lock]

cmd Shoulder Roll (Verify SR – Locked)

5.4 P5 Automatic Capture
MSS: SSRMS: Tip LEE: [SSRMS Tip LEE]

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

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

CAUTION

Due to end-to-end system latency, the RHC Trigger is hot up to 3 seconds prior to receiving a Trigger Hot icon status on the PCS.

NOTE

Once the trigger is hot, only safing or trigger commands should be sent to the Robotics equipment. If a configuration change is required, including routing MSS Cameras, safe the system to exit LEE operations (SCR 23262, 14662).

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Capture

RHC/ THC — Maneuver to within grapple envelope.

RHC — TRIGGER → press (momentarily)

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

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)

Give SRMS Operator Go to ungrapple P5 and maneuver to P5 Install Viewing Position.

Record P5 Handoff joint angles and FOR.

	SR	SY	SP	EP	WP	WY	WR
Expected	+2.5	+95.8	-82.3	+77.1	-90.7	+229.3	-130.0
	X	Y	Z	Pitch	Yaw	Roll	
Expected	+1052	-1507	+380	+180.0	0.0	+89.8	
	FOR	Loaded – P5 Maneuver, SY Held					
	Disp	W8>ISSACS					

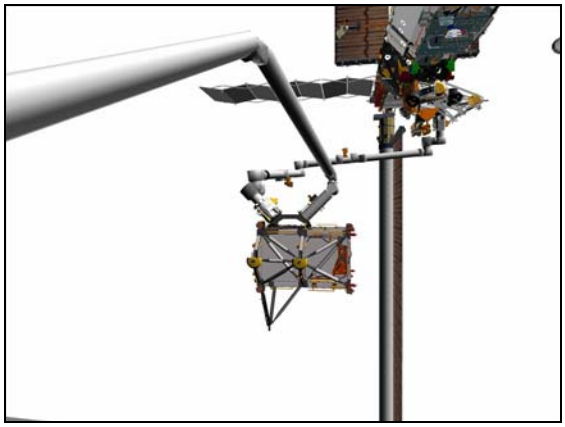

Figure 5.- SSRMS P5 Grapple
(91: Camera A: +80, 0).

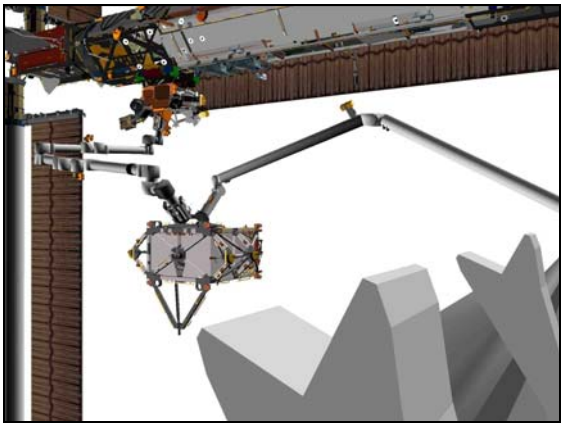

Figure 6.- SSRMS P5 Grapple
(92: Camera B: -30, 0).

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P5 INSTALL-EVA 1

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2.101 P5 INSTALL AND UNGRAPPLE

(RBT FS/12A.1/FIN 1) Page 1 of 12 pages

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
24: Tip Elbow (+20, +26)	92: Camera B (-30, 0)	09: P1 Lower Outboard (+150, +15)	SRMS Elbow (+32, +114)

PCS MSS: SSRMS: SSRMS

Verify Loaded Parameters – √
Verify 'Loaded Parameters' (two) – P5 Maneuver, SY Held

Change Display ▶ W8 ▶ P5 Install (Verify W8>P5 Install)

Verify Command – SSRMS>Internal

Verify SSRMS at P5 Handoff position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+2.5	+95.8	-82.3	+77.1	-90.7	+229.3	-130.0
X	Y	Z	Pitch	Yaw	Roll	
+1088	+1717	+379	+180.0	0.0	+89.8	
FOR	Loaded – P5 Maneuver, SY Held					
Disp	W8>P5 Install					

MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → COARSE (Verify Coarse on PCS)

2. P5 MANEUVER TO PRE-INSTALL

2.1 Joint OCAS to EPS Hold Intermediate Position

NOTE

Minimum clearance to the SRMS during this maneuver is approximately 6 feet and occurs when the SSRMS SR = -92.0 degrees. Clearance can be monitored using Camera B and the SRMS Elbow Camera. Clearance between the SSRMS and P5 during this maneuver is greater that 2 feet and can be monitored using the Tip Elbow Camera.

MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for EPS Hold Intermediate position.

SR	SY	SP	EP	WP	WY	WR
-256.7	+122.0	-197.0	+20.5	-39.8	+229.3	+93.7

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)	+2.5	+95.8	-82.3	+77.1	-90.7	+229.3	-130.0
TGT	**-256.7**	**+122.0**	**-197.0**	**+20.5**	**-39.8**	**+229.3**	**+93.7**
ERR	+259.2	-26.2	+114.7	+56.6	-50.9	0.0	-223.7

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-256.7	+122.0	-197.0	+20.5	-39.8	+229.3	+93.7

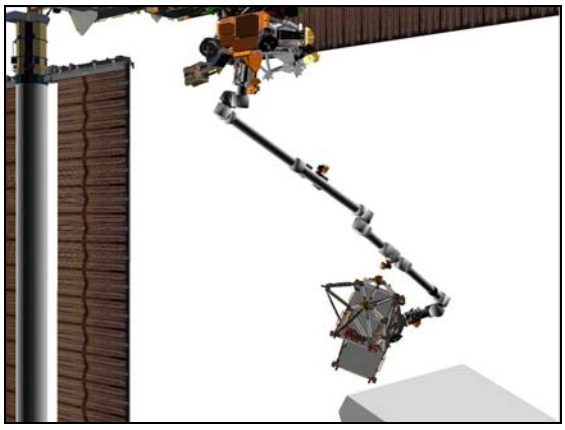

Figure 1.- EPS Hold Intermediate Position (92: Camera B: -40, 0).

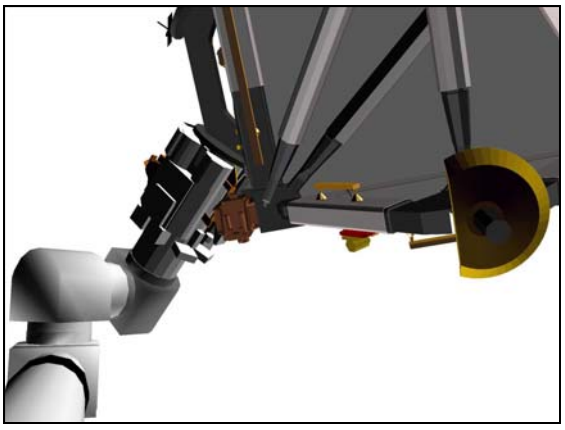

Figure 2.- EPS Hold Intermediate Position (24: Tip Elbow: +18, +8).

2.2 Single Joint WY Maneuver to EPS Hold Position
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
24: Tip Elbow (+18, +8)	92: Camera B (-40, 0)	22: Base Elbow (+155, -5)	SRMS Elbow (0, +60)

NOTE
Minimum clearance between P5 and the SSRMS during this maneuver is approximately 20 inches and can be monitored with the Base Elbow Camera.

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING
The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → WRIST YAW (Verify WY – Selected on PCS)

THC Perform "–" Single Joint maneuver to WY: +122.4 (THC down).

DCP BRAKES SSRMS → ON (Verify ON)

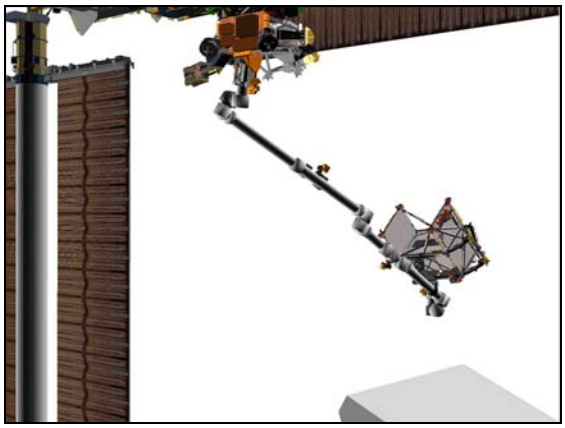

Figure 3.- EPS Hold Position (92: Camera B: -40, 0).

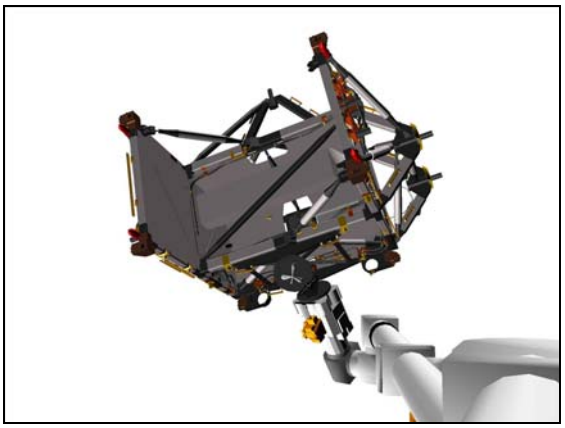

Figure 4.- EPS Hold Position (22: Base Elbow: +155, +5).

2.3 Single Joint Maneuver to P5 Pre-Install
When P4 BGAs are locked and **On MCC GO**,

BRAKES SSRMS → OFF (Verify OFF)

NOTE
Coarse rates may be selected for the first two single joint maneuvers in the following table.

RHC RATE – as required (VERNIER within 1.5 m of structure)

PCS MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING
The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

THC Perform Single Joint maneuver to P5 Pre-Install position.

	SR	SY	SP	EP	WP	WY	WR
EPS Hold	-256.7	+122.0	-197.0	+20.5	-39.8	+122.4	+93.7
1: SP +			-120.0				
2: SY –		+112.5					
3: SP +			-87.6				
Pre-Install	-256.7	+112.5	-87.6	+20.5	-39.8	+122.4	+93.7
	X	Y	Z	Pitch	Yaw	Roll	
	0	-200	0	0.0	0.0	0.0	
	FOR	Loaded – P5 Maneuver, SY Held					
	Disp	W8>P5 Install					

DCP BRAKES SSRMS → ON (Verify ON)

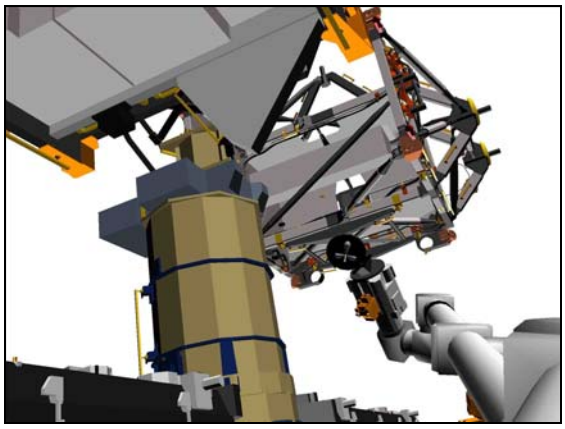

Figure 5.- P5 Pre-Install
(22: Base Elbow: +150, +3).

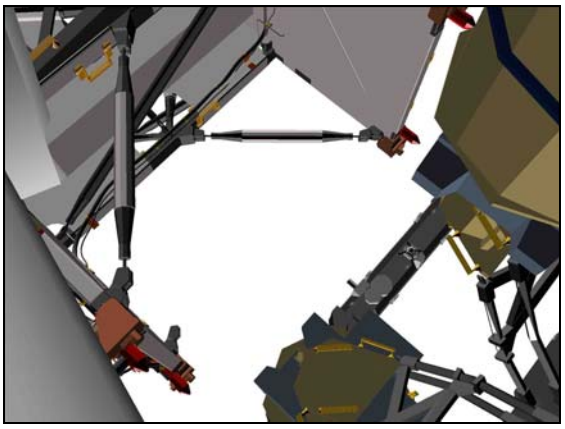

Figure 6.- P5 Pre-Install
(24: Tip Elbow: +35, -45).

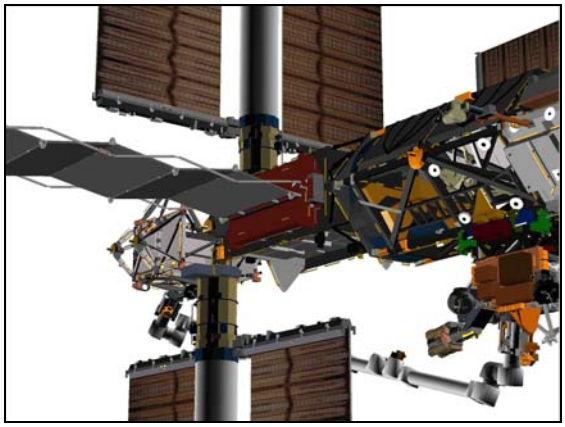

Figure 7.- P5 Pre-Install
(92: Camera B: -53, +15).

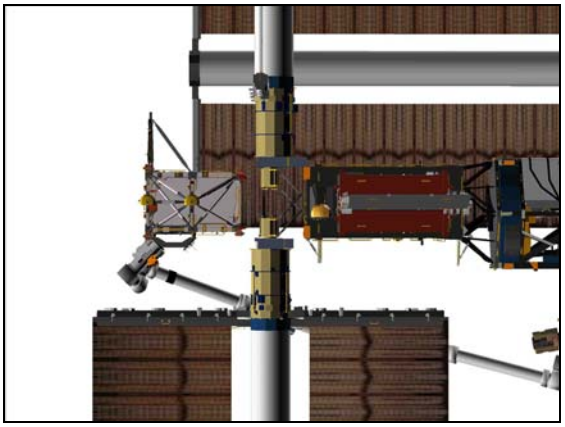

Figure 8.- P5 Pre-Install
(ISS Nadir View).

3. P5 INSTALL

3.1 P5 Install Setup

Configure Cameras and overlays as required.

V10 L	Monitor 1	Monitor 2	Monitor 3	V10 R
EV1	24: Tip Elbow (+38, -44)	09: P1 Lower Outboard (-90, -10) 92: Camera B (-53, +15)	22: Base Elbow (+150, +3) 91: SRMS Elbow (-55, +86)	EV2

NOTE
The maximum allowable rate during the maneuver through the P5 Install Corridor is 0.8 cm/s. This value can be monitored using the FOR Rate overlay. With rate scale set to 0.4, a full hand controller deflection should correspond to a rate of 0.7 cm/s.

PCS MSS: SSRMS: SSRMS

Change Loaded Parameters ▶ P5 ▶ P5 Install SYH
Verify 'Loaded Parameters' (two) – P5 Install, SY Held

Change Command ▶ W8 ▶ ISSACS (Verify W8>ISSACS)

RHC RATE → VERNIER (Verify Vernier on PCS)

PCS MSS: SSRMS: Rate: SSRMS Rate

Set 'Scale' 'Vernier' Rate Scale: 0.4 (Verify 0.4)

3.2 Thruster Inhibit

MSS: SSRMS: Thrusters: Thruster Controls for MSS Ops

Verify 'Desat Request:' – Inh

3.3 SSRMS Mode
On EVA GO,

DCP BRAKES SSRMS → OFF (Verify OFF)

PCS MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

3.4 P5 Launch Lock Removal

CAUTION

EVA GCA should maintain at least 1.2 inches (3 cm) of clearance between the 4A SSU and P5. To increase clearance, input a -X THC command. Clearance to the SSU is at a minimum for Y-value range of -140 cm to -35 cm.

NOTE

EVA GCA will be performed in station coordinates (ISSACS), which corresponds to the alignment of the loaded FOR and command frame.

THC/ RHC Maneuver P5 to Launch Lock Removal position.

	Locked					
SR	SY	SP	EP	WP	WY	WR
-250.7	+112.5	-101.4	+61.4	-62.3	+120.2	+94.9
X	Y	Z	Pitch	Yaw	Roll	
0	-20	0	0.0	0.0	0.0	
FOR	Loaded – P5 Install, SY Held					
Disp	W8>P5 Install					

DCP BRAKES SSRMS → ON (Verify ON)

Give EVA GO to remove P5 Launch Locks.

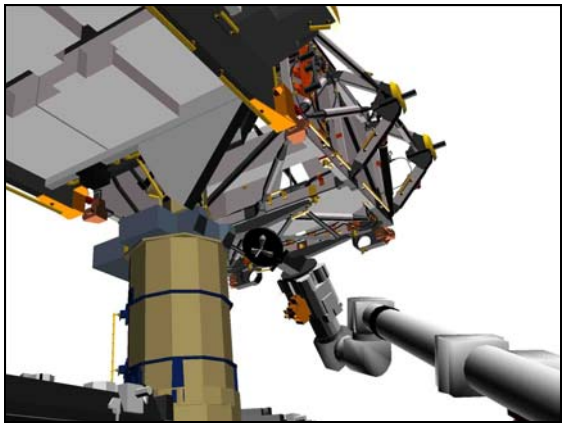

Figure 9.- P5 Launch Lock Removal
(22: Base Elbow: +125, +3).

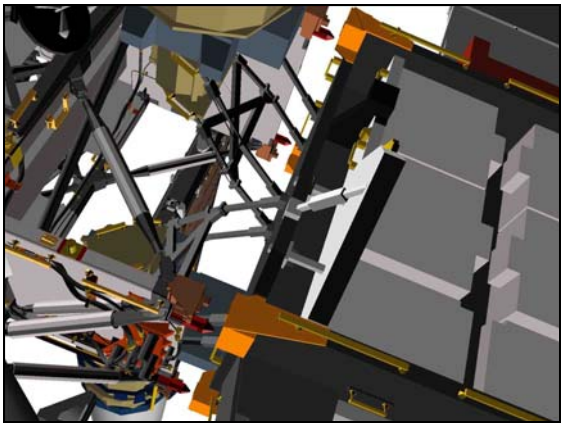

Figure 10.- P5 Launch Lock Removal
(24: Tip Elbow: +40, -38).

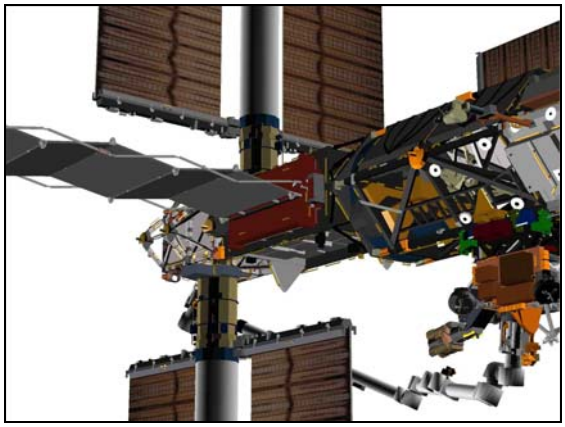

Figure 11.- P5 Launch Lock Removal
(92: Camera B: -53, +15).

3.5 <u>P5 Softdock</u>
When P5 Launch Lock Removal complete,

DCP — BRAKES SSRMS → OFF (Verify OFF)

PCS — MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

On EVA GO,

THC/ RHC — Align P5 for install per EVA GCA.

When EVA GCA is complete,

PCS MSS: SSRMS: Snapshot: Snapshot Frames

cmd Snapshot

NOTE
When the snapshot frame is loaded, both command and display frame will change to Snapshot.

MSS: SSRMS: SSRMS

Change Display ▶ W8 ▶ P5 Install (Verify W8>P5 Install)

NOTE
1. Coarse alignment cones at corners 2 and 3 are slightly longer than at corners 1 and 4. EV crew will be initially positioned at corners 2 and 3.

2. If less than four of four softdocks are acquired during initial push-in, refer to procedure {5.301 P5 INSTALL SOFTDOCK ACQUISITION}, all (SODF: RBT FS: CONTINGENCY).

3. The minimum rate during P5 install should be 0.6 cm/s. The rate can be monitored using the FOR rate overlay. With rate scale set to 0.4, a full hand controller deflection should correspond to a rate of 0.7 cm/s.

During translation from the launch lock removal position to the soft-dock position
If EV crew determines that P5 alignment will prevent P5 coarse alignment cones from entering the P4 alignment holes
Stop SSRMS motion.
Perform the steps in the following off-nominal block.

****

THC/ RHC * Stop SSRMS motion.
*
* Verify EV crew can see positive clearance between P5 and P4.
*
* Align P5 for install per EVA GCA.
*
* When EVA GCA is complete,
*
PCS * MSS: SSRMS: Snapshot: Snapshot Frames
*
* **cmd** Snapshot
*
* MSS: SSRMS: SSRMS
*
* Change Display ▶ W8 ▶ P5 Install (Verify W8>P5 Install)
*
THC/ RHC * Using SSRMS digitals, back off to a Y-value of -30 cm
* (-Y Hand Controller input).

****

THC/ RHC Maneuver P5 to Soft-dock position until EVA verifies softdocks are engaged.

	Locked					
SR	SY	SP	EP	WP	WY	WR
-250.0	+112.5	-102.0	+64.3	-64.1	+119.9	+95.0
X	Y	Z	Pitch	Yaw	Roll	
0	0	0	0.0	0.0	0.0	
FOR	Loaded – P5 Install, SY Held					
Disp	W8>P5 Install					

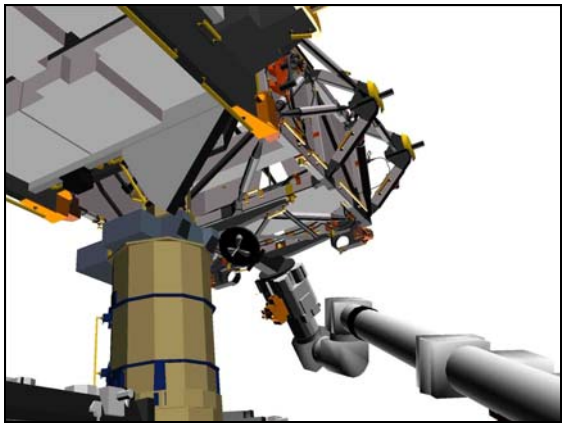

Figure 12.- P5 Softdock
(22: Base Elbow: +125, +3).

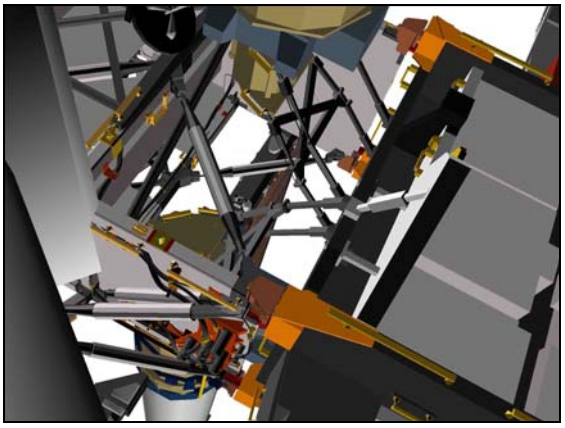

Figure 13.- P5 Softdock
(24: Tip Elbow: +30, -37).

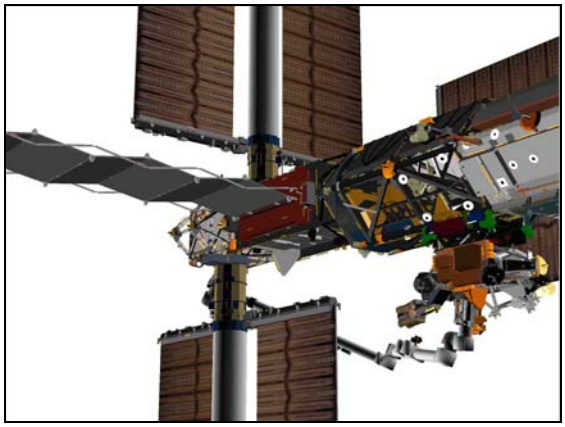

Figure 14.- P5 Softdock
(92: Camera B: -53, +15).

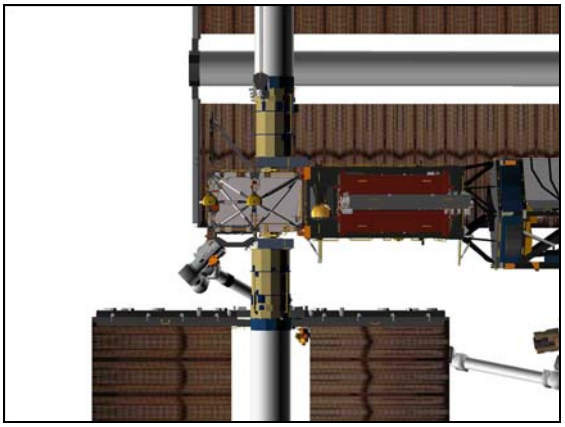

Figure 15.- P5 Softdock
(ISS Nadir View).

4. SSRMS LIMP FOR MRTAS BOLTING

PCS MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

MSS: SSRMS: Limp: SSRMS Limp

cmd All Limp (Verify Limp – blue)

MSS: SSRMS: SSRMS

Verify all joints – Limped

Give EVA GO to bolt P5 to P4.

5. CARRIAGE PUSHOFF

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
24: Tip Elbow (+10, -5)	25: Tip LEE	22: Base Elbow (+130, 0)	SRMS Elbow (-55, +85)

5.1 SSRMS Limp

On EVA GO that MRTAS Bolting Initial torque complete,

MSS: SSRMS: SSRMS

Verify all joints – Limped

5.2 AUTO Release

MSS: SSRMS: Tip LEE: SSRMS Tip LEE

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

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

CAUTION
Due to end-to-end system latency, the RHC Trigger is hot up to 3 seconds prior to receiving a Trigger Hot icon status on the PCS.

NOTE
Once the trigger is hot, only safing or trigger commands should be sent to the Robotics equipment. If a configuration change is required, including routing MSS Cameras, safe the system to exit LEE operations (SCR 23262, 14662).

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Release

RHC TRIGGER → press (momentarily)

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

5.3 SSRMS Backoff

MSS: SSRMS: Limp: SSRMS Limp

cmd None Limp (Verify Standby – blue)

MSS: SSRMS: SSRMS

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

Change Display ▶ W8 ▶ Mated P5 GF (Verify W8>Mated P5 GF)

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

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

CAUTION
This is not a nominal back-off due to clearance with the 4A solar array blanket box. As a result, the SSRMS is maneuvered to -65 cm (instead of the nominal -150 cm), where the clearance is approximately 1 foot (30 cm). Use the Tip and Base Elbow Cameras to monitor this clearance.

THC/ RHC — Maneuver SSRMS to P5 Grapple Fixture clearance position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-249.9	+106.0	-98.1	+56.7	-48.5	+119.3	+81.7
X	Y	Z	Pitch	Yaw	Roll	
-65	0	0	0.0	0.0	0.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W8>Mated P5 GF					

DCP — BRAKES SSRMS → ON (Verify ON)

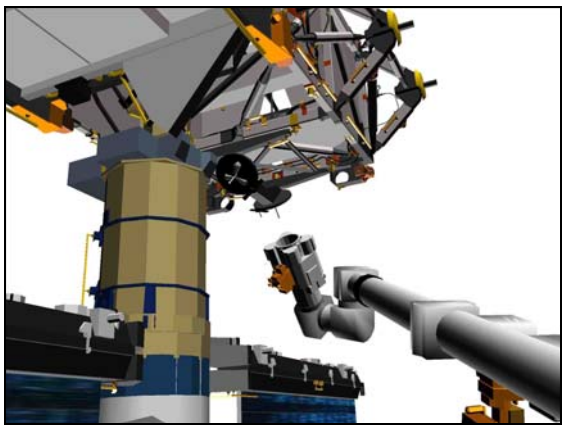

Figure 16.- P5 Grapple Fixture Clearance (22: Base Elbow: +130, 0).

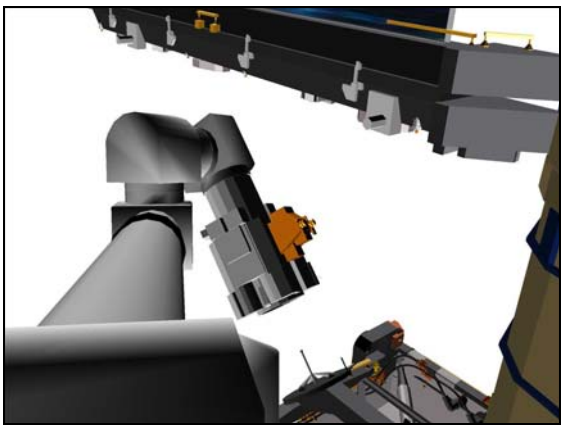

Figure 17.- P5 Grapple Fixture Clearance (24: Tip Elbow: +10, -5).

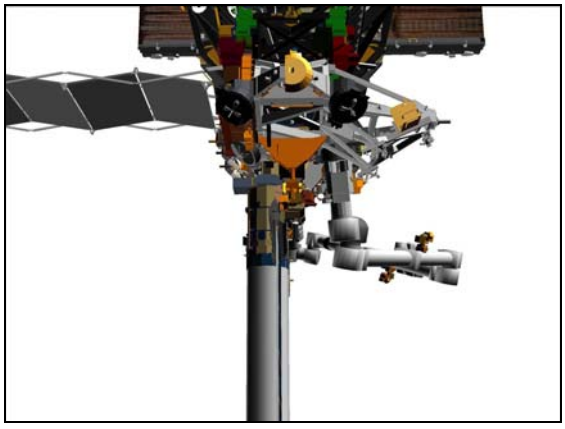

Figure 18.- P5 Grapple Fixture Clearance (91: SRMS Elbow: -55, +85).

.

2.102 SSRMS STOW FOR MT TRANSLATION DURING EVA 1

1. SETUP

   Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
24: Tip Elbow (+10, -5)	92: Camera B (-53, +15)	22: Base Elbow (+130, 0)	SRMS Elbow (-55, +85)

PCS MSS: SSRMS: Rate: [SSRMS Rate]

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

√Vernier

DCP BRAKES SSRMS → OFF (Verify OFF)

2. 4A SOLAR ARRAY CLEARANCE MANEUVER

   Verify EV Crew is clear of SSRMS.

PCS MSS: SSRMS: [SSRMS]

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

NOTE

At the start of the following maneuver, the Wrist is 33.8 cm (13.3 in.) from the P4 Solar Array, and the LEE is 38.6 cm (15.2 in.) from P5. Monitor clearances with the Tip Elbow and Base Elbow Cameras.

DCP JOINT SELECT → SHOULDER PITCH (Verify SP – Selected on PCS)

THC Perform "–" Single Joint maneuver to SP: -125.0 (THC down).

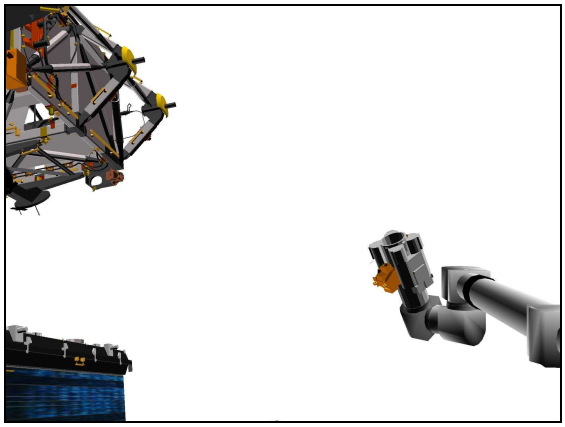

Figure 1.- 4A Solar Array Clearance
(22: Base Elbow: +120, 0).

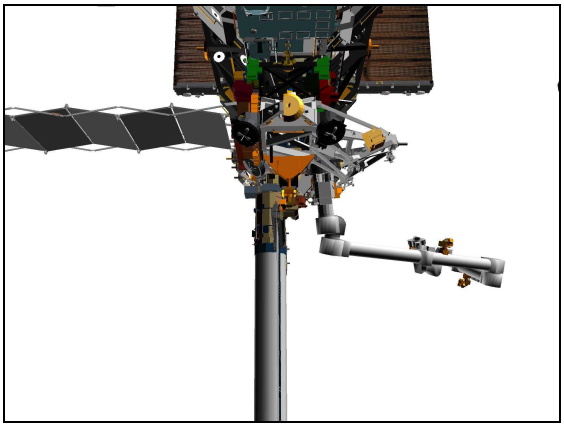

Figure 2.- 4A Solar Array Clearance
(91: SRMS Elbow: -55, +85).

3. JOINT OCAS TO MT TRANSLATION STOW

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
24: Tip Elbow (+150, -5)	92: Camera B (-30, +10)	22: Base Elbow (+130, 0)	SRMS Elbow (-55, +85)

RHC RATE → COARSE (Verify Coarse on PCS)

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for MT Translation Stow position.

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-155.0	+35.0	-34.2	+204.3	-84.5

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)	-249.9	+106.0	-125.0	+56.7	-48.5	+119.3	+81.7
TGT	**-194.4**	**+250.4**	**-155.0**	**+35.0**	**-34.2**	**+204.3**	**-84.5**
ERR	-55.5	-144.4	+30.0	+21.7	-14.3	-85.0	+166.2

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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 MT Translation Stow position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-155.0	+35.0	-34.2	+204.3	-84.5
X	Y	Z	Pitch	Yaw	Roll	
-74	+806	+242	+20.9	-5.7	+38.2	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W8>Mated P5 GF					

Figure 3.- MT Translation Stow
(92: Camera B: -30, +10).

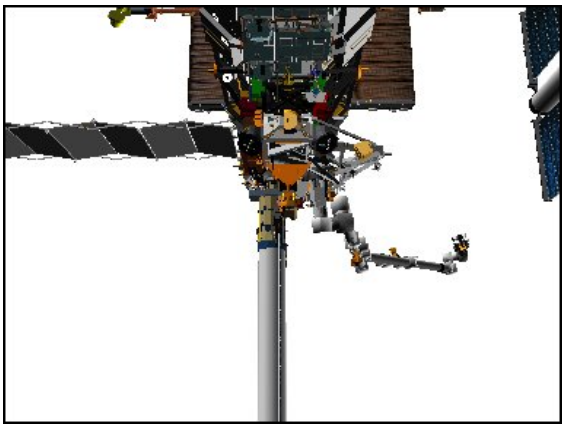

Figure 4.- MT Translation Stow
(V10: SRMS Elbow: -55, +85).

4. SAFING

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)

Give SRMS Operator a GO to Powerdown

5. SETUP FOR MANEUVER TO P6 RETRACT VIEWING
On MCC GO, after MT Translation to WS3 and MSS Powerup,

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
24: Tip Elbow (+170, -5)	13: LAB Stbd Zenith (-165, -40)	37: MBS Mast (0, 0) 22: Base Elbow (+135, -10)	SRMS Elbow (+170, +20)

PCS MSS: SSRMS: SSRMS Safing: [SSRMS Safing]

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → VERNIER (Verify Vernier on PCS)

PCS MSS: SSRMS: Rate: [SSRMS Rate]

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

6. P6 RETRACT VIEWING
MSS: SSRMS: [SSRMS]

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

NOTE
Expect singularity warning for EP between -15 and +15 deg.

DCP JOINT SELECT → ELBOW PITCH (Verify EP – Selected on PCS)

THC Perform "– " Single Joint maneuver to EP: -61.2 (THC down).

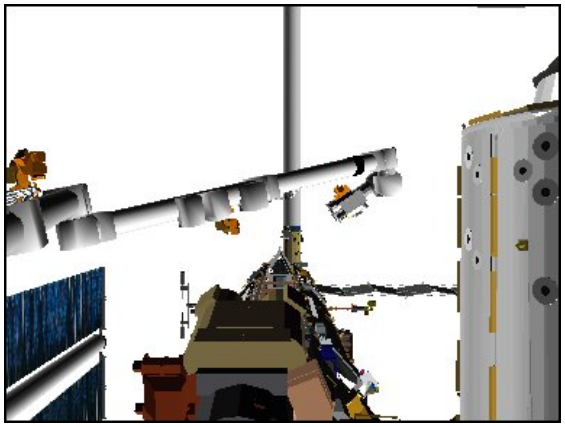

Figure 5.- P6 Retract Viewing
(37: MBS Mast: 0, 0).

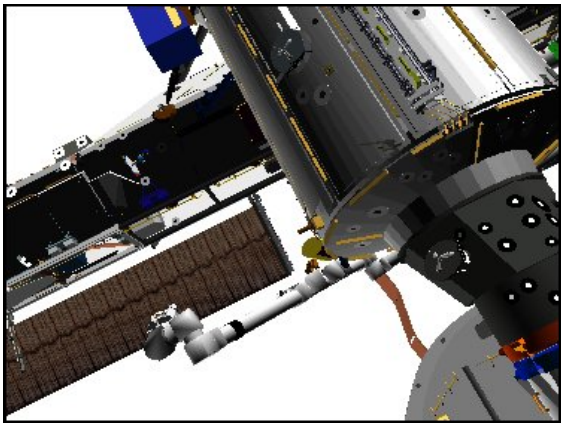

Figure 6.- P6 Retract Viewing
(V10: SRMS Elbow: +170, +20).

Verify SSRMS at P6 Retract Viewing position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-155.0	-61.2	-34.2	+204.3	-84.5
X	Y	Z	Pitch	Yaw	Roll	
-306	-9	-256	-60.2	+31.8	+110.6	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W8>Mated P5 GF					

7. SAFING

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)

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P6 4B RETRACT VIEWING

P6 4B RETRACT VIEWING

P6 4B RETRACT
VIEWING

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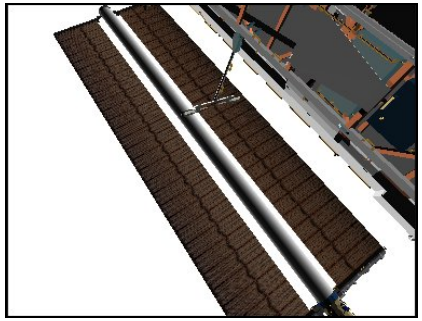
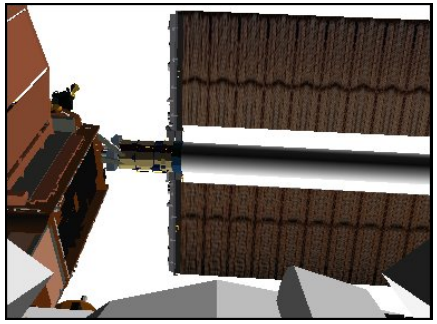
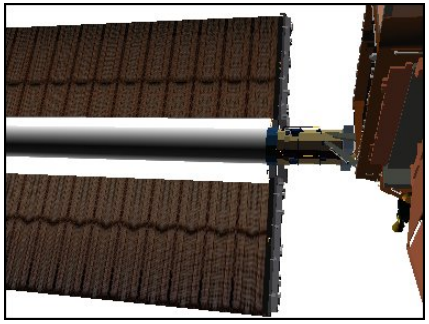
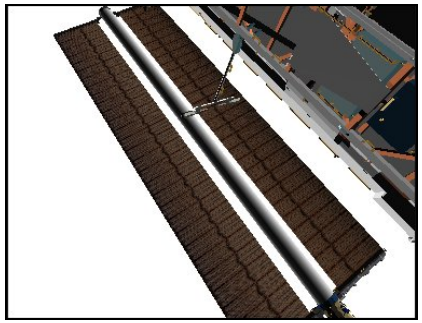
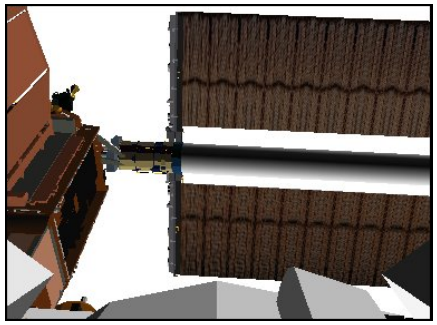
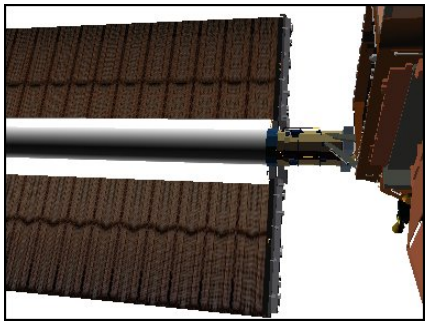
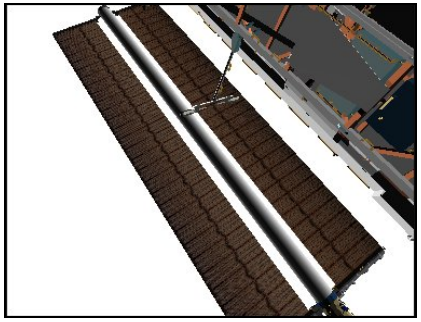
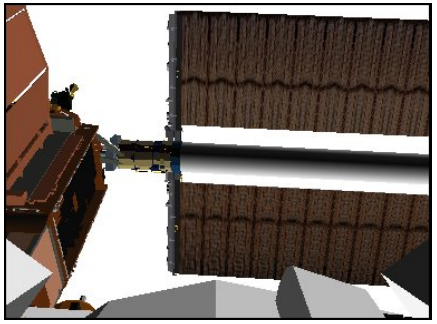
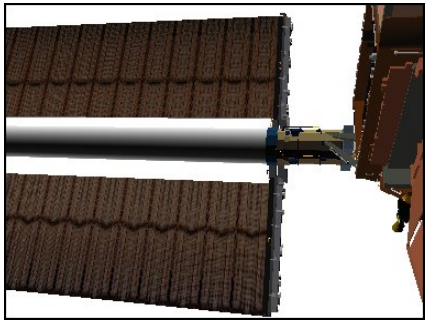
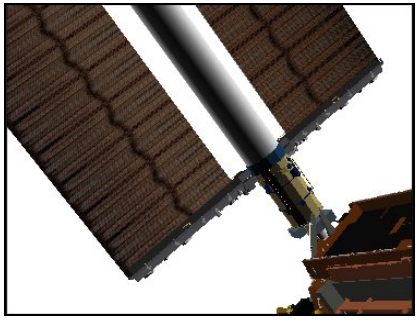
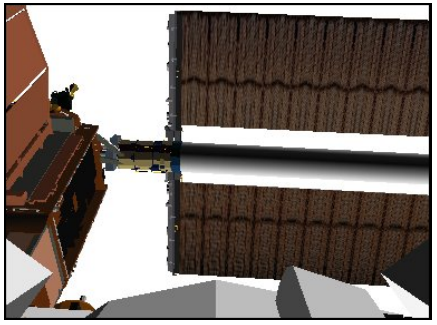
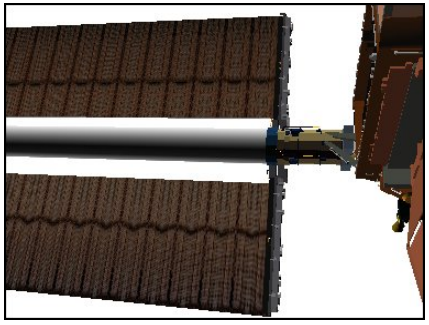
3.101 P6 4B SAW RETRACT CAMERA MATRIX

(RBT FS/12A.1/FIN) Page 1 of 6 pages

Activity	RWS MON 1	RWS MON 2	RWS MON 3
1 - Retract three bays {4.118 P6 SAW XX RETRACT (P6 ON Z1 TRUSS)}, step 12.3 (SODF: EVA 2: PUMP MODULE TRANSFER AND TUS R&R)	92: SRMS Elbow Camera (58, 14) provides overall view of the array	25: Tip LEE provides view of bottom of blanket box, guide wires, “Y” bracket (zoom as required)	24: Tip Elbow (130,26) provides view of “Y” bracket and mast canister (pan, tilt, and zoom, as required)
			
2 - Array Survey {4.118 P6 SAW XX RETRACT (P6 ON Z1 TRUSS)}, step 12.8 (SODF: EVA 2: PUMP MODULE TRANSFER AND TUS R&R)	92: SRMS Elbow Camera (58,14) provides overall view of the array Select the EE Camera to get a different view of the “Y” bracket and mast canister	25: Tip LEE provides view of bottom of blanket box, guide wires, “Y” bracket (zoom as required)	24: Tip Elbow (130,26) provides view of “Y” bracket and mast canister (pan, tilt, and zoom, as required) Move Tip Elbow to (98, 26) to get an overall view of the array
			

Activity	RWS MON 1	RWS MON 2	RWS MON 3
3 - Retract to one bay remaining {4.118 P6 SAW XX RETRACT (P6 ON Z1 TRUSS)}, steps 13.3 and 13.8 (SODF: EVA 2: PUMP MODULE TRANSFER AND TUS R&R)	92: SRMS Elbow Camera (58,14) provides overall view of the array	25: Tip LEE provides view of bottom of blanket box, guide wires (zoom as required)	24: Tip Elbow (130,26) provides view of mast canister (pan, tilt, and zoom, as required)
			
4 - SABB Unlatch {4.118 P6 SAW XX RETRACT (P6 ON Z1 TRUSS)}, steps 14.3, 14.9, 15.3, and 15.9 (SODF: EVA 2: PUMP MODULE TRANSFER AND TUS R&R)	92: SRMS Elbow Camera (74, -12) provides view of the blanket boxes and latches (pan, tilt, and zoom, as required)	25: Tip LEE provides view of bottom of blanket box, guide wires (zoom as required)	24: Tip Elbow (130,26) provides view of the blanket boxes and latches (pan, tilt, and zoom, as required)
			

3.101 P6 4B SAW RETRACT CAMERA MATRIX

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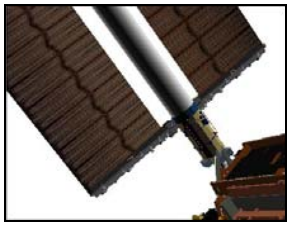
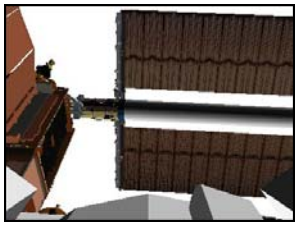
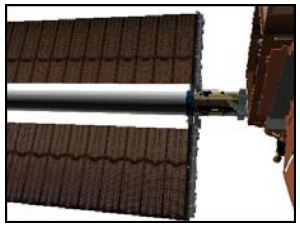
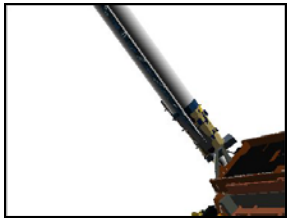
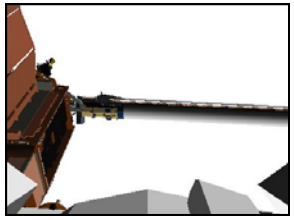
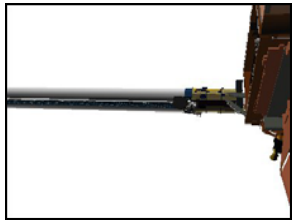
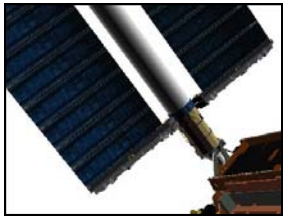
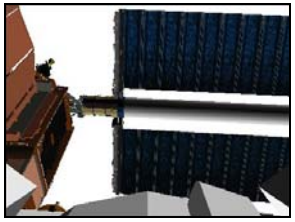
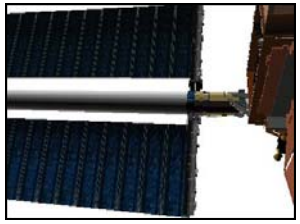
Activity	RWS MON 1	RWS MON 2	RWS MON 3
5 - P6 4B Rotation (360 degrees) 163 ▶ 236 ▶ 340 ▶ 56 {4.118 P6 SAW XX RETRACT (P6 ON Z1 TRUSS)}, step 16.2 (SODF: EVA 2: PUMP MODULE TRANSFER AND TUS R&R)	92: SRMS Elbow Camera (74,-12) provides view of blanket box and latches (pan, tilt, and zoom, as required)	25: Tip LEE provides view of blanket box, latches, and guide wires (zoom as required)	24: Tip Elbow (130,26) provides view of blanket box, latches, and guide wires provides view of mast canister (pan, tilt, and zoom, as required)
163 P6 4B Inactive Surface Containment Inspection			
236 P6 4B Left Blanket Box Containment Inspection			
340 P6 4B Active Surface Continment Inspection			

3.101 P6 4B SAW RETRACT CAMERA MATRIX

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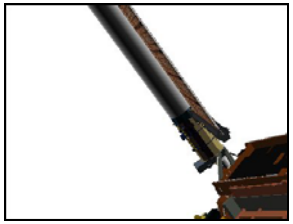
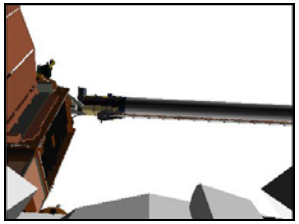
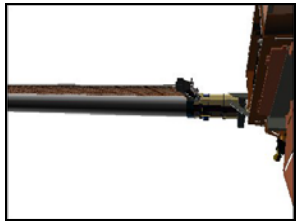
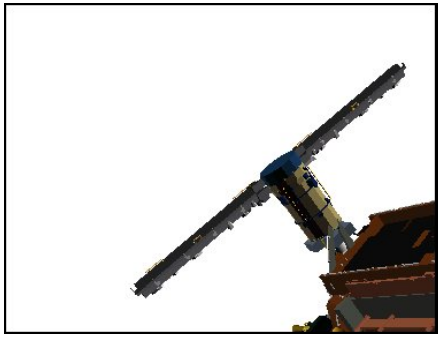
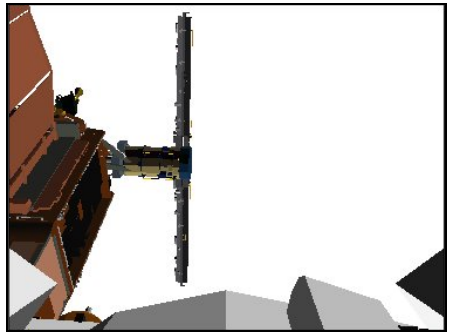
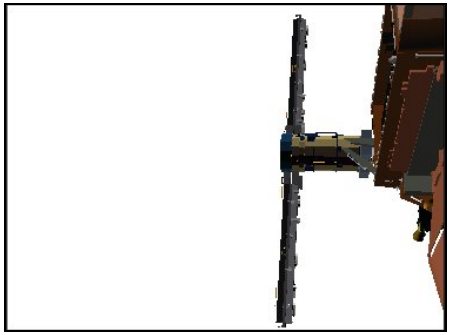
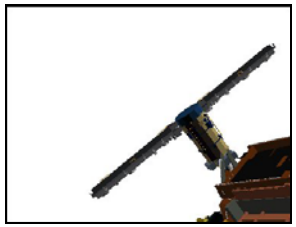
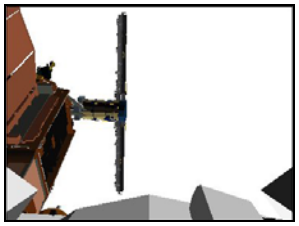
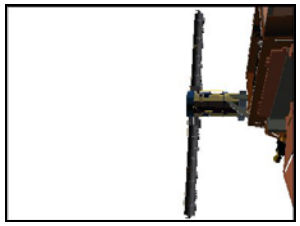
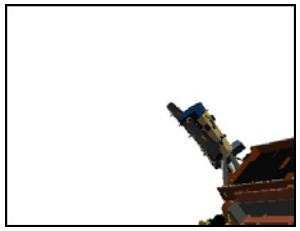
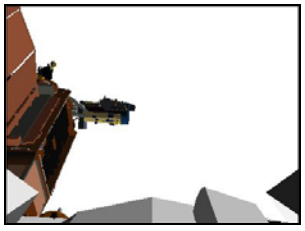
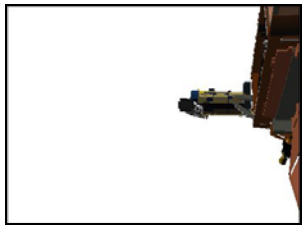
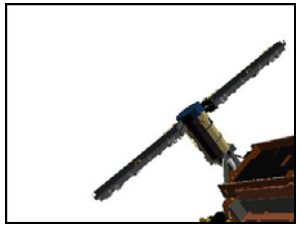
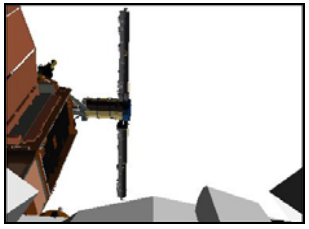
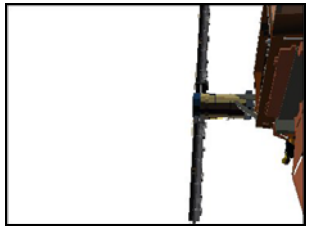
Activity	RWS MON 1	RWS MON 2	RWS MON 3
56 P6 4B Right Blanket Box Containment Inspection			
6 - Complete Retraction {4.118 P6 SAW XX RETRACT (P6 ON Z1 TRUSS)}, steps 17.3 and 17.9 (SODF: EVA 2: PUMP MODULE TRANSFER AND TUS R&R)	92: SRMS Elbow Camera (74,-12) provides view of last mast bay and blanket box	25: Tip LEE provides view of last mast bay and blanket box (zoom as required)	24: Tip Elbow (130,26) provides view of last mast bay and blanket box (pan, tilt, and zoom, as required)
			

Activity	RWS MON 1	RWS MON 2	RWS MON 3
7 - P6 4B Rotation (360 degrees) 160 ▶ 236 ▶ 340 ▶ 56 {4.118 SAW 4B RETRACT (P6 ON Z1 TRUSS)}, step 17.11 (SODF: EVA 2: PUMP MODULE TRANSFER AND TUS R&R)	92: SRMS Elbow Camera (74,-12) provides view of blanket box and latches (pan, tilt, and zoom, as required)	25: Tip LEE provides view of blanket box and latches (zoom as required)	24: Tip Elbow (130,26) provides view of blanket box and latches (pan, tilt, and zoom, as required)
160 P6 4B Inactive Surface Continement Inspection			
236 P6 4B Left Blanket Box Containment Inspection			
340 P6 4B Active Surface Containment Inspection			

3.101 P6 4B SAW RETRACT CAMERA MATRIX

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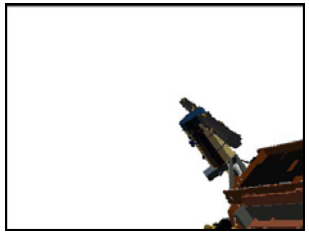
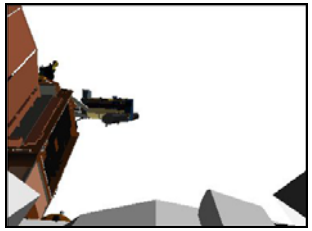
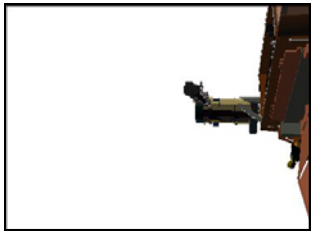
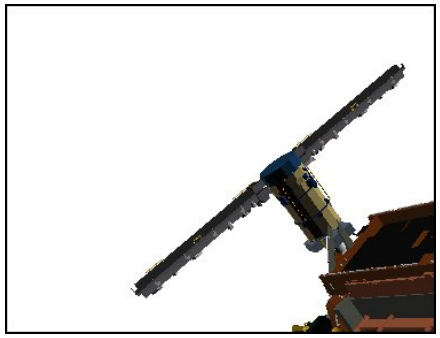
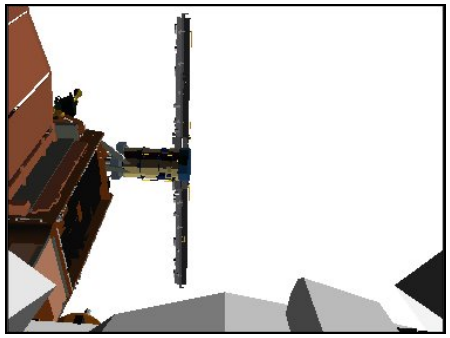
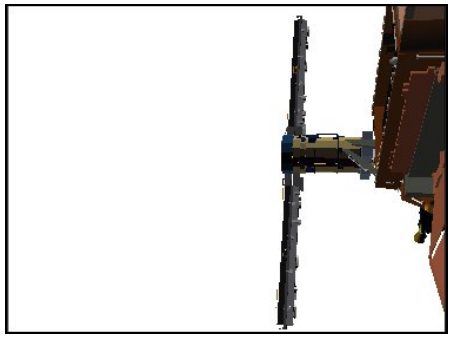
Activity	RWS MON 1	RWS MON 2	RWS MON 3
56 P6 4B Right Blanket Box Containment Inspection			
8 - SABB Latch {4.118 P6 SAW XX RETRACT (P6 ON Z1 TRUSS)}, steps 18.7 and 19.7 (SODF: EVA 2: PUMP MODULE TRANSFER AND TUS R&R)	92: SRMS Elbow Camera (74,-12) provides view of the blanket boxes and latches (pan, tilt, and zoom, as required) 	25: Tip LEE provides view of blanket box (zoom as required) 	24: Tip Elbow (130,26) provides view of the blanket boxes and latches (pan, tilt, and zoom, as required) 

3.102 SSRMS STOW TO P6 RETRACT VIEWING (CONTINGENCY)

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1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
09: P1 Lower Outboard (+100, -20)	13: LAB Stbd Zenith (-175, +55)	24: Tip Elbow (0, +5)	SRMS Elbow (+90, -65)

Verify Unloaded Parameters – √

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

Change Display ▶ W3 ▶ ISSACS (Verify W3>ISSACS)

Verify SRMS at 4B SAW Retract Viewing Position

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

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
X	Y	Z	Pitch	Yaw	Roll	
+596	+579	-601	-144.8	-64.0	-25.8	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

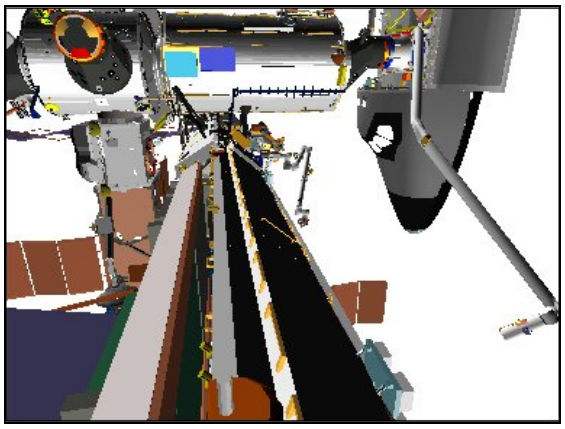

Figure 1.- SSRMS Stow
(09: P1 Lower Outboard: +100, -20).

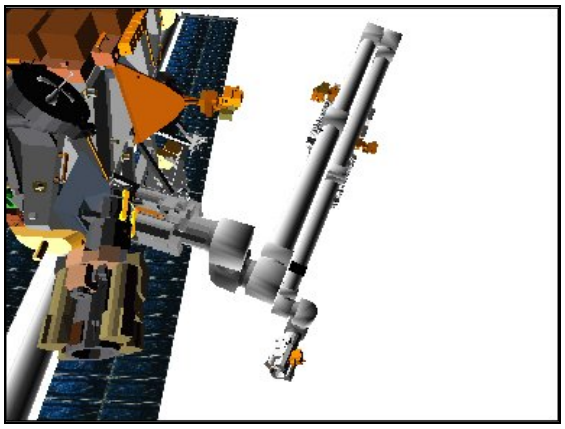

Figure 2.- SSRMS Stow
(13: LAB Stbd Zenith: -175, +55).

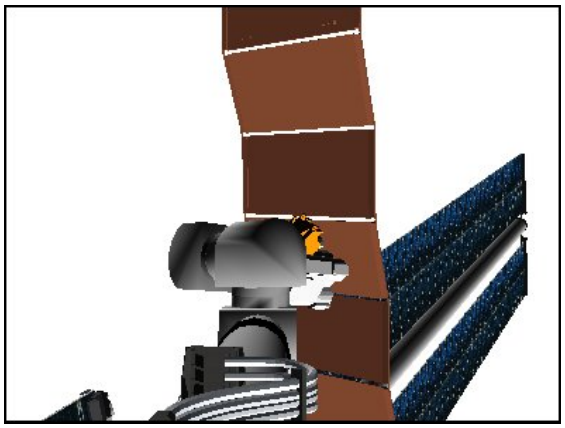

Figure 3.- SSRMS Stow
(24: Tip Elbow: 0, +5).

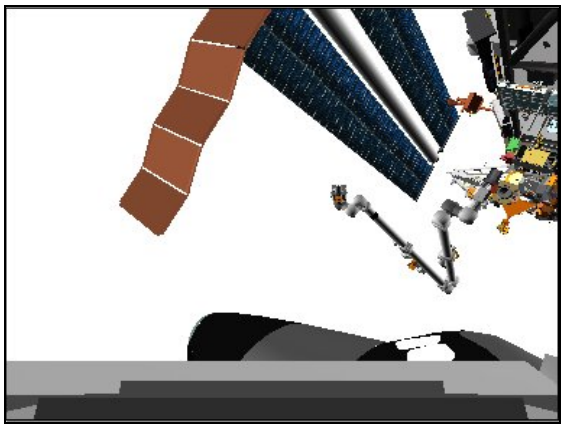

Figure 4.- SSRMS Stow
(V10: SRMS Elbow: +90, -65).

PCS MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → COARSE (Verify Coarse on PCS)

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

2. JOINT OCAS 1

NOTE
Expect singularity warning between SP -172 and -170 deg.

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Joint OCAS 1 End position.

SR	SY	SP	EP	WP	WY	WR
-194.4	+96.0	-137.0	+146.7	-34.2	+204.3	-84.5

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	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
TGT	**-194.4**	**+96.0**	**-137.0**	**+146.7**	**-34.2**	**+204.3**	**-84.5**
ERR	+14.4	0.0	-46.0	0.0	-96.9	-28.9	+209.9

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

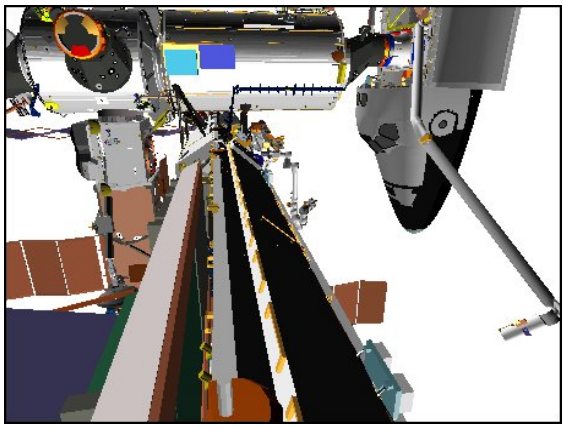

Figure 5.- Joint OCAS 1 End
(09: P1 Lower Outboard: +100, -20).

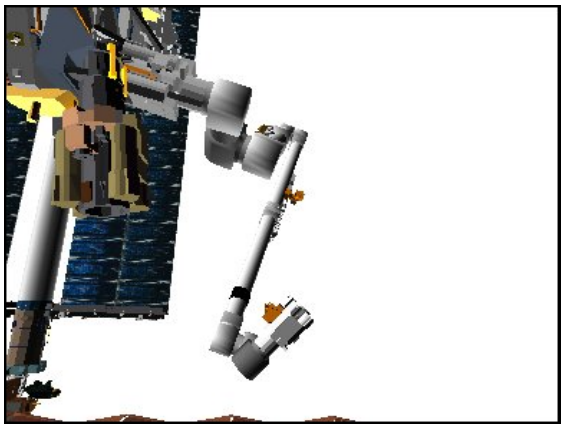

Figure 6.- Joint OCAS 1 End
(13: LAB Stbd Zenith: -175, +35).

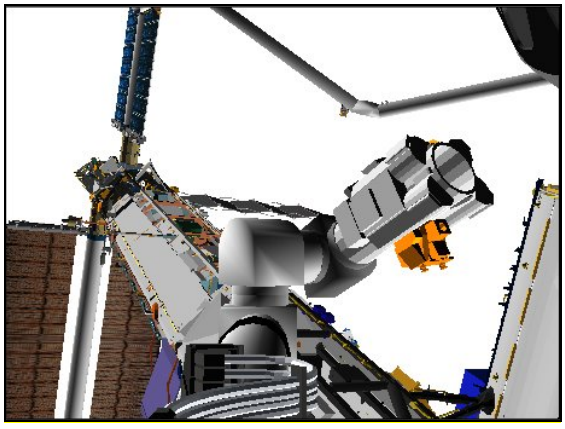

Figure 7.- Joint OCAS 1 End
(24: Tip Elbow: 0, +5).

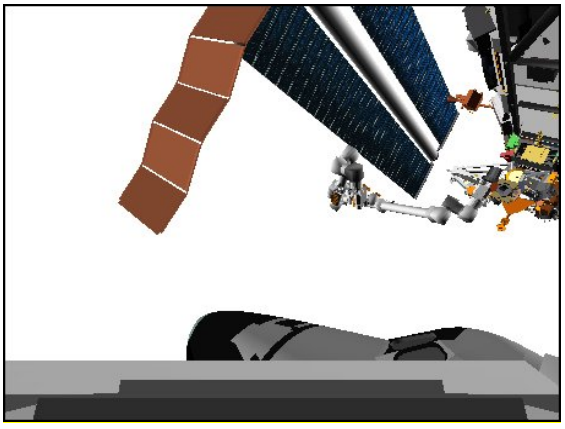

Figure 8.- Joint OCAS 1 End
(V10: SRMS Elbow: +90, -65).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at Joint OCAS 1 End position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-194.4	+96.0	-137.0	+146.7	-34.2	+204.3	-84.5
X	Y	Z	Pitch	Yaw	Roll	
+635	+403	-390	-9.3	+46.8	+108.7	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

3. JOINT OCAS 2
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
09: P1 Lower Outboard (+100, -20) 03: S1 Lower Outboard (+45, -25)	13: LAB Stbd Zenith (-175, +35)	24: Tip Elbow (0, 5) 37: MBS Mast (-60, +10)	SRMS Elbow (+90, -65)

NOTE
Expect singularity warning for EP between +15 and -15 deg.

MSS: SSRMS: Rate: SSRMS Rate

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

RHC RATE → VERNIER (Verify Vernier on PCS)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Joint OCAS 2 End position.

SR	SY	SP	EP	WP	WY	WR
-194.4	+130.0	-137.0	-30.0	-34.2	+204.3	-84.5

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)	-194.4	+96.0	-137.0	+146.7	-34.2	+204.3	-84.5
TGT	**-194.4**	**+130.0**	**-137.0**	**-30.0**	**-34.2**	**+204.3**	**-84.5**
ERR	0.0	-34.0	0.0	+176.7	0.0	0.0	0.0

	**********
	* If joint angles or errors are incorrect
PCS	* **cmd** Cancel (Verify Sequence Status – Waiting Destination)
	*
	* Input correct Dest joint angles per table above.
	*
	* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
	*
MON	* Verify joint angles and errors are correct on Joint Angle Position
	* overlay.
	**********
PCS	**cmd** Confirm (Verify Sequence Status – Auto Seq sw - Hot)
DCP	AUTO SEQ → PROC

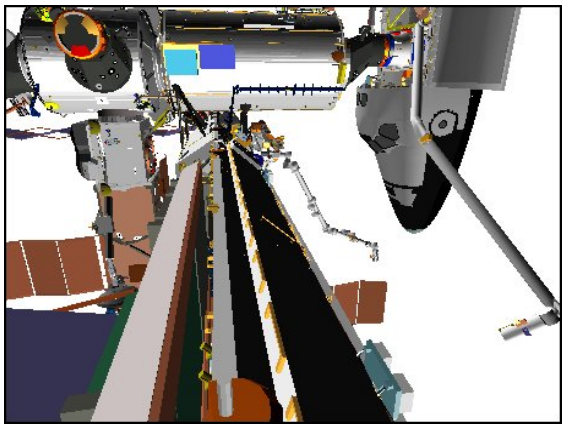

Figure 9.- Joint OCAS 2 End
(09: P1 Lower Outboard: +100, -20).

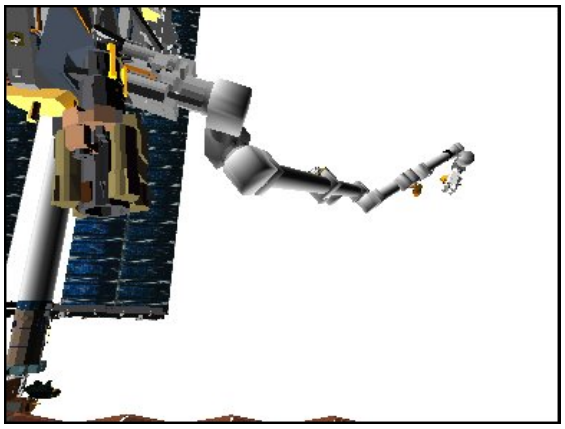

Figure 10.- Joint OCAS 2 End
(13: LAB Stbd Zenith: -175, +35).

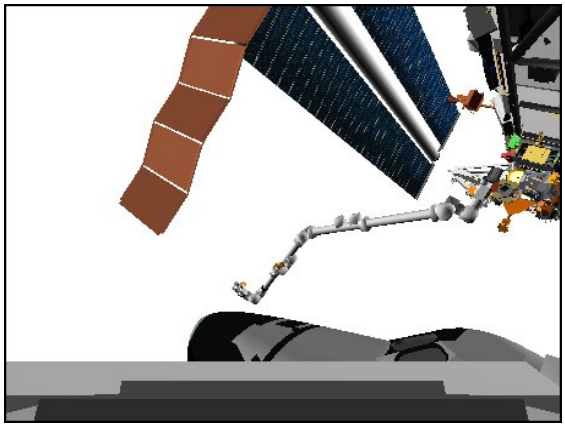

Figure 11.- Joint OCAS 2 End
(V10: SRMS Elbow: +90, -65).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at Joint OCAS 2 End position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-194.4	+130.0	-137.0	-30.0	-34.2	+204.3	-84.5
X	Y	Z	Pitch	Yaw	Roll	
+1382	+929	-1158	+173.4	-64.0	+97.8	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

4. CLEARANCE MANEUVER

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
09: P1 Lower Outboard (+100, -20)	13: LAB Stbd Zenith (-175, +30)	37: MBS Mast (-80, +30)	SRMS Elbow (+90, -65)

NOTE

Monitor clearance to Orbiter Nose and P6 Forward Radiator with the Mast Camera or P1 Outboard Lower Camera. The closest clearance to the Orbiter Nose during the manuever is approximately 144 cm (4.7 ft). The closest clearance to the P6 Forward Radiator during the maneuver is approximately 140 cm (4.6 ft).

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → SHOULDER YAW (Verify SY – Selected on PCS)

THC Perform "+" Single Joint maneuver to SY: +250.4 (THC up).

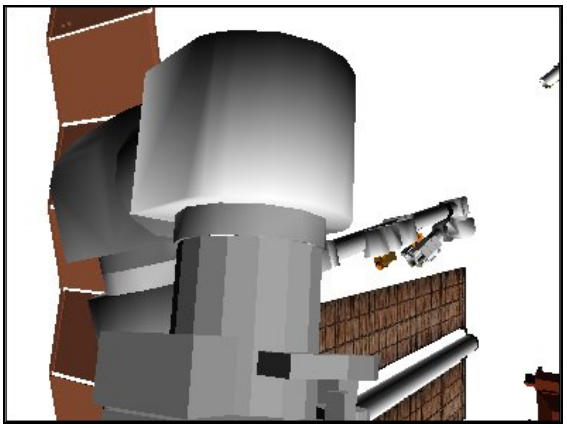

Figure 12.- Clearance
(37: MBS Mast: -35, 0).

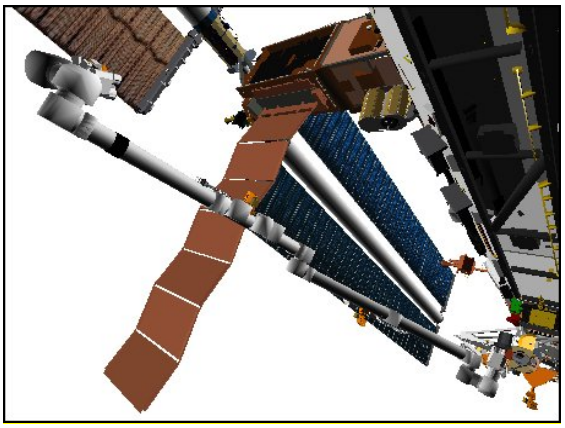

Figure 13.- Clearance
(V10: SRMS Elbow: +90, -40).

5. MANEUVERING TO P6 RETRACT VIEWIING

NOTE
Monitor clearance to SRMS with P1 Outboard Lower or SRMS Elbow Camera. The closest clearance to the SRMS during the end of the maneuver to P6 Retract Viewing Position is approximately 129 cm (4.2 ft). At the final position, the clearanace is approximately 131 cm (4.3 ft).

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for P6 Retract Viewing position.

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-155.0	-61.2	-34.2	+204.3	-84.5

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)	-194.4	+250.4	-137.0	-30.0	-34.2	+204.3	-84.5
TGT	**-194.4**	**+250.4**	**-155.0**	**-61.2**	**-34.2**	**+204.3**	**-84.5**
ERR	0.0	0.0	+18.0	+31.2	0.0	0.0	0.0

****
* If joint angles or errors are incorrect

PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*

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

****

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

DCP AUTO SEQ → PROC

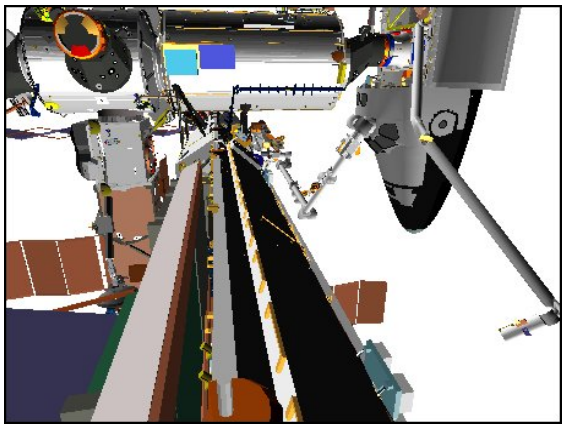

Figure 14.- P6 Retract Viewing
(09: P1 Lower Outboard: +100, -20).

Figure 15.- P6 Retract Viewing
(37: MBS Mast: -10, 0).

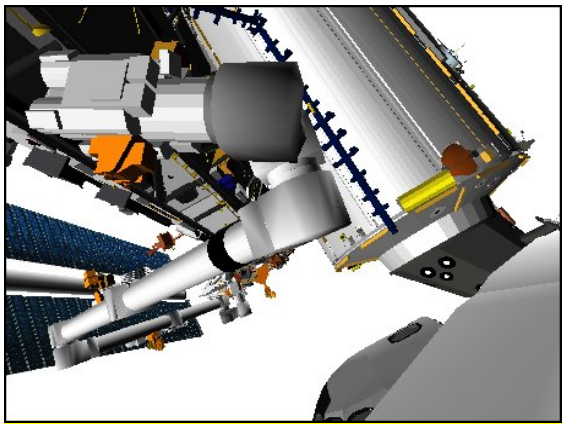

Figure 16.- P6 Retract Viewing
V10: SRMS Elbow: (+150, -40).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

3.102 SSRMS STOW TO P6 RETRACT VIEWING (CONTINGENCY)

(RBT FS/12A.1/FIN) Page 9 of 9 pages

Verify SSRMS at P6 Retract Viewing position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-155.0	-61.2	-34.2	+204.3	-84.5
X	Y	Z	Pitch	Yaw	Roll	
+468	-606	+132	+124.6	+1.9	+177.1	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

DCP BRAKES SSRMS → ON (Verify ON)

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3.103 P6 RETRACT VIEWING TO SSRMS STOW (CONTINGENCY)

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
09: P1 Lower Outboard (+100, -20)	13: LAB Stbd Zenith (-175, +30)	37: MBS Mast (-10, 0)	SRMS Elbow (+150, -40)

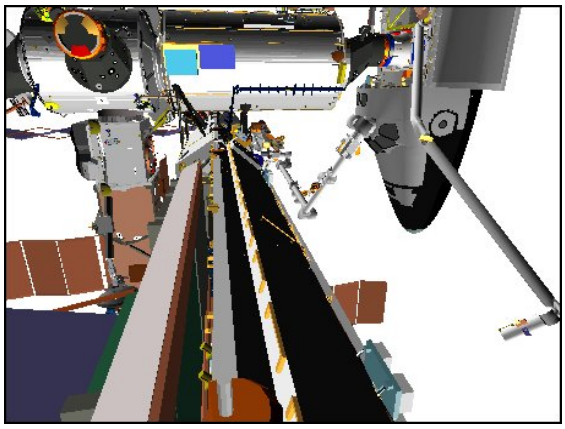

Figure 1.- P6 Retract Viewing
(09: P1 Lower Outboard: +100, -20).

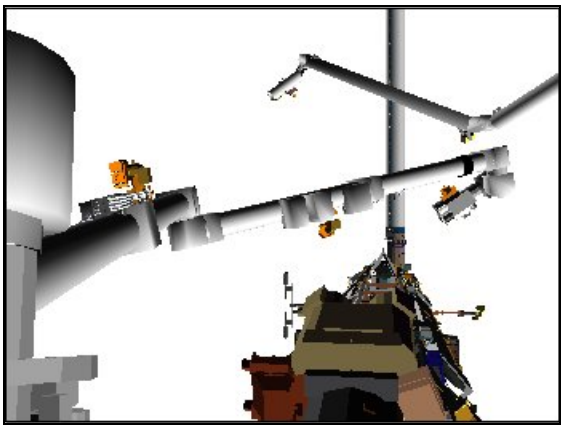

Figure 2.- P6 Retract Viewing
(37: MBS Mast: -10, 0).

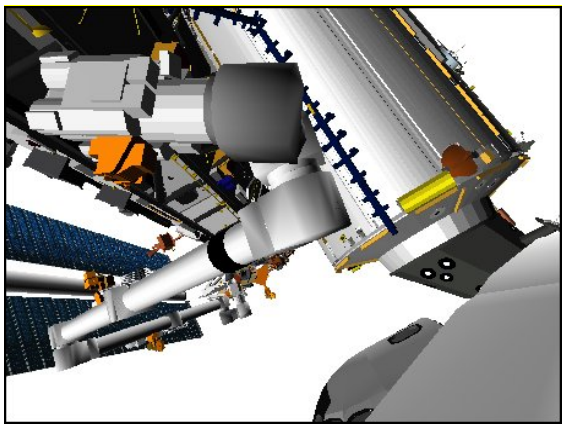

Figure 3.- P6 Retract Viewing
(V10: SRMS Elbow: +150, -40).

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

Verify Display – W3>ISSACS

DCP BRAKES SSRMS → OFF (Verify OFF)

MSS: SSRMS: SSRMS

√Vernier

Enter Mode – Joint OCAS (Verify blue)

2. JOINT OCAS 1

NOTE
Monitor clearance to SRMS with P1 Outboard Lower or SRMS Elbow Camera. The closest clearance to the SRMS during the start of the maneuver to P6 Retract Viewing Position is approximately 129 cm (4.2 ft).

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Joint OCAS 1 End position.

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-137.0	-30.0	-34.2	+204.3	-84.5

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)	-194.4	+250.4	-155.0	-61.2	-34.2	+204.3	-84.5
TGT	**-194.4**	**+250.4**	**-137.0**	**-30.0**	**-34.2**	**+204.3**	**-84.5**
ERR	0.0	0.0	-18.0	-31.2	0.0	0.0	0.0

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

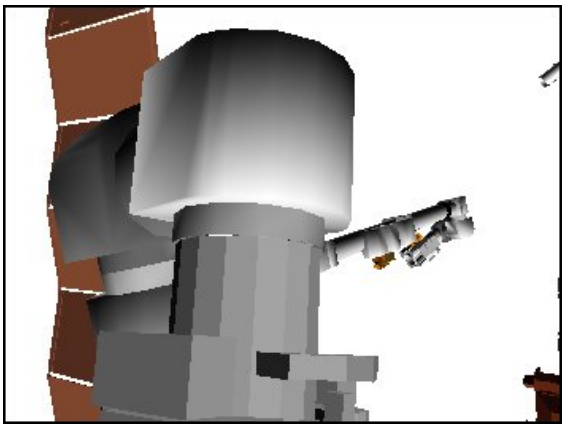

Figure 4.- Joint OCAS 1 End
(37: MBS Mast: -35, 0).

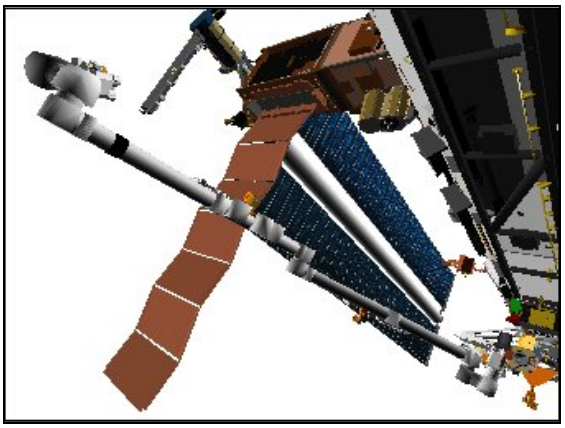

Figure 5.- Joint OCAS 1 End
(V10: SRMS Elbow: +90, -40).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at Joint OCAS 1 End position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-137.0	-30.0	-34.2	+204.3	-84.5
X	Y	Z	Pitch	Yaw	Roll	
+350	-671	-600	+143.0	+43.4	+148.2	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

3. CLEARANCE MANEUVER

NOTE
Monitor clearance to Orbiter Nose and P6 Forward Radiator with the Mast Camera or P1 Outboard Lower Camera. The closest clearance to the Orbiter Nose during the manuever is approximately 144 cm (4.7 ft). The closest clearance to the P6 Forward Radiator during the maneuver is approximately 140 cm (4.6 ft).

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING
The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → SHOULDER YAW (Verify SY – Selected on PCS)

THC Perform "-" Single Joint maneuver to SY: +130.0 (THC down).

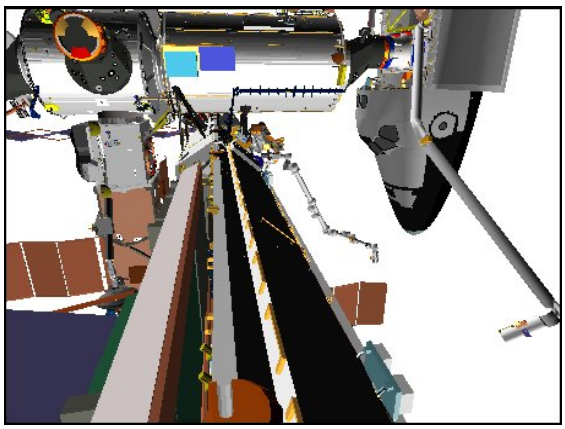

Figure 6.- Clearance
(09: P1 Lower Outboard: +100, -20).

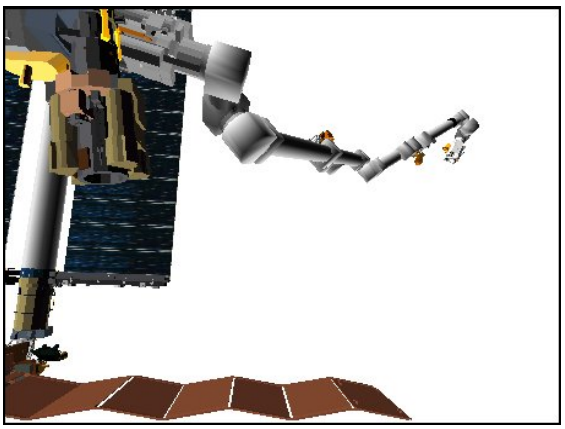

Figure 7.- Clearance
(13: LAB Stbd Zenith: -175, +30).

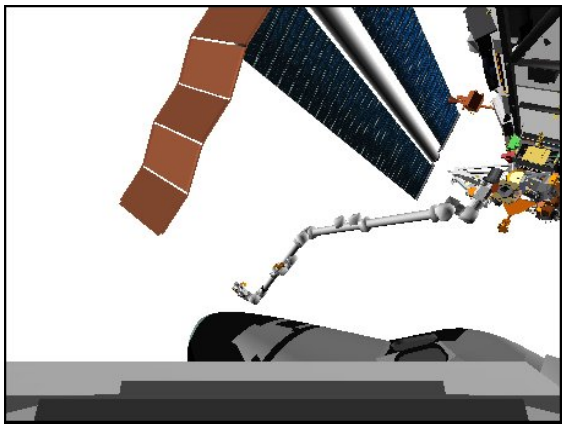

Figure 8.- Clearance
(V10: SRMS Elbow: +90, -65).

4. JOINT OCAS 2
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
09: P1 Lower Outboard (+100, -20)	13: LAB Stbd Zenith (-175, +35)	37: MBS Mast (-80, +30) 24: Tip Elbow (0, +5)	SRMS Elbow (+90, -65)

NOTE
Expect singularity warning for EP between -15 and +15 degrees.

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Joint OCAS 2 End position.

SR	SY	SP	EP	WP	WY	WR
-194.4	+96.0	-137.0	+146.7	-34.2	+204.3	-84.5

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)	-194.4	+130.0	-137.0	-30.0	-34.2	+204.3	-84.5
TGT	**-194.4**	**+96.0**	**-137.0**	**+146.7**	**-34.2**	**+204.3**	**-84.5**
ERR	0.0	+34.0	0.0	-176.7	0.0	0.0	0.0

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

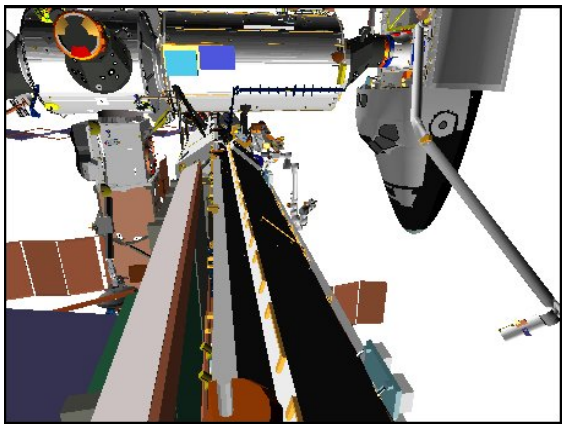

Figure 9.- JOCAS 2 End
(09: P1 Lower Outboard: +100, +20).

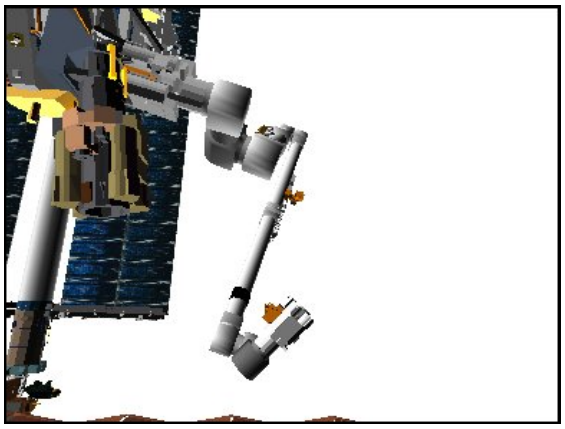

Figure 10.- JOCAS 2 End
(13: LAB Stbd Zenith: -175, +35).

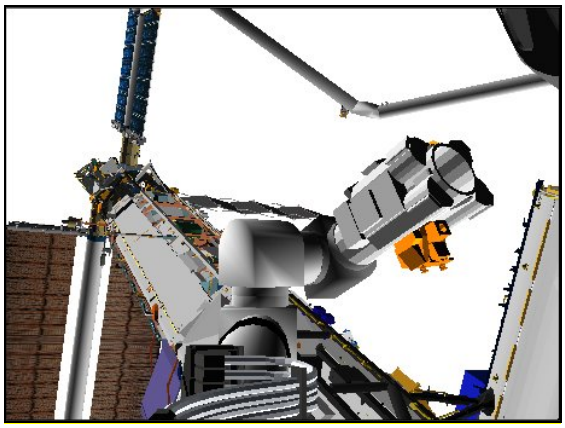

Figure 11.- JOCAS 2 End
(24: Tip Elbow: 0, +5).

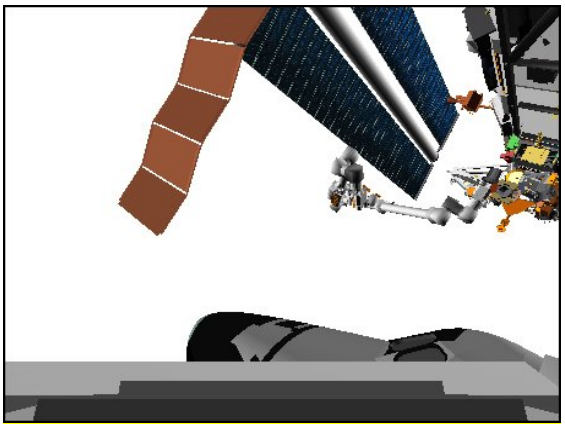

Figure 12.- JOCAS 2 End
(V10: SRMS Elbow: +90, -65).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at Joint OCAS 2 End position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-194.4	+96.0	-137.0	+146.7	-34.2	+204.3	-84.5
X	Y	Z	Pitch	Yaw	Roll	
+635	+403	-390	-9.3	+46.8	+108.7	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

5. MANEUVERING TO SSRMS STOW

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
09: P1 Lower Outboard (+100, -20)	13: LAB Stbd Zenith (-175, +35)	24: Tip Elbow (0, +5)	SRMS Elbow (+90, -65)

RHC RATE → COARSE (Verify Coarse on PCS)

NOTE
Expect singularity warning between SP -172 and -170 deg.

SSRMS Joint OCAS

Input ‘Joint Angles’ ‘Destination’ for SSRMS Stow position.

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4

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)	-194.4	+96.0	-137.0	+146.7	-34.2	+204.3	-84.5
TGT	**-180.0**	**+96.0**	**-183.0**	**+146.7**	**-131.1**	**+175.4**	**+125.4**
ERR	-14.4	0.0	+46.0	0.0	+96.9	+28.9	-209.9

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

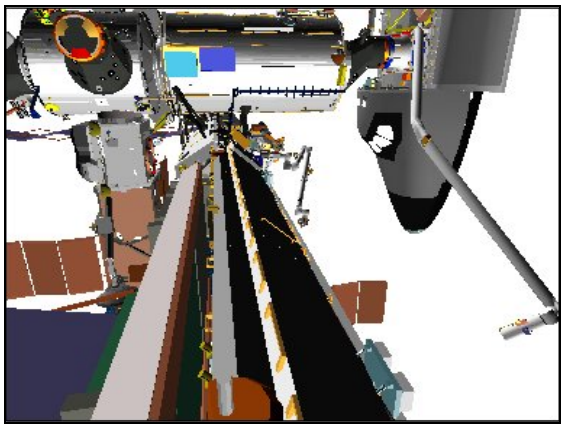

Figure 13.- SSRMS Stow
(09: P1 Lower Outboard: +100, -20).

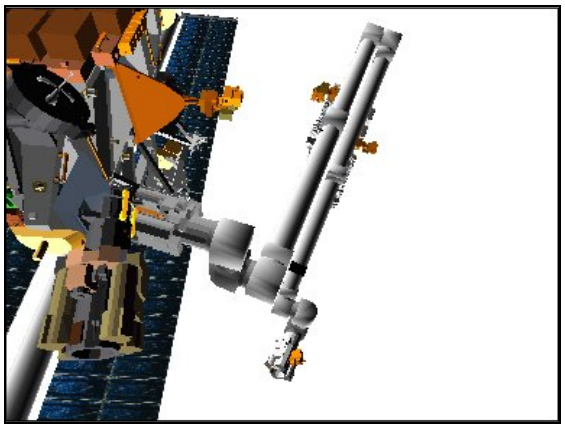

Figure 14.- SSRMS Stow
(13: LAB Stbd Zenith: -175, +55).

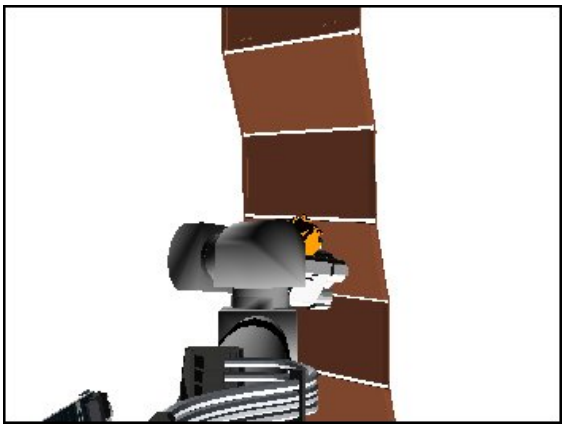

Figure 15.- SSRMS Stow
(24: Tip Elbow: 0, +5).

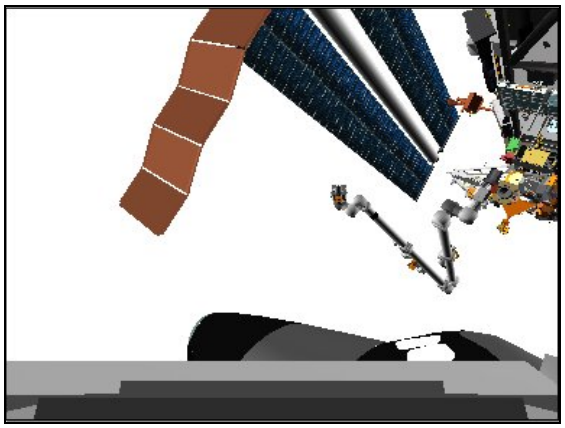

Figure 16.- SSRMS Stow
(V10: SRMS Elbow: +90, -65).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
X	Y	Z	Pitch	Yaw	Roll	
+596	+579	-601	-144.8	-64.0	-25.8	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

6. CLEANUP

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)

EVA 2

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4.101 STBD CETA CART 2 RELOCATION

(RBT FS/12A.1/FIN 1) Page 1 of 16 pages

1. HAND CONTROLLER CALIBRATION

1.1 Translational Hand Controller (THC) Calibration

THC

- Deflect [X] Axis to positive hard stop where [X] = [X] [Y] [Z]
- Deflect [X] Axis to negative hard stop.
- Repeat

1.2 Rotational Hand Controller (RHC) Calibration

RHC

- Deflect [X] Axis to positive hard stop where [X] = [P] [Y] [R]
- Deflect [X] Axis to negative hard stop.
- Repeat

2. SETUP

NOTE
During the channel 2/3 power reconfig on EVA 2, there is limited video capability available. Only one shuttle Camera view (Channel 91)and three station Camera views are available. Of the three station Camera views available, only two SSRMS Cameras, or one SSRMS Camera and one MBS Camera, are available at the same time.

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
09: P1 Lower Outboard (+110, -10)	13: LAB Stbd Zenith (-170, +20)	37: MBS Mast (-10, 0)

PCS

MSS: SSRMS: [SSRMS]

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

Change Display ▶ W3 ▶ ISSACS (Verify W3>ISSACS)

Change Command ▶ W3 ▶ ISSACS (Verify W3>ISSACS)

Verify SSRMS is in the P6 Retract Viewing position (within 5cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-155.0	-61.2	-34.2	+204.3	-84.5
X	Y	Z	Pitch	Yaw	Roll	
+468	-606	+132	+124.6	+1.9	+177.1	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

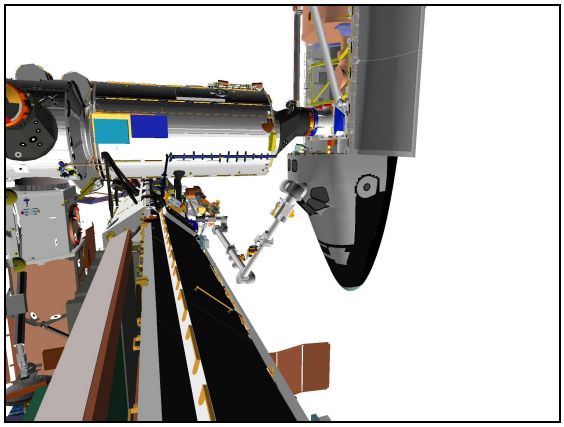

Figure 1.- P6 Retract Viewing
(09: P1 Lower Outboard: +110, -10).

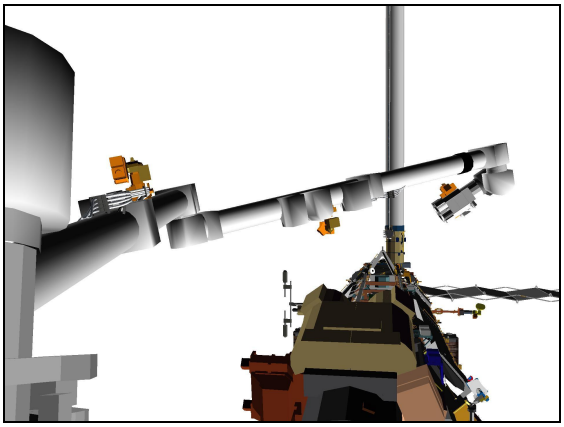

Figure 2.- P6 Retract Viewing
(37: MBS Mast: -10, 0).

3. MANEUVERING TO EVA SETUP POSITION

MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → VERNIER (Verify Vernier on PCS)

3.1 Joint OCAS Maneuver to Intermediate 1

MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Intermediate 1 position.

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-137.0	-30.0	-154.8	+184.9	-61.5

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)	-194.4	+250.4	-155.0	-61.2	-34.2	+204.3	-84.5
TGT	**-194.4**	**+250.4**	**-137.0**	**-30.0**	**-154.8**	**+184.9**	**-61.5**
ERR	0.0	0.0	-18.0	-31.2	+120.6	+19.4	-23.0

****
* If joint angles or errors are incorrect

PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.

****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-137.0	-30.0	-154.8	+184.9	-61.5

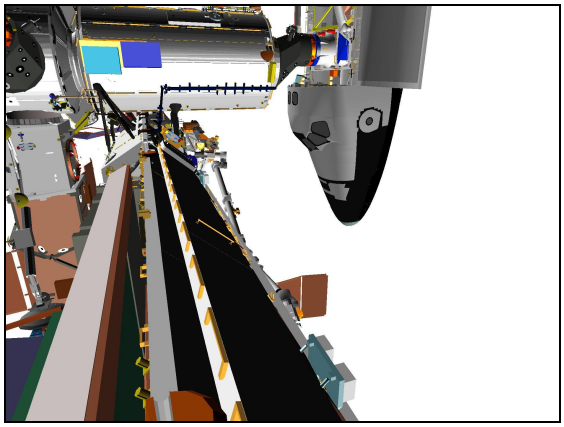

Figure 3.- Intermediate 1
(09: P1 Lower Outboard: +110, -20).

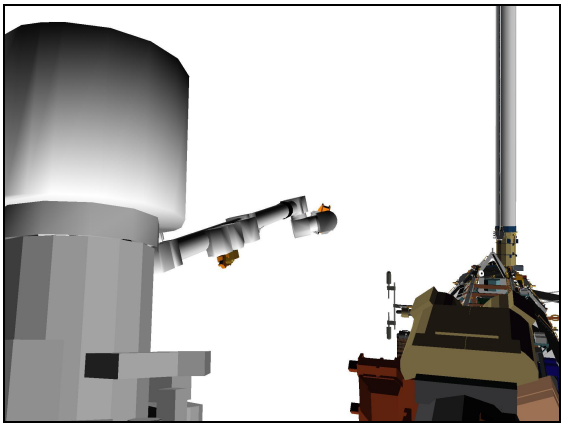

Figure 4.- Intermediate 1
(37: MBS Mast: -10, 0).

3.2 Single Joint Maneuver

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

NOTE

1. Expect singularity warning for EP between -15 and +15 deg.

2. During the SY Maneuver, the clearance between the Tip Boom and the orbiter nose can be as low as 57 inches. The clearance between the Tip Boom and the Forward Radiator can be as low as 55 inches. This occurs when the SY is between 198 and 195 deg.

THC Perform Single Joint maneuver to Intermediate 2 position (within 1 deg).

	SR	SY	SP	EP	WP	WY	WR
Intermediate 1	-194.4	+250.4	-137.0	-30.0	-154.8	+184.9	-61.5
1: SY –		+80.0	→				
2: EP +				+90.0			
Intermediate 2	-194.4	+80.0	-137.0	+90.0	-154.8	+184.9	-61.5

X	Y	Z	Pitch	Yaw	Roll
+508	+274	-1246	+79.2	-82.1	+10.7

FOR	Unloaded – LEE Tip, SR Held
Disp	W3>ISSACS

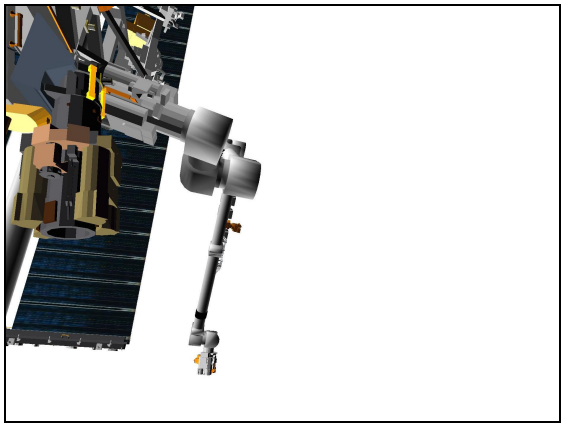

Figure 5.- Intermediate 2
(13: LAB Stbd Zenith: -170, +40).

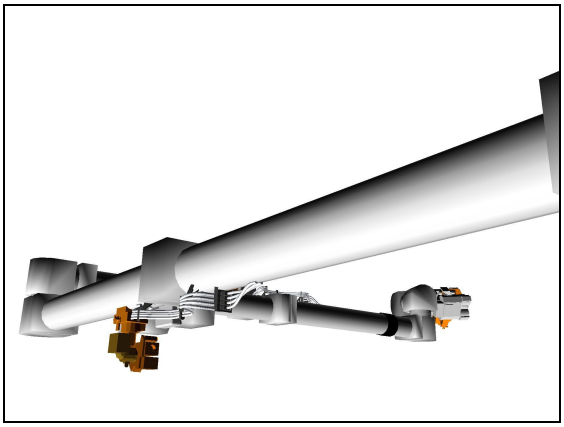

Figure 6.- Intermediate 2
(37: MBS Mast: -85, +10).

3.3 Joint OCAS Maneuver to EVA Setup

NOTE
Note that the clearance between the MCAS RTL and the SSRMS SP joint is approximately 1 foot until step 7 is complete. Clearance should be monitored with the MBS Mast Camera.

MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for EVA Setup position.

SR	SY	SP	EP	WP	WY	WR
-180.0	-89.9	-57.1	+122.4	-154.8	+184.9	-61.5

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)	-194.4	+80.0	-137.0	+90.0	-154.8	+184.9	-61.5
TGT	**-180.0**	**-89.9**	**-57.1**	**+122.4**	**-154.8**	**+184.9**	**-61.5**
ERR	-14.4	+169.9	-79.9	-32.4	0.0	0.0	0.0

****
* If joint angles or errors are incorrect
PCS * | **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* | Input correct Dest joint angles per table above.
*
* | **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * | Verify joint angles and errors are correct on Joint Angle Position
* | overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-180.0	-89.9	-57.1	+122.4	-154.8	+184.9	-61.5

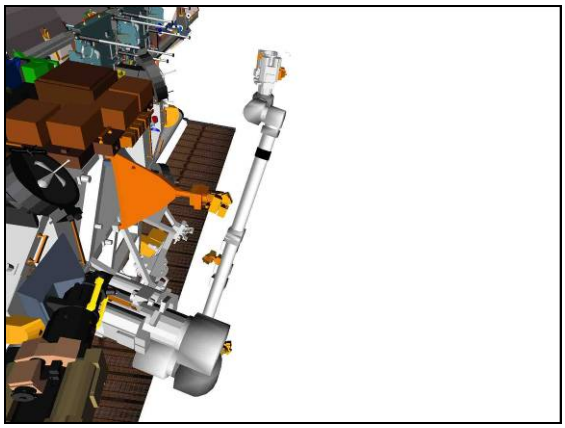

Figure 7.- EVA Setup
(13: LAB Stbd Zenith: -170, +70).

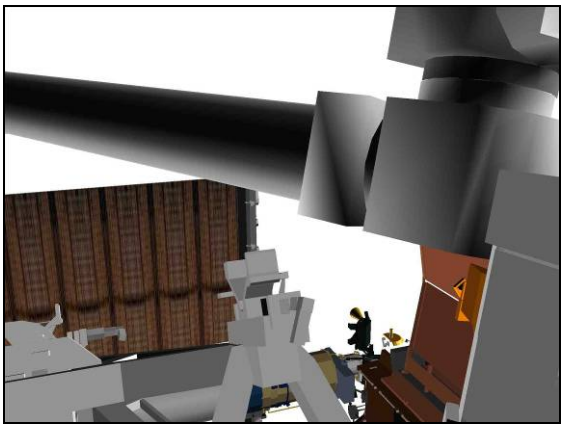

Figure 8.- EVA Setup
(37: MBS Mast: -70,-15).

Give SSRMS Operator a GO to maneuver to the CETA Cart Viewing position.

4. FMS SHROUD AND APFR INSTALL POSITION

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (+55, -45) 13: LAB Stbd Zenith (-170, +75)	22: Base Elbow (+75, -25)	37: MBS Mast (-70, -15)

Give SRMS Operator a GO to maneuver to the CETA Cart Viewing position.

When CETA Cart 2 is in position and on EVA GO,

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

THC/ RHC — Maneuver to FMS Shroud Installation position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	-101.1	-57.6	+121.2	-154.1	+184.9	-72.7
X	Y	Z	Pitch	Yaw	Roll	
+350	+1410	+14	-89.9	+0.8	+16.3	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

THC/ RHC — Maneuver SSRMS per EVA GCA to install the FMS Shroud.

When the SSRMS is in position to install the FMS Shroud,

DCP — BRAKES SSRMS → ON (Verify ON)

When the FMS Shroud Installation is complete,

DCP — BRAKES SSRMS → OFF (Verify OFF)

PCS — MSS: SSRMS: [SSRMS]

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: [Joint Lock]

cmd Shoulder Roll (Verify SR – Locked)

THC/ RHC — Maneuver SSRMS per EVA GCA to install APFR.

NOTE
APFR settings are 12/PP/F/6.

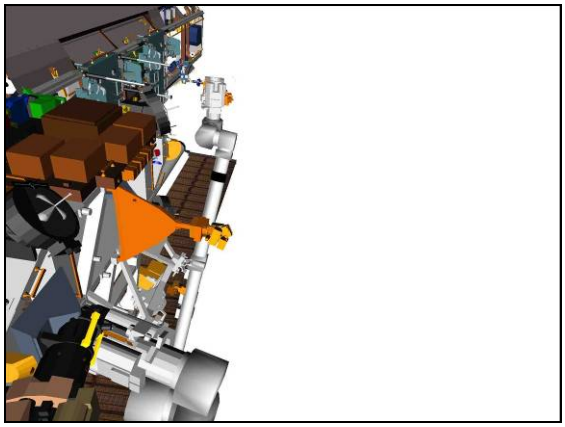

Figure 9.- APFR Install
(13: LAB Stbd Zenith: -170, +75).

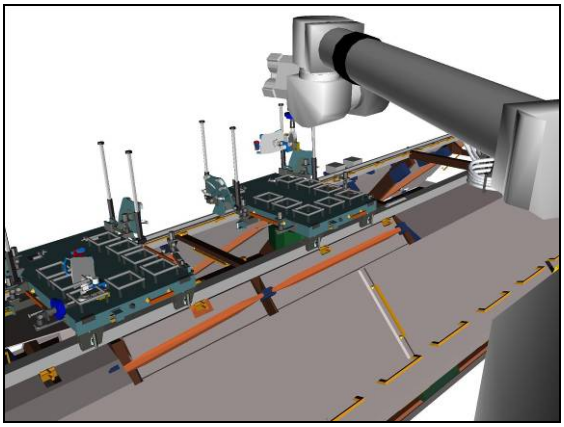

Figure 10.- APFR Install
(22: Base Elbow: +75, -25).

Figure 11.- APFR Install
(37: MBS Mast: -70, -15).

5. APFR INGRESS/STBD CETA CART REMOVAL POSITION
On EVA GO,

THC/ RHC — Maneuver to APFR Ingress/STBD CETA Cart Removal position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	-100.0	-70.2	+120.5	-140.7	+184.9	-71.7
X	Y	Z	Pitch	Yaw	Roll	
+350	+1410	-145	-89.9	+0.8	+16.3	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

THC/ RHC — Maneuver SSRMS per EVA GCA to ingress the APFR.

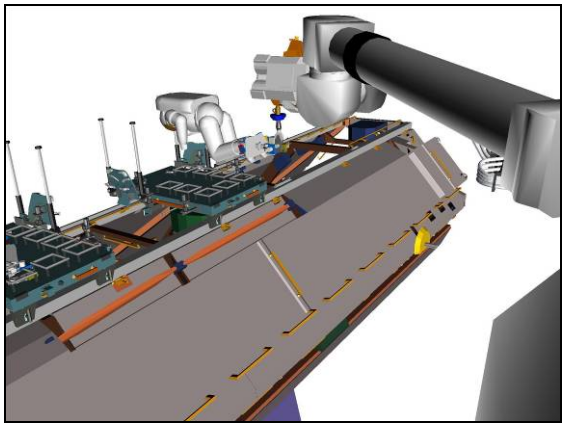

Figure 12.- APFR Ingress
(22: Base Elbow: +75, -25).

When APFR Ingress complete,

PCS MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

Change Unloaded Parameters ▶ EVA ▶ Chest 12/PP/F/6 SRH
Verify 'Unloaded Parameters' (two) – Chest 12/PP/F/6, SR Held

Change Command ▶ W3 ▶ ISSACS/Internal (Verify W3>ISSACS/Internal)

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

Verify CETA Cart 2 brake handles are stowed (up).

THC/ RHC Maneuver SSRMS per EVA GCA to remove the CETA Cart from the truss and away from structure.

6. STBD CETA CART REMOVAL CLEARANCE POSITION
When CETA Cart removal is complete,

THC/ RHC — Maneuver to STBD CETA Cart Removal Clearance Position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	-54.5	-74.4	+70.9	-83.2	+183.7	-26.0
X	Y	Z	Pitch	Yaw	Roll	
+950	+1413	-650	-179.9	+0.8	+0.8	
FOR	Unloaded – Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

PCS — MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

Figure 13.- STBD CETA Cart Removal Clearance
(37: MBS Mast: -70, -15).

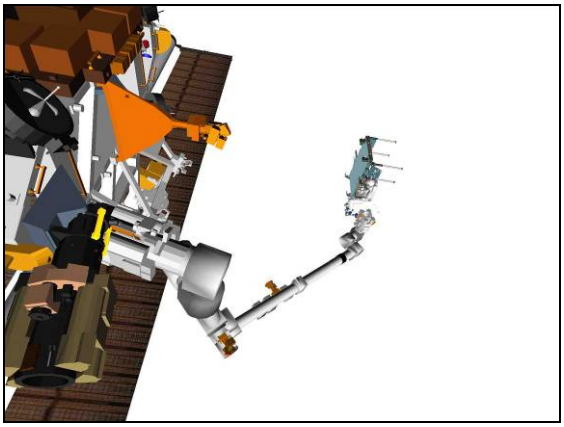

Figure 14.- STBD CETA Cart Removal Clearance
(13: LAB Stbd Zenith: -170, +60).

7. PORT CETA CART INSTALL CLEARANCE POSITION
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (+55, -45)	22: Base Elbow (+115, -5)	37: MBS Mast (-70, -15) 13: LAB Stbd Zenith (-170, +60)

MSS: SSRMS: SSRMS

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 ▶ W3MBS3 ▶ MT Port

Verify 'FOR' 'Destination' for Port CETA Cart Install Clearance position.

X	Y	Z	Pitch	Yaw	Roll
+950	+200	-650	-179.9	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	+950	+1413	-650	-179.9	+0.8	+0.8
TGT	+950	+200	-650	-179.9	0.0	0.0
ERR	0	+1213	0	0.0	+0.8	+0.8

****
* If FOR or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest FOR per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify FOR and errors are correct on FOR Position overlay.
****

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 Port CETA Cart Install Clearance position
(within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-180.0	+35.8	-94.0	+92.1	-84.9	+176.2	+64.8
X	Y	Z	Pitch	Yaw	Roll	
+950	+200	-650	-179.9	0.0	0.0	
FOR	Unloaded – Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

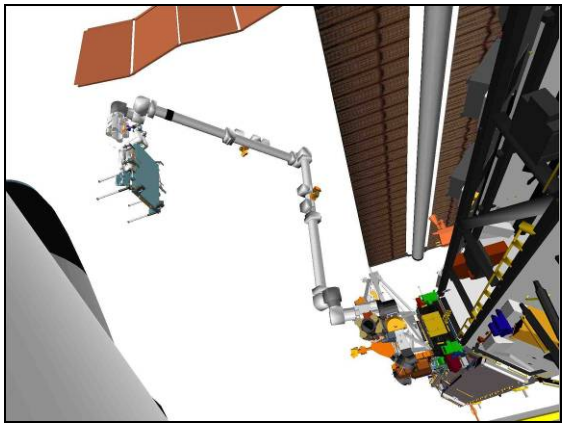

Figure 15.- Port CETA Cart Install Clearance
(91: SRMS Elbow: +45, -45).

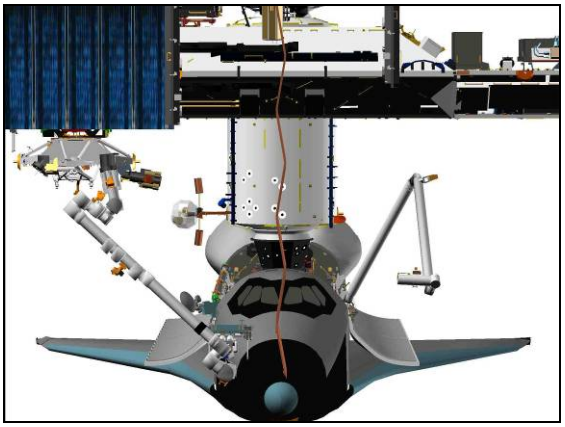

Figure 16.- Port CETA Cart Install Clearance
(ISS Zenith view).

8. PORT CETA CART INSTALL POSITION

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (+45, -45)	22: Base Elbow (+85, -5)	13: LAB Stbd Zenith (-170, +25)

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

THC/ RHC

Maneuver to Port CETA Cart Install position (within 5 cm/1 deg).

	Locked						
	SR	SY	SP	EP	WP	WY	WR
	-180.0	+35.8	-94.0	+92.1	-84.9	+176.2	+64.8
	X	Y	Z	Pitch	Yaw	Roll	
Port CETA Cart Install Clearance	+950	+200	-650	-179.9	0.0	0.0	
1: X –	+550	→					
2: Z +		←	-100				
3: X –	+250						
Port CETA Cart Install	+250	+200	-100	-179.9	0.0	0.0	
	SR	SY	SP	EP	WP	WY	WR
	-180.0	+115.8	-106.1	+144.8	-131.9	+176.3	+145.0
	FOR	Unloaded – Chest 12/PP/F/6, SR Held					
	Disp	W3>ISSACS					

THC/ RHC Maneuver SSRMS per EVA GCA to install CETA Cart.

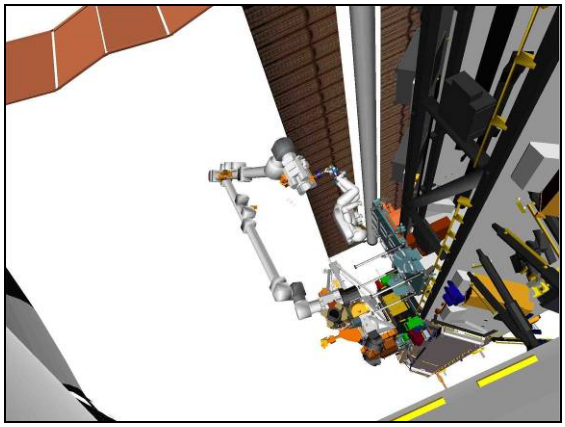

Figure 17. - Port CETA Cart Install (91: SRMS Elbow: +55, -45).

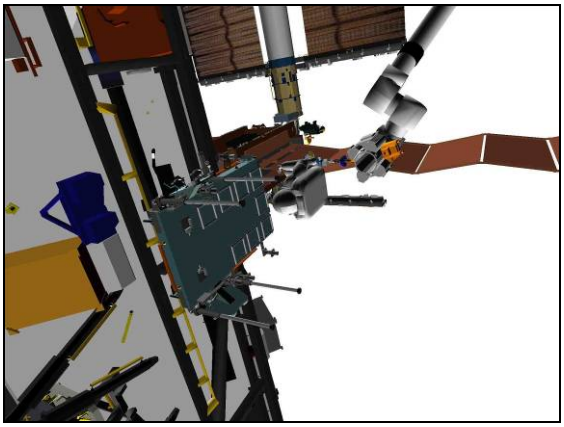

Figure 18. - Port CETA Cart Install (13: LAB Stbd Zenith: +150, -5).

9. PORT CETA CART INSTALL CLEARANCE POSITION
When CETA Cart Install is complete and on EVA GO,

THC/ RHC Maneuver EVA to Truss clearance position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+97.8	-107.5	+146.9	-131.2	+175.5	+127.0
X	Y	Z	Pitch	Yaw	Roll	
+400	+200	-100	-179.9	0.0	0.0	
FOR	Unloaded – Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

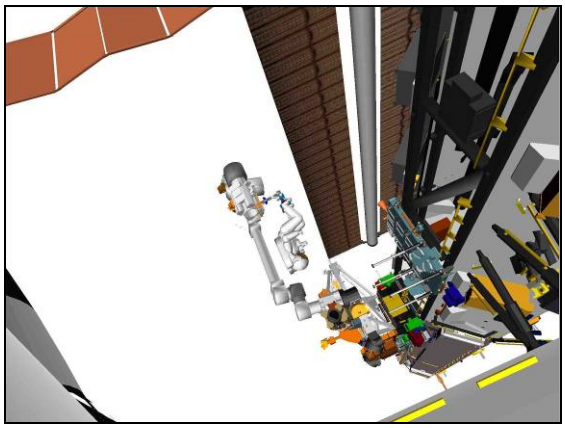

Figure 19.- Truss Clearance (91: SRMS Elbow: +55, -45).

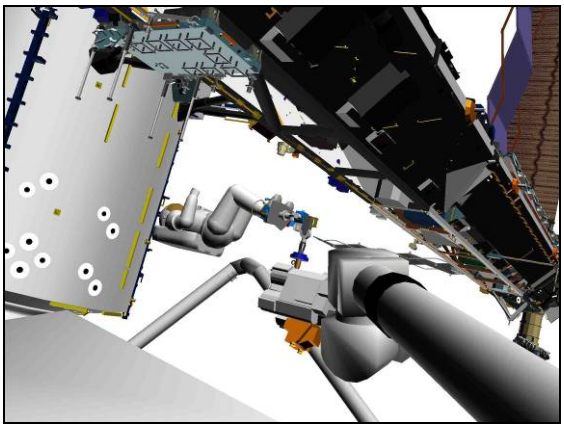

Figure 20.- Truss Clearance (22: Base Elbow: +40, -5).

√**MCC** to determine status of MBSUs and DDCUs

If MBSU R&R required
Perform {5.201 MBSU R&R}, all (SODF: RBT FS: CONTINGENCY), then:

If DDCU R&R is required
Perform {4.102 STBD CETA CART 1 RELOCATION}, steps 6 and 8 (SODF: RBT FS: EVA 2), then:

THC/ RHC — Maneuver to Port CETA Cart Install Clearance position (within 5 cm/1 deg).

	Locked						
	SR	SY	SP	EP	WP	WY	WR
	-180.0	+97.8	-107.5	+146.9	-131.2	+175.5	+127.0
	X	Y	Z	Pitch	Yaw	Roll	
Port CETA Cart Install	+400	+200	-100	-179.9	0.0	0.0	
1: X +	+550	→					
2: Z –			-650				
3: X +	+950	←					
Port CETA Cart Install Clearance	+950	+200	-650	-179.9	0.0	0.0	
	SR	SY	SP	EP	WP	WY	WR
	-180.0	+35.8	-94.0	+92.1	-84.9	+176.2	+64.8
	FOR	Unloaded – Chest 12/PP/F/6, SR Held					
	Disp	W3>ISSACS					

PCS — MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

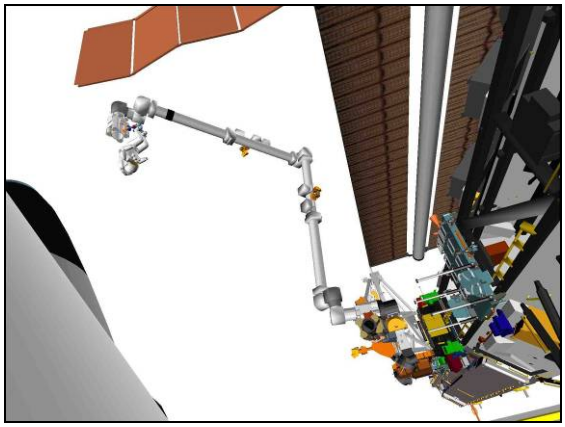

Figure 21.- Port CETA Cart Install Clearance
(91: SRMS Elbow: +45, -45).

10. STBD CETA CART REMOVAL CLEARANCE POSITION

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (+45, -45)	22: Base Elbow (+90, -5)	37: MBS Mast (-70, -15) 13: LAB Stbd Zenith (-170, +30)

NOTE

Note that the clearance between the MCAS RTL and the SSRMS SP joint is approximately 1 foot at the end of this maneuver and through the end of the procedure. Clearance should be monitored with MBS Mast Camera.

MSS: SSRMS: SSRMS

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 ▶ W3MBS3 ▶ MT Stbd

Verify 'FOR' 'Destination' for Stbd CETA Cart Removal Clearance position.

X	Y	Z	Pitch	Yaw	Roll
+950	+1410	-650	-179.9	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	+950	+200	-650	-179.9	0.0	0.0
TGT	+950	+1410	-650	-179.9	0.0	0.0
ERR	0	-1210	0	0.0	0.0	0.0

****

* If FOR or errors are incorrect

PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)

*

* Input correct Dest FOR per table above.

*

* **cmd** Load (Verify Sequence Status – Confirm or Cancel)

*

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

****

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 Stbd CETA Cart Removal Clearance position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-180.0	-54.6	-74.2	+70.6	-82.6	+183.1	-25.3
X	Y	Z	Pitch	Yaw	Roll	
+950	+1410	-650	-179.9	0.0	0.0	
FOR	Unloaded – Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

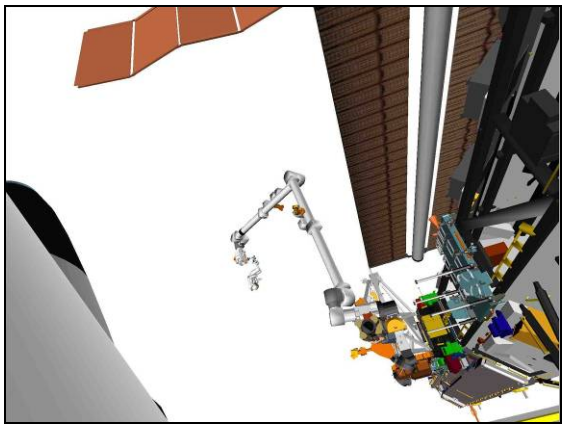

Figure 22.- STBD CETA Cart Removal Clearance
(91: SRMS Elbow: +45, -45).

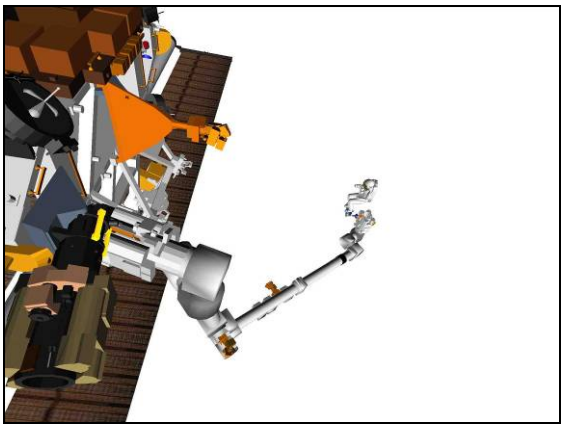

Figure 23.- STBD CETA Cart Removal Clearance
(13: LAB Stbd Zenith: -170, +60).

4.102 STBD CETA CART 1 RELOCATION

1. SETUP

NOTE
During the channel 2/3 power reconfig on EVA 2, there is limited video capability available. Only one shuttle Camera view (Channel 91) and three station Camera views are available. Of the three station Camera views available, only two SSRMS Cameras, or one SSRMS Camera and one MBS Camera, are available at the same time.

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (+55, -45) 13: LAB Stbd Zenith (-170, +60)	22: Base Elbow (+115, -10)	37: MBS Mast (-70, -15)

PCS MSS: SSRMS: SSRMS

Verify 'Unloaded Parameters' (two) – Chest 12/PP/F/6, SR Held

Verify Display – W3>ISSACS

Verify Command – W3>ISSACS/Internal

Verify SSRMS is in the Stbd CETA Cart Removal Clearance position (within 5 cm/ 1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	-54.6	-74.2	+70.6	-82.6	+183.1	-25.3
X	Y	Z	Pitch	Yaw	Roll	
+950	+1410	-650	-179.9	0.0	0.0	
FOR	Unloaded – Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

2. STBD CETA CART REMOVAL POSITION

NOTE
Note that the clearance between the MCAS RTL and the SSRMS SP joint is approximately 1 foot until step 4 is complete. Clearance should be monitored with the MBS Mast Camera.

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

THC/ RHC — Maneuver to STBD CETA Cart Removal Setup position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	-89.8	-69.9	+121.7	-140.3	+184.7	-60.5
X	Y	Z	Pitch	Yaw	Roll	
+400	+1410	+15	-179.9	0.0	0.0	
FOR	Unloaded – Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

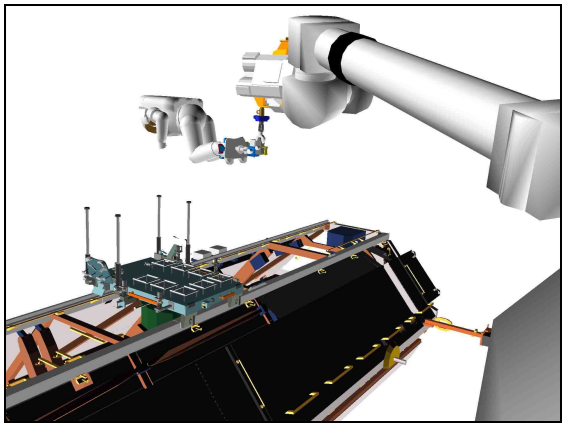

Figure 1.- Stbd CETA Cart Removal Setup Position (22: Base Elbow: +75, -25).

Verify CETA Cart 1 brake handles are stowed (up).

When CETA Cart is in position and on EVA GO,

THC/ RHC — Maneuver to STBD CETA Cart Removal position (within 5cm/1deg)

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	-101.0	-69.9	+120.2	-139.7	+184.9	-71.9
X	Y	Z	Pitch	Yaw	Roll	
+250	+1410	+15	-179.9	0.0	0.0	
FOR	Unloaded – Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

THC/ RHC — Maneuver SSRMS per EVA GCA to remove the CETA Cart from the truss and away from structure.

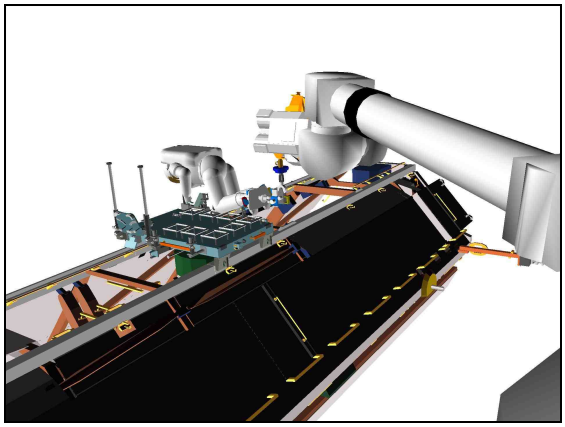

Figure 2.- Stbd CETA Cart Removal Position
(22: Base Elbow: +75, -20).

3. STBD CETA CART REMOVAL CLEARANCE POSITION
When CETA Cart removal is complete,

THC/ RHC — Maneuver to STBD CETA Cart Removal Clearance position (within 5 cm/1 deg)

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	-54.6	-74.2	+70.6	-82.6	+183.1	-25.3
X	Y	Z	Pitch	Yaw	Roll	
+950	+1410	-650	-179.9	0.0	0.0	
FOR	Unloaded – Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

PCS — MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

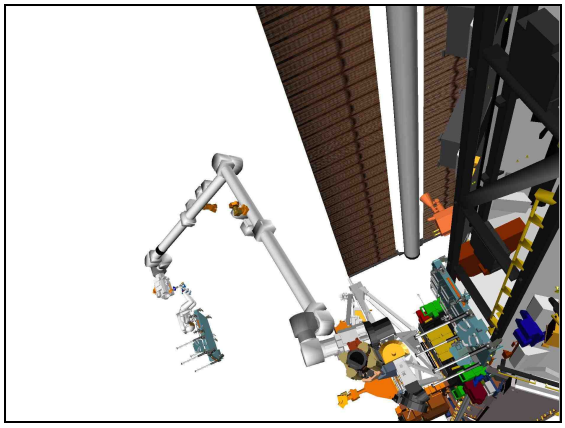

Figure 3.- STBD CETA Cart Removal Clearance Position
(91: SRMS Elbow: +55, -45).

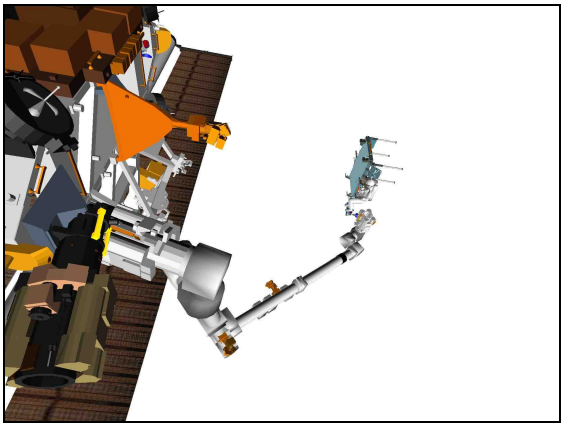

Figure 4.- STBD CETA Cart Removal Clearance Position
(13: LAB Stbd Zenith: -170, +60).

4. PORT CETA CART INSTALL CLEARANCE POSITION

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (+55, -45)	22: Base Elbow (+115, -5)	37: MBS Mast (-70, -15) 13: LAB Stbd Zenith (-170, +60)

MSS: SSRMS: [SSRMS]

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 ▶ W3MBS3 ▶ MT Port

Verify 'FOR' 'Destination' for Port CETA Cart Install Clearance position.

X	Y	Z	Pitch	Yaw	Roll
+950	+200	-650	-179.9	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	+950	+1410	-650	-179.9	0.0	0.0
TGT	+950	+200	-650	-179.9	0.0	0.0
ERR	0	+1210	0	0.0	0.0	0.0

****
* If FOR or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest FOR per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify FOR and errors are correct on FOR Position overlay.
****

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 Port CETA Cart Install Clearance position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-180.0	+35.8	-94.0	+92.2	-84.9	+176.2	+64.8
X	Y	Z	Pitch	Yaw	Roll	
+950	+200	-650	-179.9	0.0	0.0	
FOR	Unloaded – Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

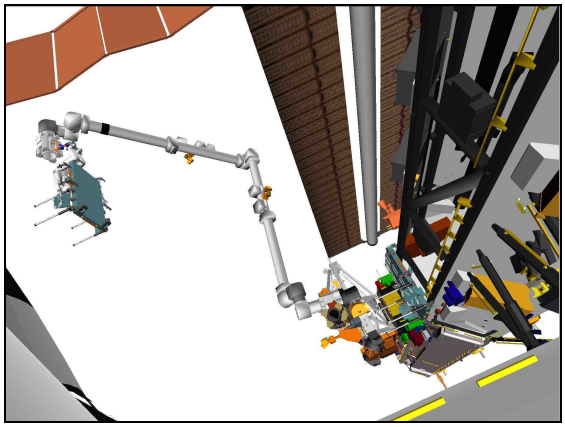

Figure 5.- Port CETA Cart Install Clearance Position (91: SRMS Elbow: +45, -45).

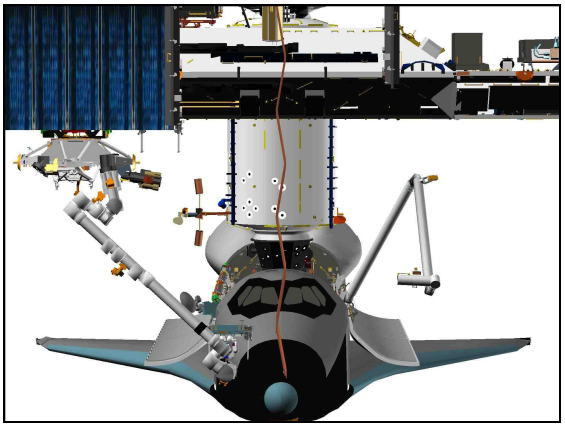

Figure 6.- Port CETA Cart Install Clearance Position (ISS Zenith view).

5. PORT CETA CART INSTALL POSITION

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (+45, -45)	22: Base Elbow (+85, -5)	13: LAB Stbd Zenith (-170, +25)

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

THC/ RHC — Maneuver to Port CETA Cart Install position (within 5 cm/1 deg).

	Locked						
	SR	SY	SP	EP	WP	WY	WR
	-180.0	+35.8	-94.0	+92.2	-84.9	+176.2	+64.8
	X	Y	Z	Pitch	Yaw	Roll	
Port CETA Cart Install Clearance	+950	+200	-650	-179.9	0.0	0.0	
1: X –	+550	→					
2: Z +		←	-100				
3: X –	+250						
Port CETA Cart Install	+250	+200	-100	-179.9	0.0	0.0	
	SR	SY	SP	EP	WP	WY	WR
	-180.0	+115.7	-106.0	+144.9	-131.9	+176.3	+145.0
	FOR	Unloaded – Chest 12/PP/F/6, SR Held					
	Disp	W3>ISSACS					

THC/ RHC — Maneuver SSRMS per EVA GCA to install CETA Cart.

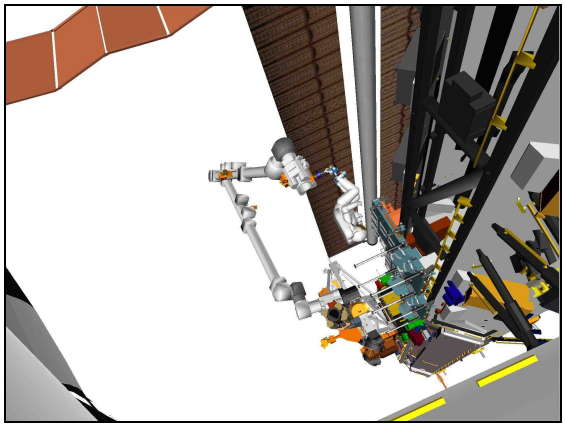

Figure 7. - Port CETA Cart Install Position (91: SRMS Elbow: +55, -45).

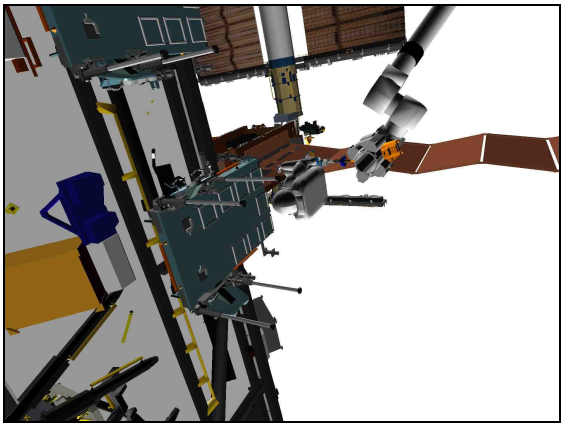

Figure 8. - Port CETA Cart Install Position (13: LAB Stbd Zenith: +150, -5).

6. APFR EGRESS AND REMOVAL
When CETA Cart Install is complete,

THC/ RHC — Maneuver SSRMS per EVA GCA to egress the APFR.

PCS — MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

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

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

When APFR egress is complete and on EVA GO,

THC/ RHC Maneuver SSRMS to APFR removal position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+113.6	-81.5	+151.1	-162.7	+176.2	+142.0
X	Y	Z	Pitch	Yaw	Roll	
+375	+200	-60	-89.9	0.0	+17.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

THC/ RHC Maneuver SSRMS per EVA GCA to remove the APFR.

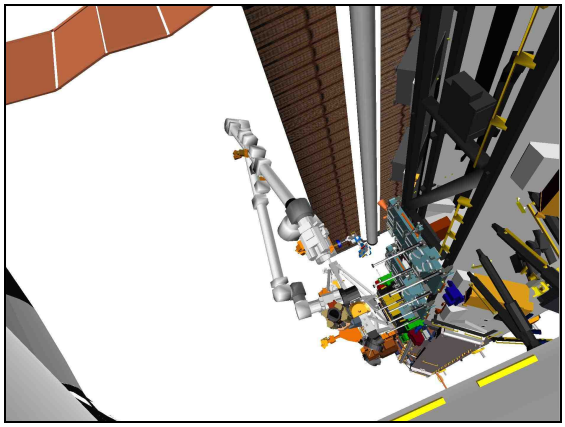

Figure 9.- APFR Removal Position (91: SRMS Elbow: +55, -45).

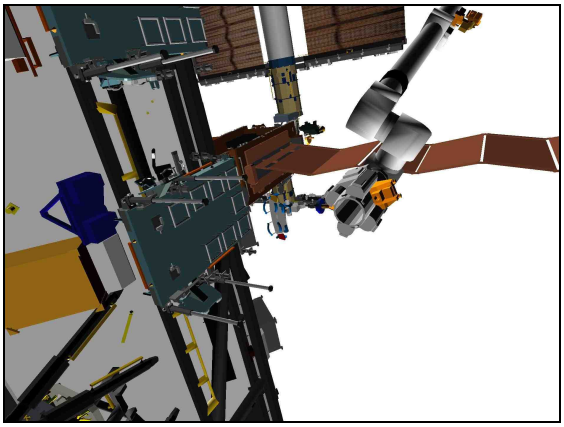

Figure 10.- APFR Removal Position (13: LAB Stbd Zenith: +150, -5).

7. SSRMS CLEARANCE MANEUVER
When APFR removal is complete and on EVA GO,

THC/ RHC — Maneuver SSRMS to MT Port Clearance position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-107.3	+146.7	-131.1	+175.4	+125.4
X	Y	Z	Pitch	Yaw	Roll	
+500	+200	-260	-89.9	0.0	+17.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

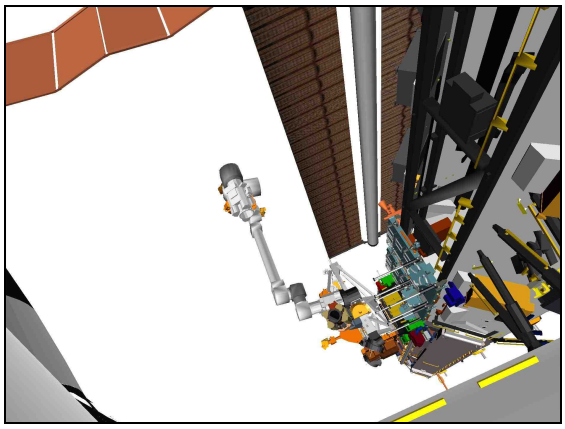

Figure 11.- SSRMS MT Port Clearance Position
(91: SRMS Elbow: +55, -45).

DCP — BRAKES SSRMS → ON (Verify ON)

Notify EV Crew GO to install FMS Shroud on Base LEE.

When FMS Shroud Installation is complete and on EVA GO,

BRAKES SSRMS → OFF (Verify OFF)

PCS — MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP — JOINT SELECT → SHOULDER PITCH (Verify SP – Selected on PCS)

THC Perform "–" Single Joint maneuver to SP: -183.0 (THC down).

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)

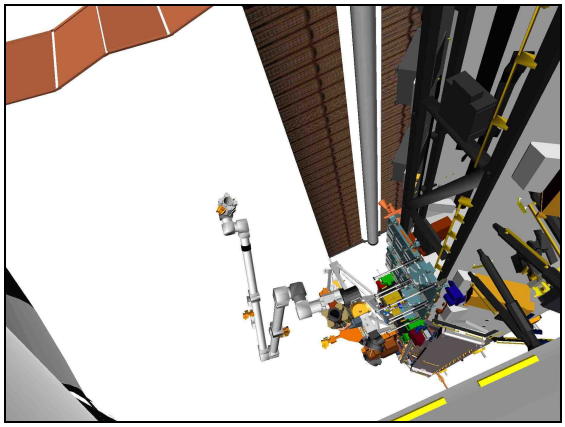

Figure 12.- SSRMS Stow Position
(91: SRMS Elbow: +55, -45).

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4.103 MANEUVER FROM EVA2 STOW TO STAGE EVA1 VIEWING

(RBT FS/12A.1/FIN) Page 1 of 4 pages

1. HAND CONTROLLER CALIBRATION

1.1 Translational Hand Controller (THC) Calibration

THC

Deflect [X] Axis to positive hard stop where [X] = [X] [Y] [Z]

Deflect [X] Axis to negative hard stop.

Repeat

1.2 Rotational Hand Controller (RHC) Calibration

RHC

Deflect [X] Axis to positive hard stop where [X] = [P] [Y] [R]

Deflect [X] Axis to negative hard stop.

Repeat

2. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
13: LAB Stbd Zenith (+160, +90)	22: Base Elbow (+50, -10)	24: Tip Elbow (+50, -20)

PCS

MSS: SSRMS: [SSRMS]

Change Display ▶ W2 ▶ ISSACS (Verify W2>ISSACS)
Verify Display – W2>ISSACS

Verify SSRMS in EVA 2 Stow position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
X	Y	Z	Pitch	Yaw	Roll	
+596	+1437	-601	-144.8	-64.0	-25.8	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W2>ISSACS					

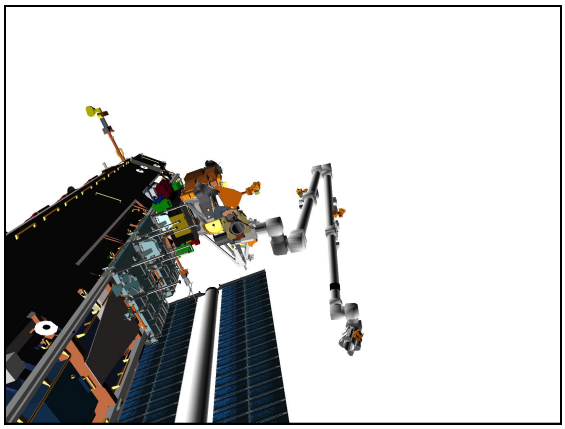

Figure 1.- EVA 2 Stow
(13: LAB Stbd Zenith: +160, +90).

3. JOINT OCAS TO STAGE EVA 1 VIEWING SETUP

MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → VERNIER (Verify Vernier on PCS)

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

MSS: SSRMS: SSRMS

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Joint OCAS 1 position.

SR	SY	SP	EP	WP	WY	WR
-213.0	+173.2	-150.0	+102.0	-89.3	-97.2	+7.2

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	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
TGT	**-213.0**	**+173.2**	**-150.0**	**+102.0**	**-89.3**	**-97.2**	**+7.2**
ERR	+33.0	-77.2	-33.0	+44.7	-41.8	+272.6	+118.2

****
* If joint angles or errors are incorrect

PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*

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

****

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

NOTE
Expect a Cross Cluster Collision annunciation during this maneuver.

DCP AUTO SEQ → PROC

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-213.0	+173.2	-150.0	+102.0	-89.3	-97.2	+7.2

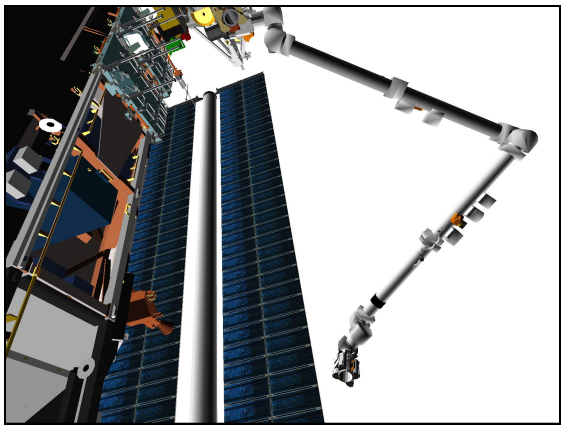

Figure 2.- Stage EVA 1 Setup
(13: LAB Stbd Zenith: +160, +60).

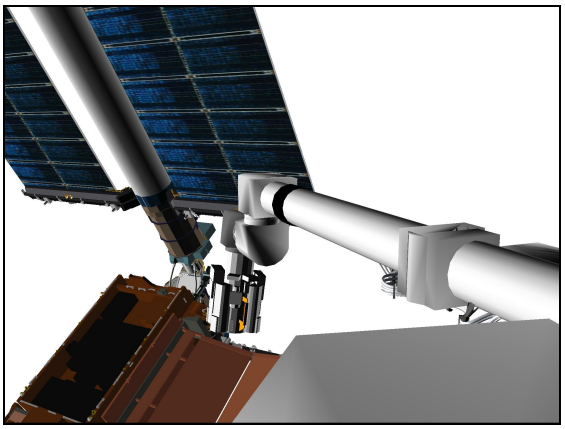

Figure 3.- Stage EVA 1 Setup
(22: Base Elbow: 100, -10).

4. SINGLE JOINT TO STAGE EVA 1 VIEWING

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → SHOULDER PITCH (Verify SP – Selected on PCS)

THC Perform "+" Single Joint maneuver to SP: -106.0 (THC up).

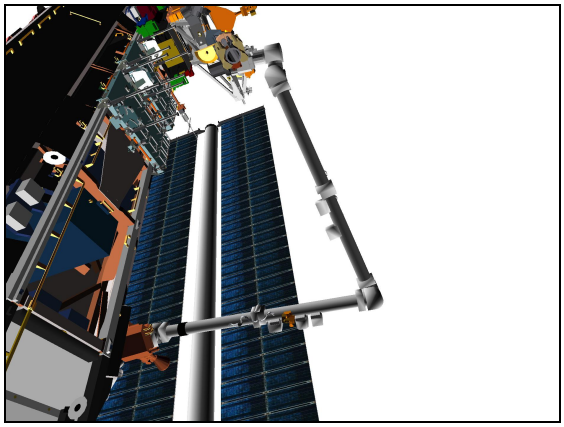

Figure 4.- Stage EVA 1 Viewing
(13: LAB Stbd Zenith: +160, +60).

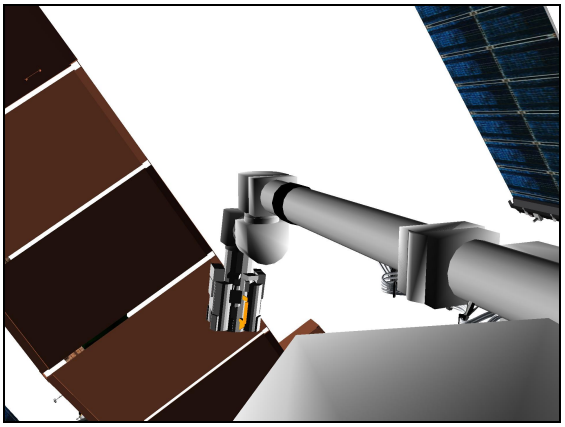

Figure 5.- Stage EVA 1 Viewing
(22: Base Elbow: 100, -10).

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)

CONTINGENCY

CONTINGENCY

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5.101 S1 PUMP MODULE R&R

(RBT FS/12A.1/FIN 1) Page 1 of 26 pages

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (-75, +35) 92: Camera B (+25, +20)	24: Tip Elbow (-5, +10) 22: Base Elbow (0, 0)	13: LAB Stbd Zenith (0, +90) 03: S1 Lower Outboard (+80, -15)

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

Change Display ▶ W2 ▶ ISSACS (Verify W2>ISSACS)

Change Command ▶ W2 ▶ ISSACS/Internal (Verify W2>ISSACS/Internal)

Verify SSRMS is in the SSRMS Stow position (within 5cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
X	Y	Z	Pitch	Yaw	Roll	
+596	+1437	-601	-144.8	-64.0	-25.8	
FOR	Unloaded – LEE Tip, SY Held					
Disp	W2>ISSACS					

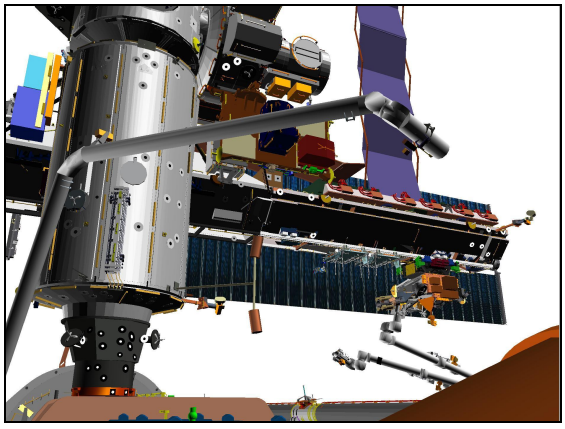

Figure 1.- SSRMS Stow
(92: Camera B: +25, +20).

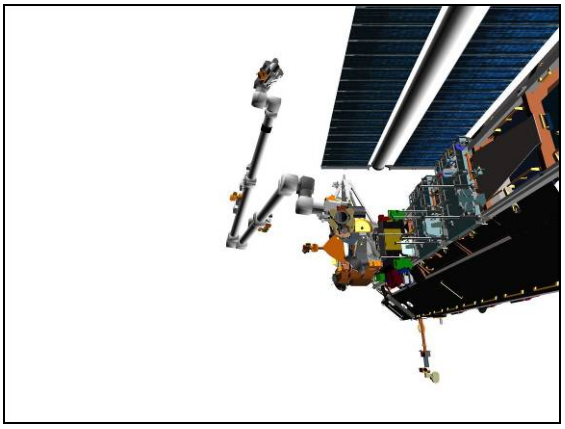

Figure 2.- SSRMS Stow
(13: LAB Stbd Zenith: 0, +90).

2. ESP2 CLEARANCE

PCS MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

PCS MSS: SSRMS: SSRMS

RHC RATE → VERNIER (Verify Vernier on PCS)

2.1 Joint OCAS Maneuver to Intermediate Position

MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

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

SR	SY	SP	EP	WP	WY	WR
-180.0	+160.1	-150.8	+113.3	-173.1	+215.0	+92.7

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	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
TGT	**-180.0**	**+160.1**	**-150.8**	**+113.3**	**-173.1**	**+215.0**	**+92.7**
ERR	0.0	-64.1	-32.2	+33.4	+44.2	-39.6	+32.7

****

* If joint angles or errors are incorrect

PCS * | **cmd** Cancel (Verify Sequence Status – Waiting Destination)

*

* | Input correct Dest joint angles per table above.

*

* | **cmd** Load (Verify Sequence Status – Confirm or Cancel)

*

MON * | Verify joint angles and errors are correct on Joint Angle Position

* | overlay.

****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-180.0	+160.1	-150.8	+113.3	-173.1	+215.0	+92.7

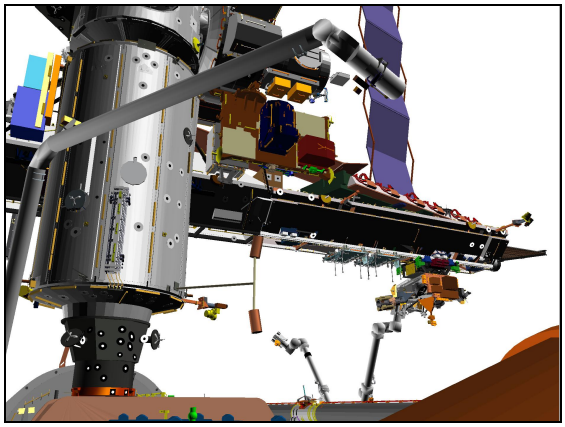

Figure 3.- Intermediate
(92: Camera B: +25, +20).

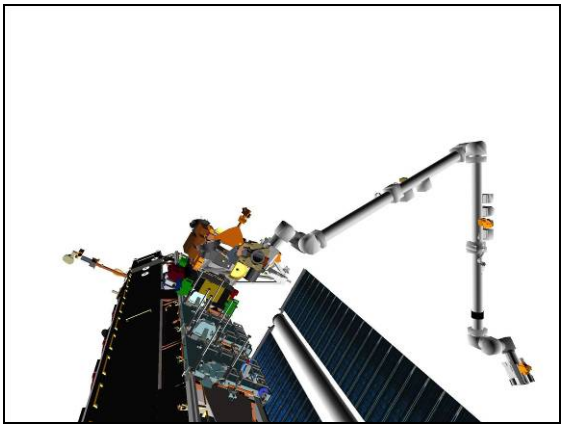

Figure 4.- Intermediate
(13: LAB Stbd Zenith: 120, +90).

2.2 Single Joint Maneuver to ESP2 Clearance

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → Shoulder Roll (Verify SR – Selected on PCS)

NOTE

During this maneuver, the distance between the SP and the POA can be as low as 20 inches and can be monitored with the Base Elbow Camera.

THC Perform "+" Single Joint maneuver to SR: +71.1 (THC up).

Verify SSRMS at ESP2 Clearance position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+71.1	+160.1	-150.8	+113.3	-173.1	+215.0	+92.7
X	Y	Z	Pitch	Yaw	Roll	
+446	+659	+440	-114.2	-2.1	+20.6	
FOR	Unloaded – LEE Tip, SY Held					
Disp	W2>ISSACS					

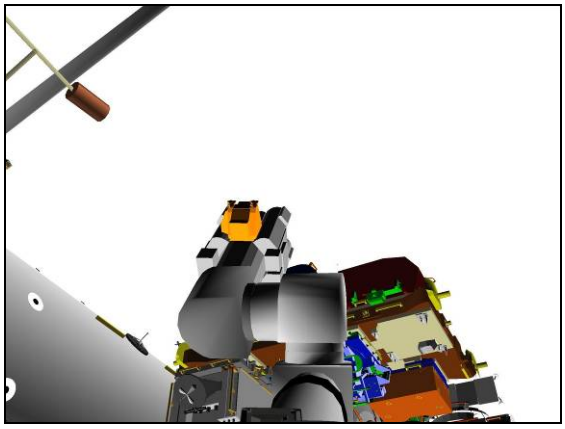

Figure 5.- ESP2 Clearance
(24: Tip Elbow: -5, +10).

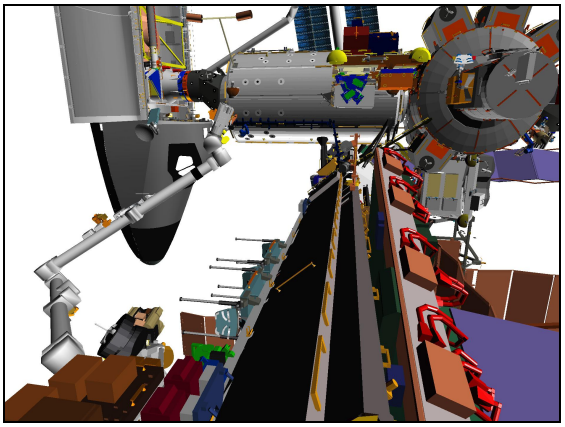

Figure 6.- ESP2 Clearance
(03: S1 Lower Outboard: +80, -15).

3. APFR INSTALL
On EVA Go,

PCS — MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC — Maneuver SSRMS to APFR Install position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
+77.3	+160.1	-129.4	+107.6	-182.9	+217.7	+99.1
X	Y	Z	Pitch	Yaw	Roll	
+186	+659	+470	-114.2	-2.1	+20.6	
FOR	Unloaded – LEE Tip, SY Held					
Disp	W2>ISSACS					

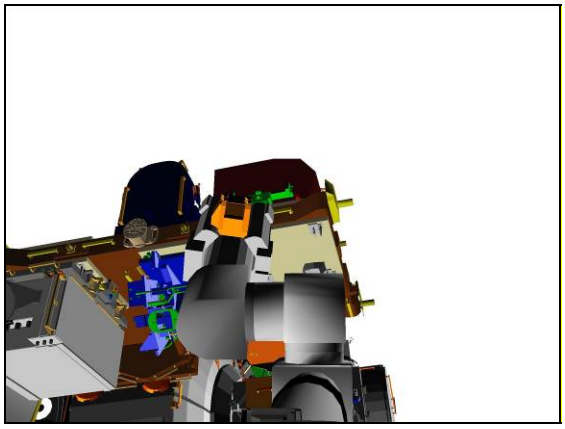

Figure 7.- APFR Install
(24: Tip Elbow: -5, +10).

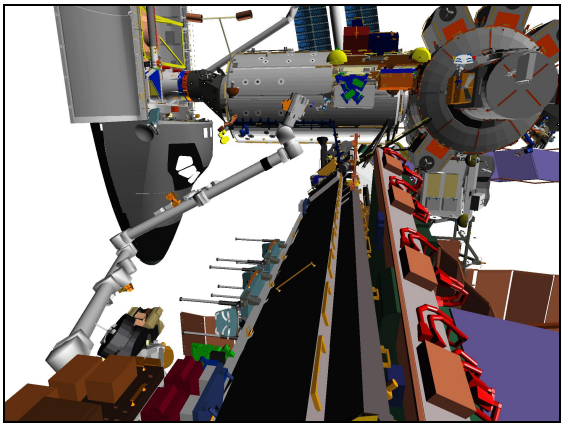

Figure 8.- APFR Install
(03: S1 Lower Outboard: +80, -15).

THC/ RHC Maneuver SSRMS per EVA GCA to install the APFR.

4. APFR INGRESS
When APFR Install complete and on EVA Go,

THC/ RHC Maneuver SSRMS to APFR Ingress position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
+74.3	+160.1	-137.4	+110.2	-180.3	+216.5	+96.0
X	Y	Z	Pitch	Yaw	Roll	
+286	+659	+470	-114.2	-2.1	+20.6	
FOR	Unloaded – LEE Tip, SY Held					
Disp	W2>ISSACS					

THC/ RHC Maneuver SSRMS per EVA GCA to ingress the APFR.

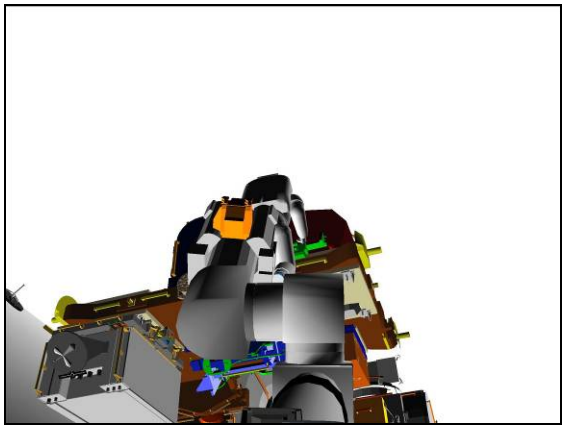

Figure 9.- APFR Ingress
(24: Tip Elbow: -5, +10).

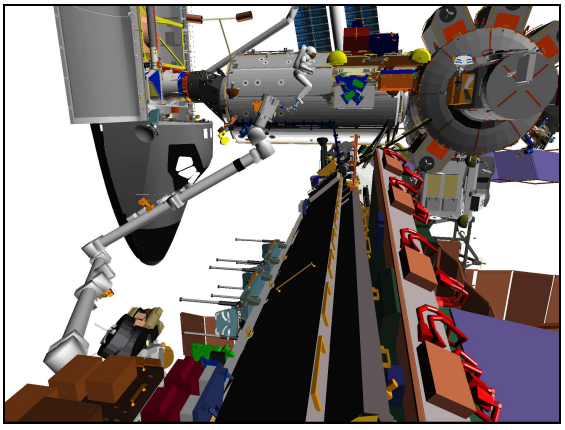

Figure 10.- APFR Ingress
(03: S1 Lower Outboard: +80, -15).

5. FGB REMOVAL

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
92: Camera D (+90, +120) 91: SRMS Elbow (-75, +35)	24: Tip Elbow (-5, +10) 22: Base Elbow (0, 0)	03: S1 Lower Outboard (+80, -15) 13: LAB Stbd Zenith (+60, 0)

When EVA Ingress complete and on EVA Go,

PCS MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

Change Unloaded Parameters ▶ EVA ▶ Chest 12/PP/F/6 SYH
Verify 'Unloaded Parameters' (two) – Chest 12/PP/F/6, SY Held

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC Maneuver SSRMS to FGB Removal position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
+79.9	+160.1	-135.7	+86.4	-152.7	+218.7	+102.0
X	Y	Z	Pitch	Yaw	Roll	
+211	+350	+480	+155.7	-3.6	-2.1	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	W2>ISSACS					

NOTE
At this position, the distance between the SSRMS Wrist Cluster and the LAB Camera is approximately 38 inches. This clearance can be monitored using the Tip Elbow Camera.

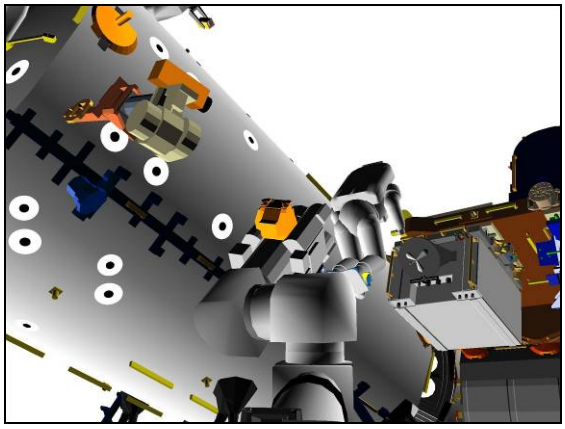

Figure 11.- FGB Removal
(24: Tip Elbow: -5, +10).

Figure 12.- FGB Removal
(03: S1 Lower Outboard: +80, -15).

THC/ RHC — Maneuver SSRMS per EVA GCA to remove the FGB.

6. FGB INSTALL
On EVA Go,

THC/ RHC — Maneuver SSRMS to FGB Install position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
+119.1	+160.1	-177.0	+147.8	-128.2	+218.5	+149.6
X	Y	Z	Pitch	Yaw	Roll	
+290	+950	0	+155.7	-3.6	-2.1	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	W2>ISSACS					

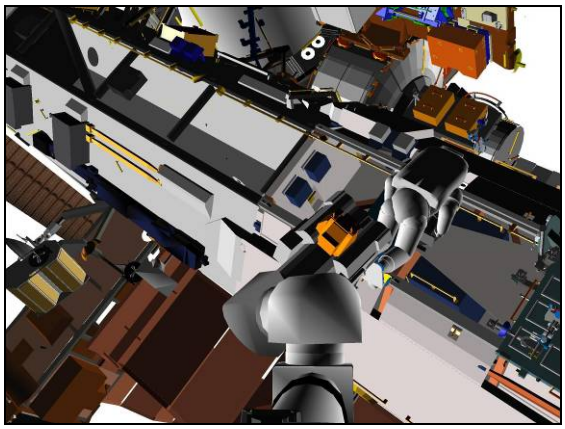

Figure 13.- FGB Install
(24: Tip Elbow: -5, +10).

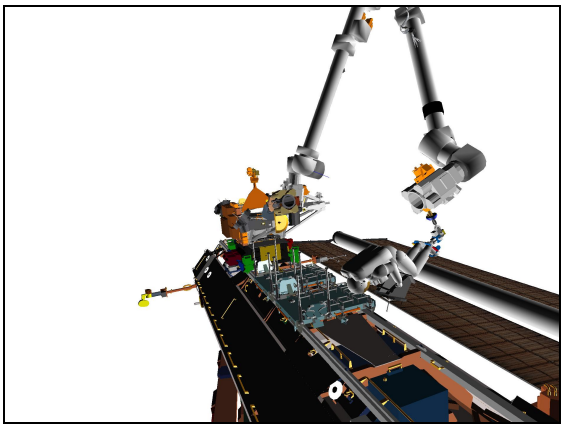

Figure 14.- FGB Install
(13: LAB Stbd Zenith: +85, +80).

THC/ RHC — Maneuver SSRMS per EVA GCA to install the FGB on the failed Pump Module.

7. FAILED PUMP MODULE REMOVAL
On EVA Go,

THC/ RHC — Maneuver SSRMS to Pump Module Removal position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
+126.2	+160.1	-176.7	+145.1	-118.8	+215.6	+157.1
X	Y	Z	Pitch	Yaw	Roll	
+290	+950	-80	+155.7	-3.6	-2.1	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	W2>ISSACS					

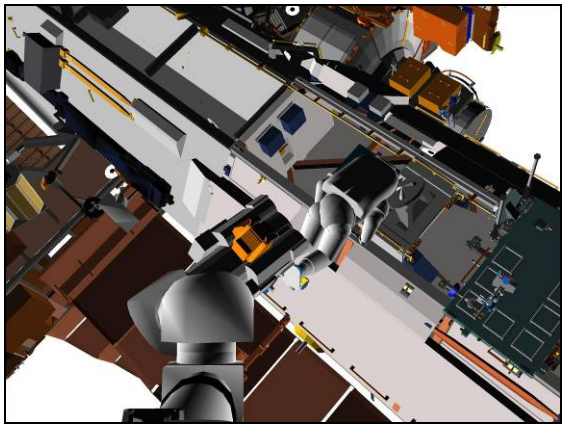

Figure 15.- Pump Module Removal
(24: Tip Elbow: +5, +10).

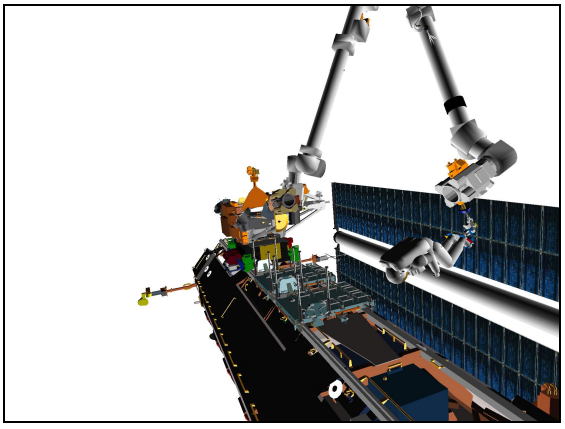

Figure 16.- Pump Module Removal
(13: LAB Stbd Zenith: +85, +80).

THC/ RHC — Maneuver SSRMS per EVA GCA to allow EVA to get a firm grip on the failed Pump Module.

8. TRUSS CLEARANCE POSITION
On EVA Go,

THC/ RHC — Maneuver SSRMS to Truss Clearance position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
+119.4	+160.1	-199.1	+140.2	-98.2	+218.4	+149.9
X	Y	Z	Pitch	Yaw	Roll	
+490	+950	-80	+155.7	-3.6	-2.1	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	W2>ISSACS					

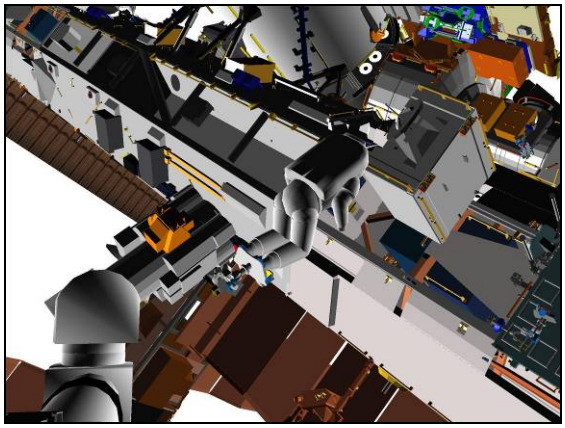

Figure 17.- Truss Clearance
(24: Tip Elbow: +15, +10).

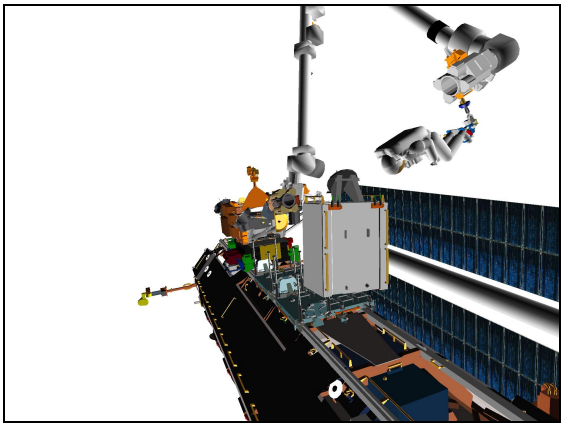

Figure 18.- Truss Clearance
(13: LAB Stbd Zenith: +85, +80).

THC/ RHC — Maneuver SSRMS per EVA GCA to move the Pump Module clear of the truss.

Pause to allow EV Crew to reposition pump module so that the bottom Handrails are being held and the pump module is parallel to the EV with the FGB at the crew's head.

9. FAILED PUMP MODULE HANDOFF

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (-45, +5)	24: Tip Elbow (+15, +10) 22: Base Elbow (+160, 0)	13: LAB Stbd Zenith (+85, +80) 03: S1 Lower Outboard (+70, -10)

PCS — MSS: SSRMS: SSRMS

√Vernier

9.1 Single Joint Maneuver

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP — JOINT SELECT → Shoulder Roll (Verify SR – Selected on PCS)

THC — Perform "-" Single Joint maneuver to SR: +30.7 (THC down).

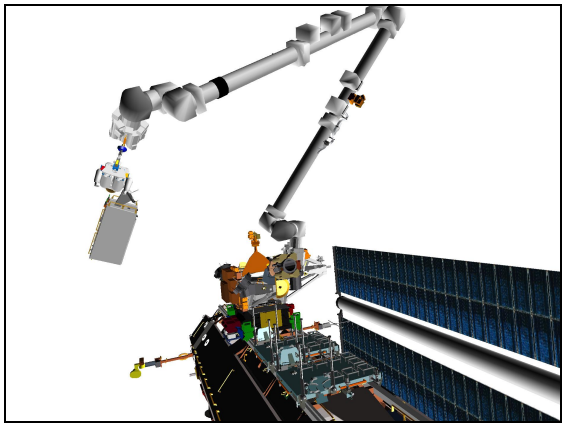

Figure 19.- Intermediate 2
(13: LAB Stbd Zenith: +85, +90).

9.2 Joint OCAS Maneuver to Handoff

MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Handoff position.

SR	SY	SP	EP	WP	WY	WR
+30.7	+160.1	-102.6	+20.2	-149.9	+161.2	+147.6

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)	+30.7	+160.1	-199.1	+140.2	-98.2	+218.4	+149.9
TGT	**+30.7**	**+160.1**	**-102.6**	**+20.2**	**-149.9**	**+161.2**	**+147.6**
ERR	0.0	0.0	-96.5	+120.0	+51.7	+57.2	+2.3

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
+30.7	+160.1	-102.6	+20.2	-149.9	+161.2	+147.6

DCP BRAKES SSRMS → ON (Verify ON)

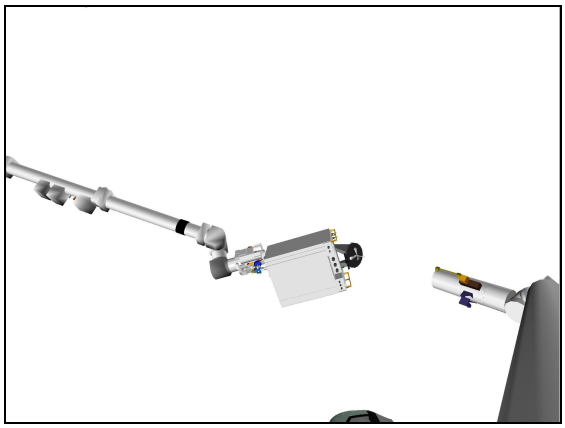

Figure 20.- Handoff
(91: SRMS Elbow: -35, +5).

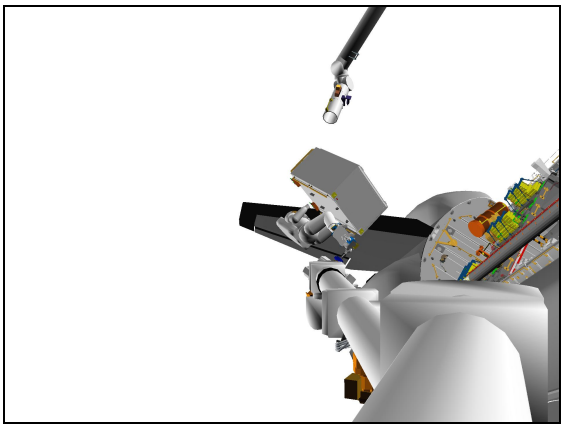

Figure 21.- Handoff
(22: Base Elbow: +160, 0).

Give SRMS operator a go to move in for grapple and alert EVA to SRMS motion.

When SRMS grapple is complete

Give EVA a go to release Pump Module Handrails so that the SRMS can maneuver to the Clearance position.

Verify that the SRMS clearance maneuver is complete before initiating SSRMS motion.

10. SPARE PUMP MODULE RETRIEVAL

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (-35, +45) 92: Camera B (+25, +20)	22: Base Elbow (+160, 0) 37: MBS Mast (+15, 0)	03: S1 Lower Outboard (+50, +30) 13: LAB Stbd Zenith (0, +90)

10.1 Joint OCAS Maneuver to Intermediate
On EVA and SRMS Operator Go,

DCP BRAKES SSRMS → OFF (Verify OFF)

PCS MSS: SSRMS: [SSRMS]

Enter Mode – Joint OCAS (Verify blue)

[SSRMS Joint OCAS]

Input 'Joint Angles' 'Destination' for Intermediate 3 position.

SR	SY	SP	EP	WP	WY	WR
+30.7	+160.1	-135.7	+86.4	-152.7	+218.7	+102.0

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)	+30.7	+160.1	-102.6	+20.2	-149.9	+161.2	+147.6
TGT	**+30.7**	**+160.1**	**-135.7**	**+86.4**	**-152.7**	**+218.7**	**+102.0**
ERR	0.0	0.0	+33.1	-66.2	+2.8	-57.5	+45.6

****
* If joint angles or errors are incorrect
PCS * | **cmd** Cancel (Verify Sequence Status – Waiting Destination)
* |
* | Input correct Dest joint angles per table above.
* |
* | **cmd** Load (Verify Sequence Status – Confirm or Cancel)
* |
MON * | Verify joint angles and errors are correct on Joint Angle Position
* | overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: [SSRMS]

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
+30.7	+160.1	-135.7	+86.4	-152.7	+218.7	+102.0

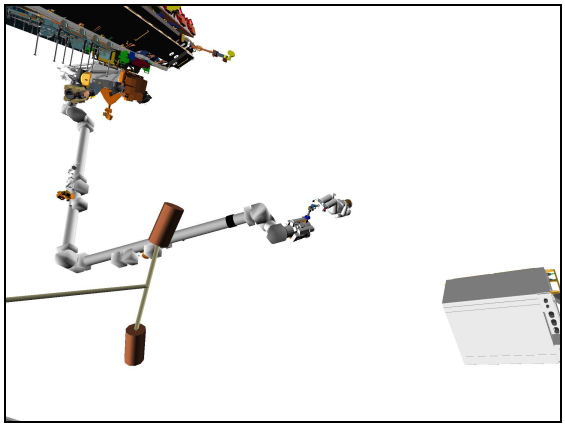

Figure 22.- Intermediate 3
(91: SRMS Elbow: -50, +10).

10.2 Single Joint Maneuver

PCS MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → Shoulder Roll (Verify SR – Selected on PCS)

THC Perform "+" Single Joint maneuver to SR: +79.9 (THC up).

Verify SSRMS at Spare Pump Module Retrieval position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+79.9	+160.1	-135.7	+86.4	-152.7	+218.7	+102.0
X	Y	Z	Pitch	Yaw	Roll	
+211	+350	+480	+155.7	-3.6	-2.1	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	W2>ISSACS					

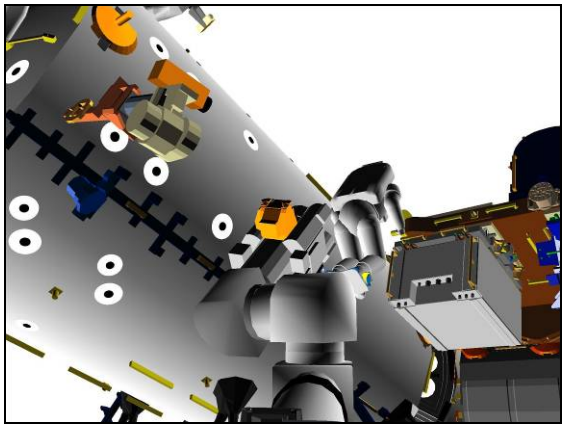

Figure 23.- Spare Pump Module Retrieval
(24: Tip Elbow: -5, +10).

PCS MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC Maneuver SSRMS per EVA GCA to allow EVA to get a secure grip on the spare pump module.

11. ESP2 CLEARANCE POSITION
On EVA Go,

THC/ RHC Maneuver SSRMS per EVA GCA to pull the pump module off the FRAM.

NOTE

1. Note that during the X motion of the clearance maneuver, the distance between the SSRMS Wrist and the LAB Camera (when the Lab Camera is pointed at the ESP2) can be as low as 16 inches. The clearance between the pump module and the edge of the FRAM can be as low as 2 inches. The Z maneuver to the clearance position increases these distances.

2. During the Y maneuver, the distance between the Pump Module and the FSE can be as low as 14 inches. These clearances can be monitored with the MBS Mast Camera.

THC/ RHC — Maneuver SSRMS to ESP2 Clearance position (within 5 cm/1 deg).

		Locked					
	SR	SY	SP	EP	WP	WY	WR
	+79.9	+160.1	-135.7	+86.4	-152.7	+218.7	+102.0
	X	Y	Z	Pitch	Yaw	Roll	
Pump Module Retrieval	+211	+350	+480	+155.7	-3.6	-2.1	
1: X +	+270						
2: Z –			+380				
3: Y +		+650					
ESP2 Clearance	+270	+650	+380	+155.7	-3.6	-2.1	
	SR	SY	SP	EP	WP	WY	WR
	+82.4	+160.1	-154.1	+119.9	-165.2	+219.5	+104.8
	FOR	Unloaded – Chest 12/PP/F/6, SY Held					
	Disp	W2>ISSACS					

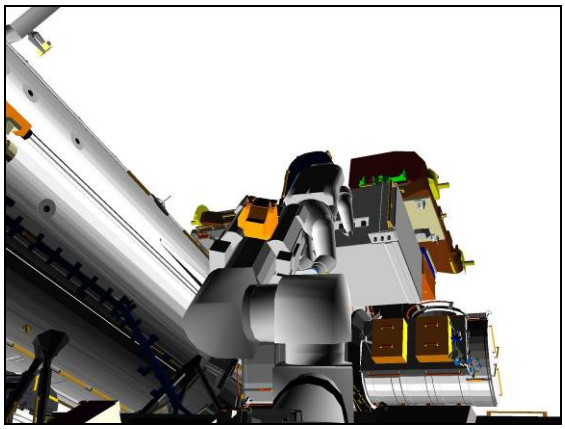

Figure 24.- ESP2 Clearance
(24: Tip Elbow: -5, +10).

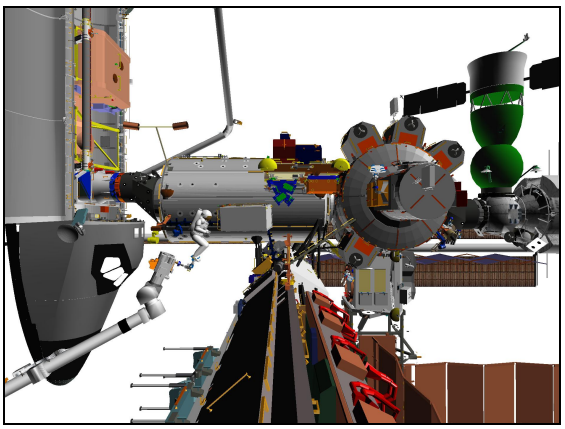

Figure 25.- ESP2 Clearance
(03: S1 Lower Outboard: +90, 0).

12. SPARE PUMP MODULE INSTALL
On EVA Go,

THC/ RHC — Maneuver SSRMS to Spare Pump Module Install position (within 5 cm/1 deg).

		Locked					
	SR	SY	SP	EP	WP	WY	WR
	+82.4	+160.1	-154.1	+119.9	-165.2	+219.5	+104.8
	X	Y	Z	Pitch	Yaw	Roll	
ESP2 Clearance	+270	+650	+380	+155.7	-3.6	-2.1	
1: X +	+420						
2: Y +		+950					
3: Z –			0				
Spare Pump Module Install	+420	+950	0	+155.7	-3.6	-2.1	
	SR	SY	SP	EP	WP	WY	WR
	+114.2	+160.1	-193.8	+145.5	-114.3	+220.1	+144.0
	FOR	Unloaded – Chest 12/PP/F/6, SY Held					
	Disp	W2>ISSACS					

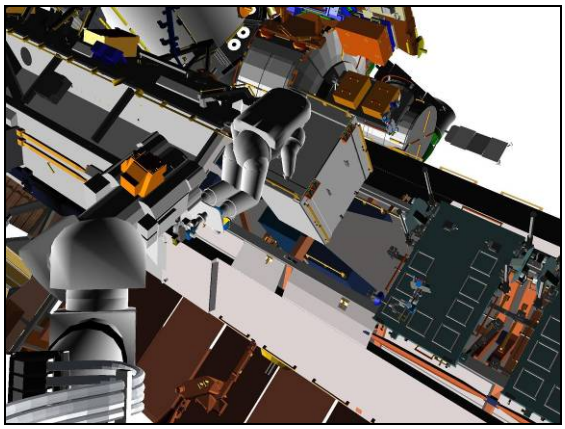

Figure 26.- Spare Pump Module Install (24: Tip Elbow: -5, +10).

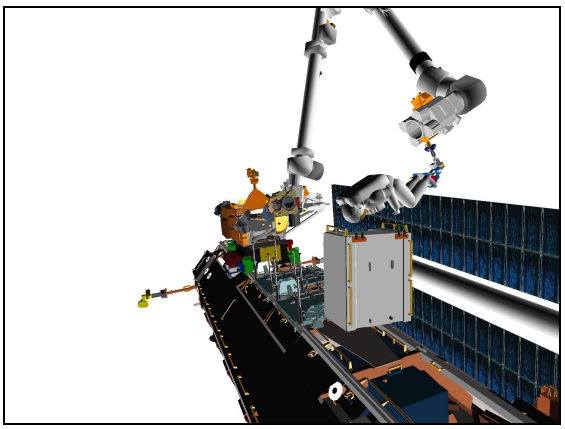

Figure 27.- Spare Pump Module Install (13: LAB Stbd Zenith: +85, +80).

THC/ RHC — Maneuver SSRMS per EVA GCA to install the spare Pump Module in the truss.

13. TRUSS CLEARANCE

When pump module install is complete and on EVA Go,

THC/ RHC — Maneuver SSRMS to the Truss Clearance position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
+120.9	+160.1	-169.7	+147.9	-133.7	+217.8	+151.6
X	Y	Z	Pitch	Yaw	Roll	
+240	+950	0	+155.7	-3.6	-2.1	
FOR	Unloaded – LEE Tip, SY Held					
Disp	W2>ISSACS					

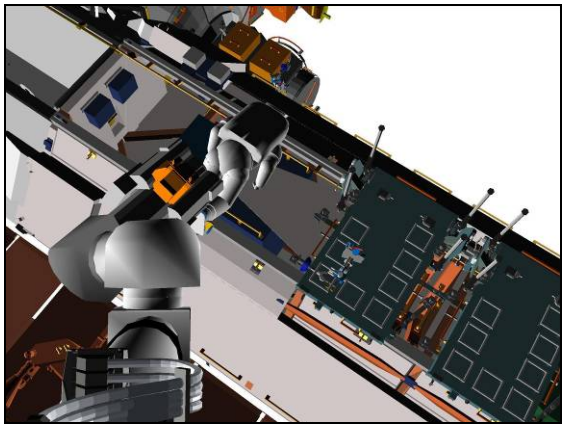

Figure 28.- Truss Clearance
(24: Tip Elbow: +10, +5).

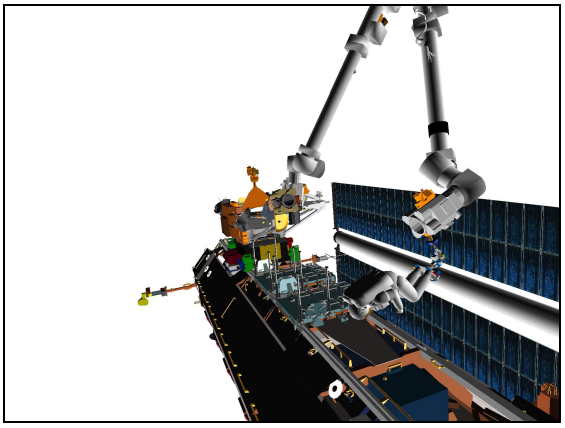

Figure 29.- Truss Clearance
(13: LAB Stbd Zenith: +85, +80).

14. FAILED PUMP MODULE RETRIEVAL

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (-45, +5) 92: Camera B (+25, +10)	24: Tip Elbow (+10, +5) 22: Base Elbow (+160, 0)	03: S1 Lower Outboard (+70, 0) 37: MBS Mast (+10, -10)

On EVA Go,

PCS — MSS: SSRMS: SSRMS

√Vernier

14.1 Single Joint Maneuver

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → Shoulder Roll (Verify SR – Selected on PCS)

THC Perform "-" Single Joint maneuver to SR: +25.5 (THC down).

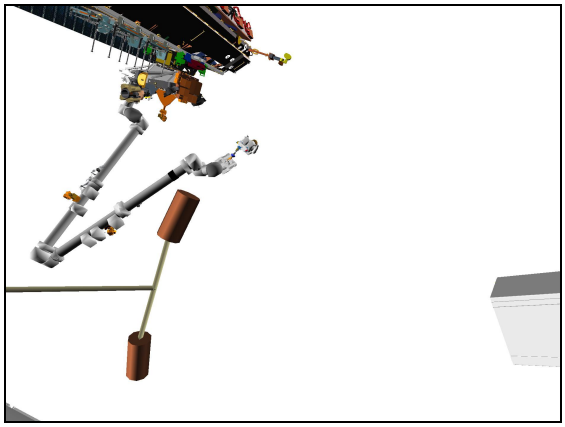

Figure 30.- Intermediate 4
(91: SRMS Elbow: -55, +10).

14.2 Joint OCAS Maneuver to Handoff Clearance

MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Handoff position.

SR	SY	SP	EP	WP	WY	WR
+25.5	+160.1	-111.4	+41.0	-162.4	+157.3	+144.4

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)	+25.5	+160.1	-169.7	+147.9	-133.7	+217.8	+151.6
TGT	**+25.5**	**+160.1**	**-111.4**	**+41.0**	**-162.4**	**+157.3**	**+144.4**
ERR	0.0	0.0	-58.3	+106.9	+28.7	+60.5	+7.2

****
* If joint angles or errors are incorrect

PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*

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

****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
+25.5	+160.1	-111.4	+41.0	-162.4	+157.3	+144.4

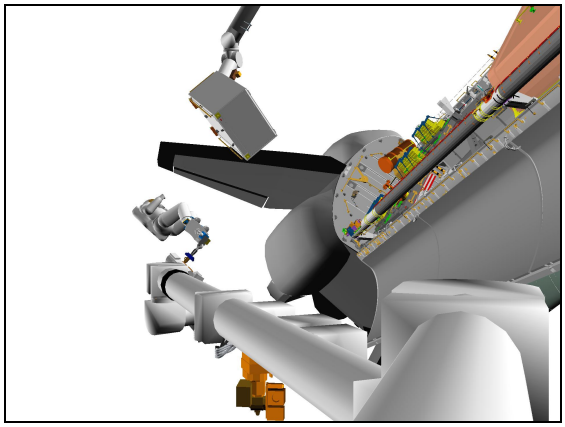

Figure 31.- Handoff Clearance
(22: Base Elbow: +160, 0).

Give SRMS operator a go to maneuver to the Handoff position.

When the SRMS is in position,

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC — Maneuver per EVA GCA to allow EVA to obtain a secure grip on the failed pump module.

When EVA has obtained a firm grip
Give the SRMS operator a go to release the failed pump module and maneuver to the clearance position.

Verify that the SRMS is in the clearance position before initiating SSRMS motion.

15. AUTOSEQUENCE START
On EVA Go,

THC/ RHC — Maneuver to Autosequence Start position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
+25.5	+160.1	-111.4	+41.0	-162.4	+157.3	+144.4
X	Y	Z	Pitch	Yaw	Roll	
+446	+800	+1423	+61.3	-70.3	-73.2	
FOR	Unloaded – Ch12PPF6, SY Held					
Disp	ISS>ISSACS					

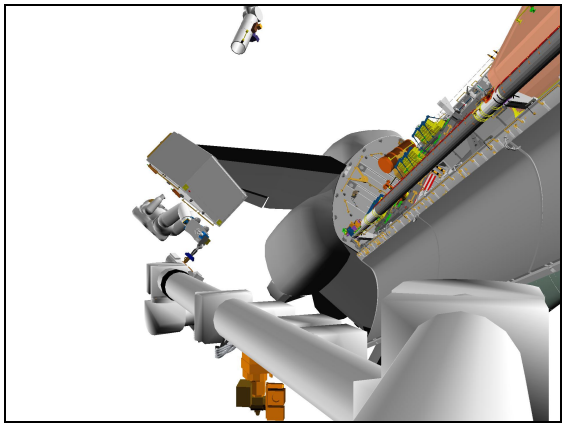

Figure 32.- Autosequence Start
(22: Base Elbow: 160, 0).

16. FAILED PUMP MODULE INSTALL ON ESP2
When SRMS is in position and on EVA Go,

16.1 Joint OCAS Maneuver to Intermediate

MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Intermediate 5 position.

SR	SY	SP	EP	WP	WY	WR
+25.5	+160.1	-150.9	+118.2	-169.3	+218.7	+101.9

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)	+25.5	+160.1	-111.4	+41.0	-162.4	+157.3	+144.4
TGT	**+25.5**	**+160.1**	**-150.9**	**+118.2**	**-169.3**	**+218.7**	**+101.9**
ERR	0.0	0.0	+39.5	-77.2	+6.9	-61.4	+42.5

****
* If joint angles or errors are incorrect
PCS * | **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* | Input correct Dest joint angles per table above.
*
* | **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * | Verify joint angles and errors are correct on Joint Angle Position
* | overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
+25.5	+160.1	-150.9	+118.2	-169.3	+218.7	+101.9

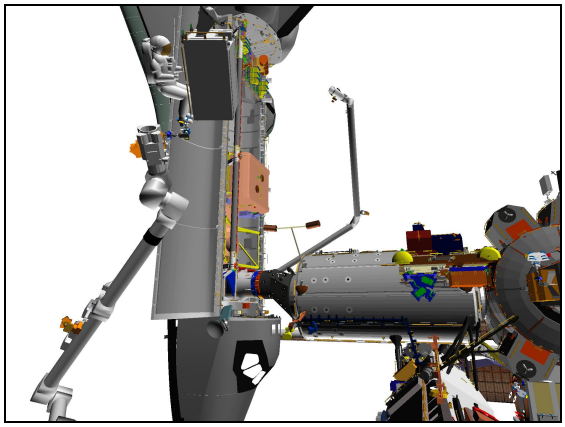

Figure 33.- Intermediate 5
(03: S1 Lower Outboard: +90, 0).

16.2 Single Joint Maneuver

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → Shoulder Roll (Verify SR – Selected on PCS)

THC Perform "+" Single Joint maneuver to SR: +79.8 (THC up).

NOTE

Note that at this position, the clearances are the following:

(a) FGB to ESP2 is approximately 43 inches
(b) FGB to FSE is approximately 26 inches
(c) Pump Module to S0 is approximately 43 inches

Verify SSRMS at Failed Pump Module Install Clearance position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+79.8	+160.1	-150.9	+118.2	-169.3	+218.7	+101.9
X	Y	Z	Pitch	Yaw	Roll	
+250	+650	+430	+155.7	-3.6	-2.1	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	W2>ISSACS					

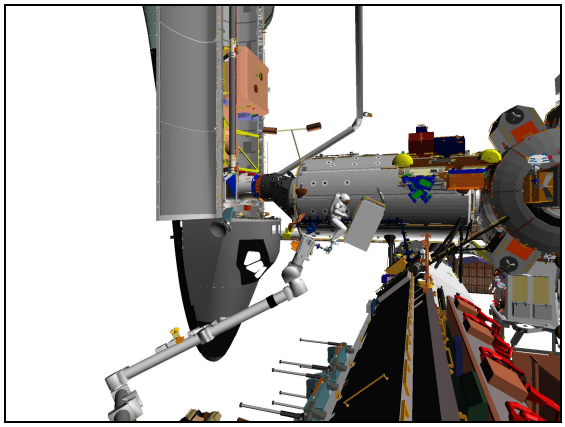

Figure 34.- Failed Pump Module Install Clearance
(03: S1 Lower Outboard: +70, 0).

16.3 Manual Maneuver

PCS MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

NOTE
At this position, the distance between the SSRMS Wrist Cluster and the LAB Camera is approximately 25 inches. This clearance can be monitored using the Tip Elbow Camera.

THC/ RHC Maneuver SSRMS to the Failed Pump Module Install position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
+81.3	+160.1	-139.4	+88.4	-149.5	+219.2	+103.6
X	Y	Z	Pitch	Yaw	Roll	
+250	+350	+430	+155.7	-3.6	-2.1	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	W2>ISSACS					

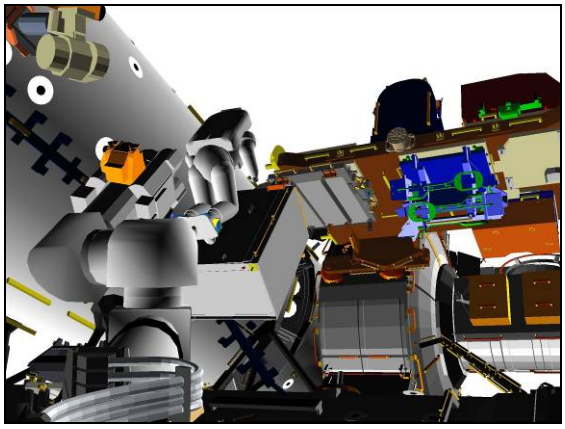

Figure 35.- Failed Pump Module Install
(24: Tip Elbow: +10, +5).

Pause to allow EV Crew to reorient pump module to be installed on ESP2.

THC/ RHC — Maneuver SSRMS per EVA GCA to install the failed pump module on ESP2.

17. APFR EGRESS

When pump module install is complete and on EVA Go,

THC/ RHC — Maneuver SSRMS to the APFR Egress position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
+74.3	+160.1	-137.4	+110.3	-180.5	+216.5	+95.9
X	Y	Z	Pitch	Yaw	Roll	
+141	+650	+580	+155.7	-3.6	-2.1	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	W2>ISSACS					

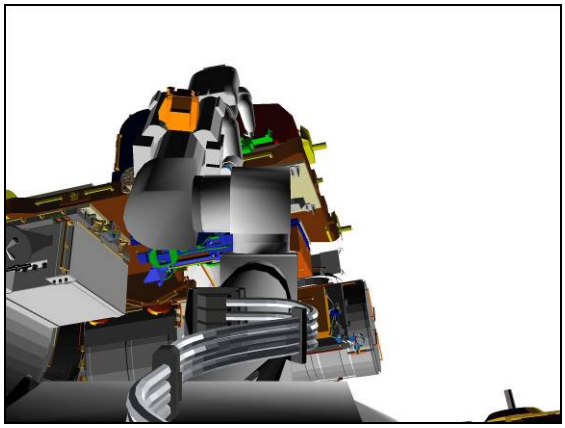

Figure 36.- APFR Egress
(24: Tip Elbow: 0, 0).

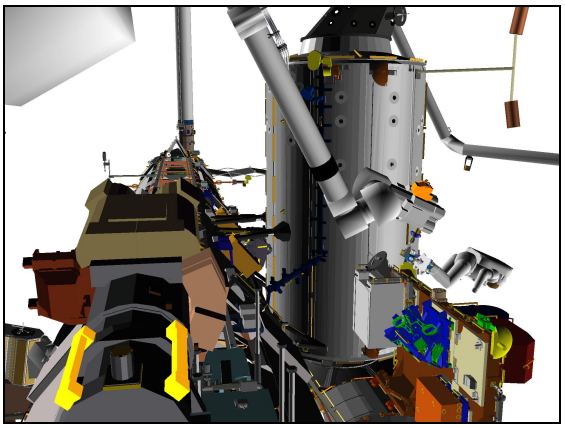

Figure 37.- APFR Egress
(37: MBS Mast: +10, -10).

THC/ RHC Maneuver SSRMS per EVA GCA to egress the APFR.

18. APFR REMOVAL
After APFR egress complete and on EVA Go,

MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

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

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC Maneuver SSRMS to the APFR Removal position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
+77.3	+160.1	-129.4	+107.8	-183.0	+217.7	+99.1
X	Y	Z	Pitch	Yaw	Roll	
+186	+661	+470	-114.2	-2.1	+20.6	
FOR	Unloaded – LEE Tip, SY Held					
Disp	W2>ISSACS					

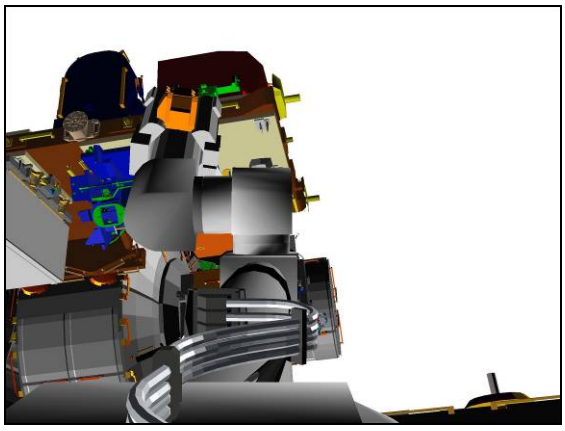

Figure 38.- APFR Removal
(24: Tip Elbow: 0, 0).

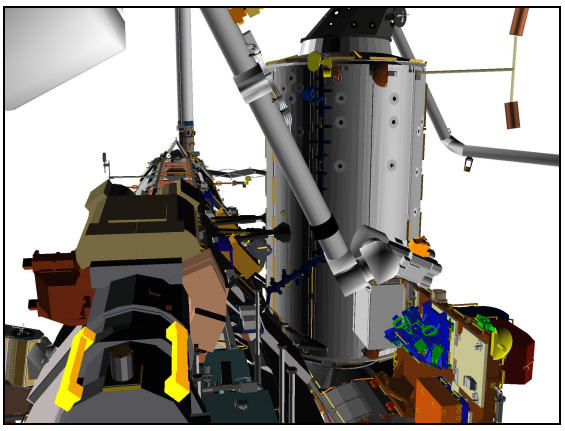

Figure 39.- APFR Removal
(37: MBS Mast: +10, -10).

THC/ RHC Maneuver SSRMS per EVA GCA to remove the APFR.

19. ESP2 CLEARANCE
After APFR removed and on EVA Go,

THC/ RHC — Maneuver SSRMS to the ESP2 Clearance position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
+71.1	+160.1	-150.8	+113.3	-173.1	+215.0	+92.7
X	Y	Z	Pitch	Yaw	Roll	
+446	+659	+440	-114.2	-2.1	+20.6	
FOR	Unloaded – LEE Tip, SY Held					
Disp	W2>ISSACS					

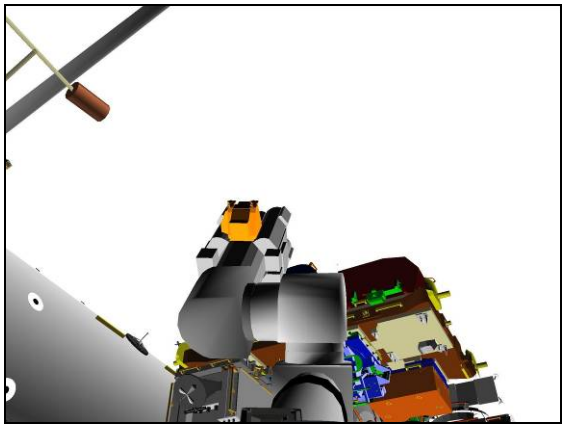

Figure 40.- ESP2 Clearance
(24: Tip Elbow: -5, +10).

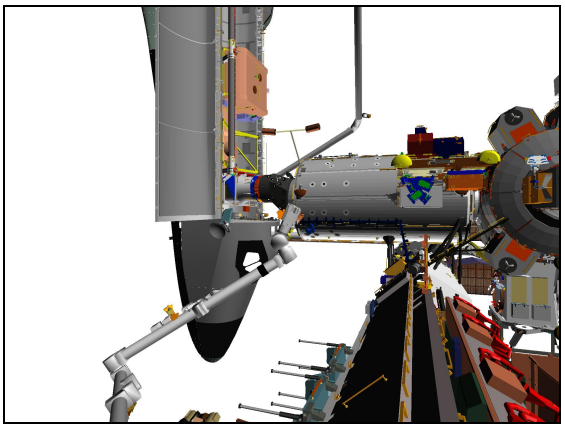

Figure 41.- ESP2 Clearance
(03: S1 Lower Outboard: +70, 0).

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)

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: Camera D (-20, +60) 92: SRMS Elbow (-125, -10)	13: LAB Stbd Zenith (+45, -20) 37: MBS Mast (+100, -20)	22: Base Elbow (+95, 0) 03: S1 Lower Outboard (+90, +20)

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

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

Change Command ▶ ISS ▶ ISSACS/Internal (Verify ISS>ISSACS/Internal)

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

SR	SY	SP	EP	WP	WY	WR
-73.4	-190.0	-125.5	+107.3	-119.2	-201.3	+111.3
X	Y	Z	Pitch	Yaw	Roll	
+285	+679	+1003	+92.8	-4.7	-164.1	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

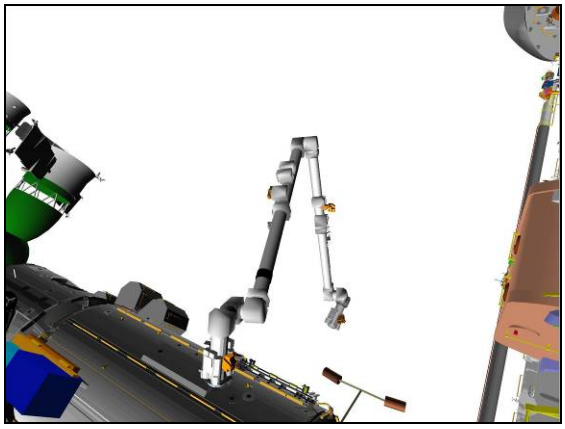

Figure 1.- SSRMS Overnight Park (92: SRMS Elbow: -125, -10).

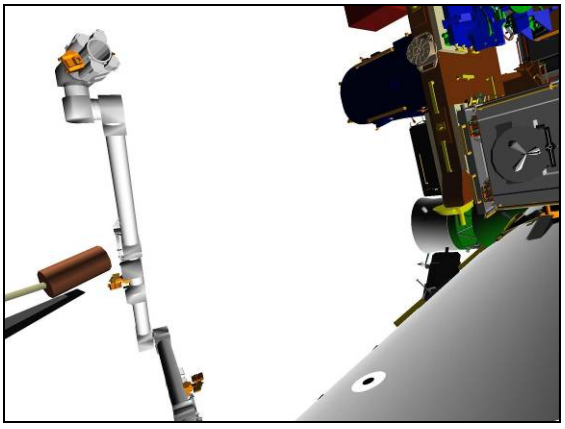

Figure 2.- SSRMS Overnight Park (13: LAB Stbd Zenith: +45, -20).

2. APFR INSTALL

PCS MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → VERNIER (Verify Vernier on PCS)

PCS MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

On EVA Go,

THC/ RHC Maneuver to APFR Install position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-48.0	-190.0	-85.5	+108.4	-166.9	-217.4	+133.5
X	Y	Z	Pitch	Yaw	Roll	
+185	+679	+454	+92.8	-4.7	-164.1	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

THC/ RHC Maneuver SSRMS per EVA GCA to install the APFR.

NOTE

1. APFR Setting is 12/PP/F/6.
2. The clearance between the Upper Boom and the FHRC is approximately 20 inches at this position and can be monitored with the S1 Lower Outboard Camera.

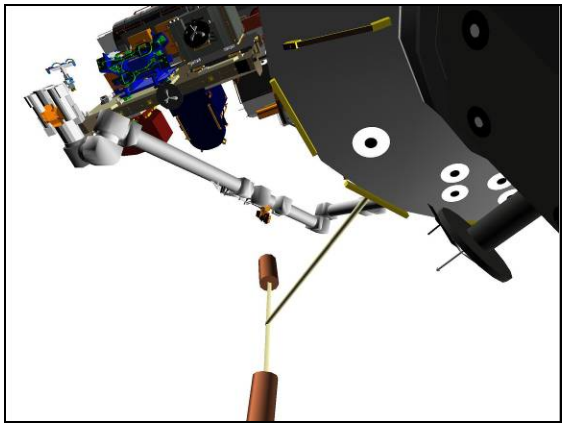

Figure 3.- APFR Install
(91: Camera D: -30, +50).

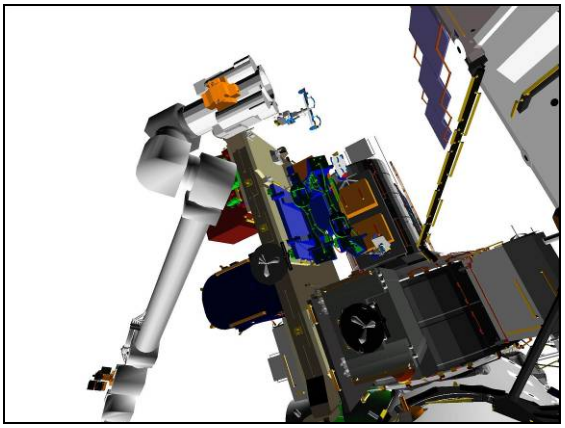

Figure 4.- APFR Install
(13: LAB Stbd Zenith: +65, +10).

3. APFR INGRESS
After APFR Installation and on EVA go,

THC/ RHC — Maneuver to APFR Ingress position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-63.9	-190.0	-106.4	+113.0	-145.5	-207.6	+118.9
X	Y	Z	Pitch	Yaw	Roll	
+255	+679	+703	+92.8	-4.7	+164.1	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

THC/ RHC — Maneuver SSRMS per EVA GCA to Ingress APFR.

NOTE
The clearance between the Upper Boom and the FHRC is approximately 21 inches at this position and can be monitored with the S1 Lower Outboard Camera.

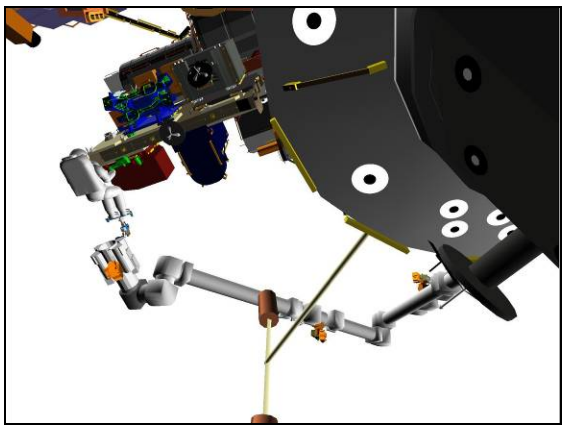

Figure 5.- APFR Ingress
(91: Camera D: -20, +60).

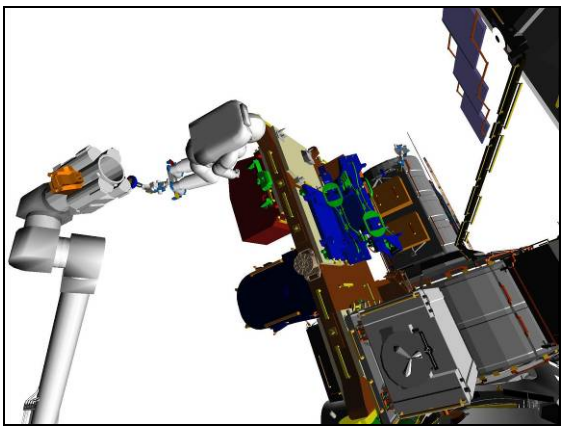

Figure 6.- APFR Ingress
(13: LAB Stbd Zenith: +60, +10).

4. FGB REMOVAL
When APFR ingress is complete and on EVA Go,

PCS — MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

Change Unloaded Parameters ▶ EVA ▶ Chest 12/PP/F/6 SYH
Verify 'Unloaded Parameters' (two) – Chest 12/PP/F/6, SY Held

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC Maneuver to FGB Removal position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-52.6	-190.0	-111.8	+140.3	-170.6	-214.7	+129.0
X	Y	Z	Pitch	Yaw	Roll	
+160	+364	+500	-177.1	-1.1	-175.3	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	ISS>ISSACS					

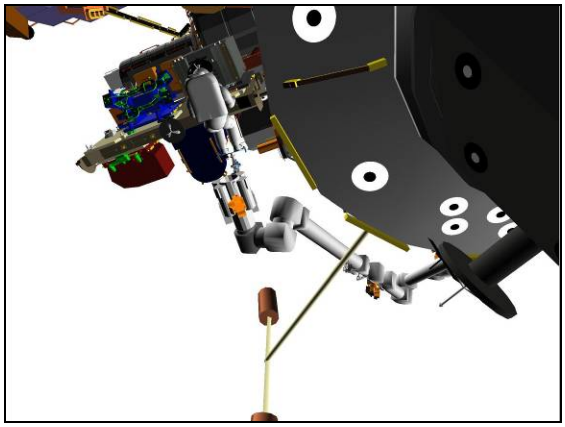

Figure 7.- FGB Removal
(91: Camera D: -20, +60).

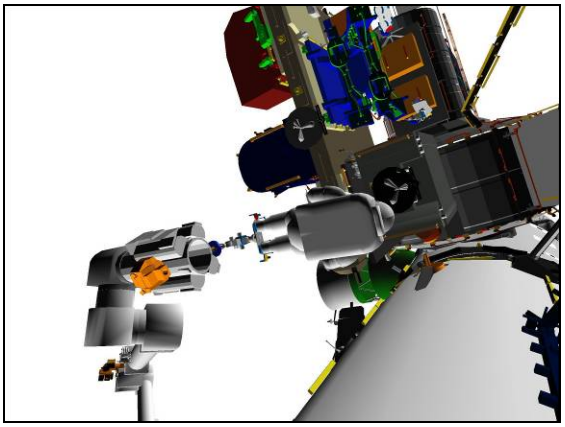

Figure 8.- FGB Removal
(13: LAB Stbd Zenith: +60, -10).

THC/ RHC Maneuver SSRMS per EVA GCA to remove the FGB and maneuver clear of the pump module.

5. ESP2 CLEARANCE
When FGB is clear of pump module, and on EVA go,

THC/ RHC Maneuver to ESP2 Clearance position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-66.6	-190.0	-145.1	+134.8	-128.0	-205.8	+116.7
X	Y	Z	Pitch	Yaw	Roll	
+160	+364	+800	-177.1	-1.1	-175.3	
FOR	Unloaded – Ch12PPF6, SY Held					
Disp	ISS>ISSACS					

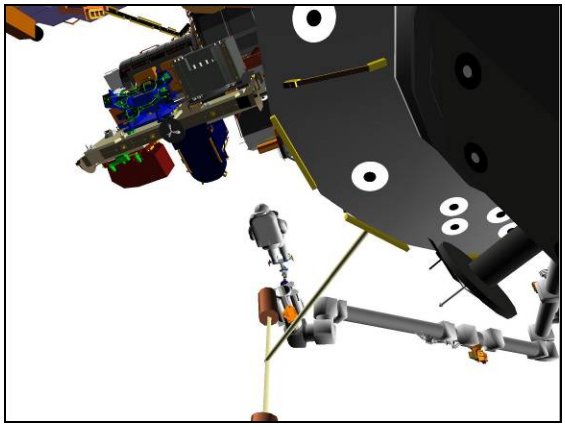

Figure 9.- ESP2 Clearance
(91: Camera D: -20, +60).

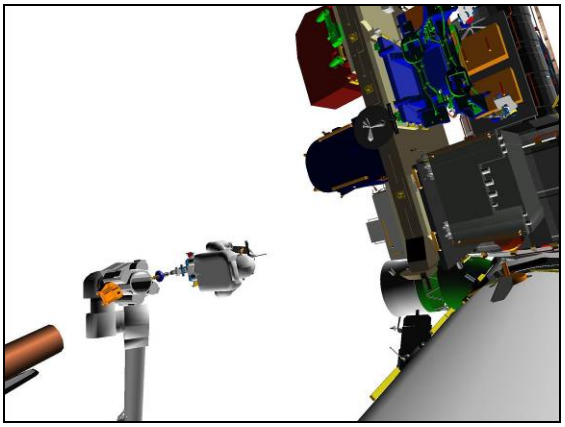

Figure 10.- ESP2 Clearance
(13: LAB Stbd Zenith: +50, -10).

6. FGB INSTALL CLEARANCE

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
92: Camera B (+25, +25) 91: Camera A (+95, +35)	03: S1 Lower Outboard (+90, +20) 09: P1 Lower Outboard (+110, +20)	22: Base Elbow (+50, 0) 24: Tip Elbow (+60, -10)

√Vernier

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for FGB Install Clearance position.

SR	SY	SP	EP	WP	WY	WR
-89.7	-190.0	-222.4	-90.0	-186.8	-196.1	+92.2

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)	-66.6	-190.0	-145.1	+134.7	-128.0	-205.8	+116.8
TGT	**-89.7**	**-190.0**	**-222.4**	**-90.0**	**-186.8**	**-196.1**	**+92.2**
ERR	+23.1	0.0	+77.3	+224.7	+58.8	-9.7	+24.6

NOTE
Expect singularity warning for EP between -15 and +15 deg.

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-89.7	-190.0	-222.4	-90.0	-186.8	-196.1	+92.2

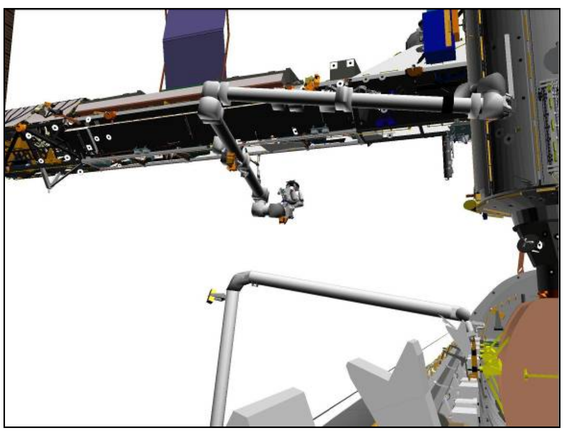

Figure 11.- FGB Install Clearance
(92: Camera B: -20, +10).

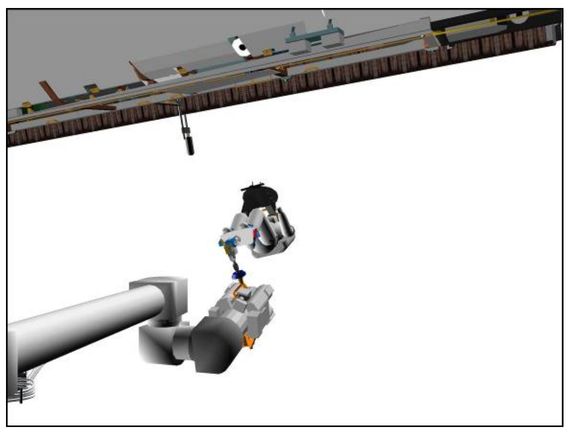

Figure 12.- FGB Install Clearance
(22: Base Elbow: -100, 0).

7. FGB INSTALL

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: Camera A (+95, +35) 92: Camera B (-20, +25)	09: P1 Lower Outboard (+110, 0) 37: MBS Mast (0, 0)	22: Base Elbow (-100, 0) 24: Tip Elbow (-110, -10)

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC Maneuver to FGB Install position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-96.3	-190.0	-221.6	-91.5	-185.9	-191.9	+87.1
X	Y	Z	Pitch	Yaw	Roll	
+288	-962	-15	-171.5	-8.3	-178.2	
FOR	Unloaded – Ch12PPF6, SY Held					
Disp	ISS>ISSACS					

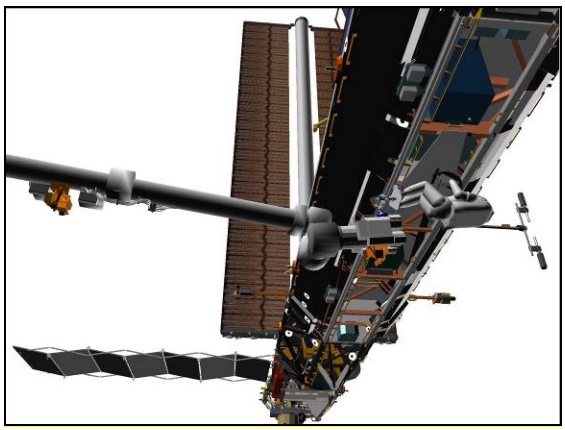

Figure 13.- FGB Install
(91: Camera A: +95, +35).

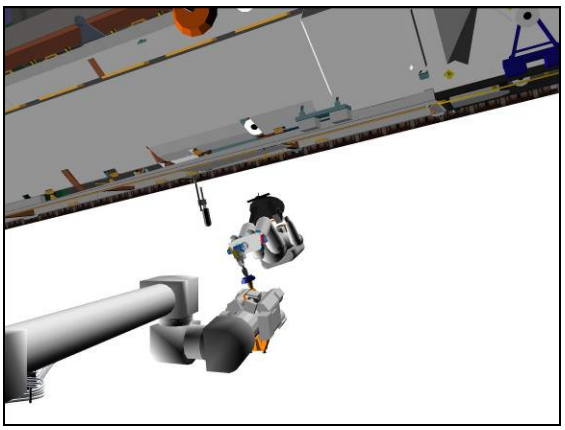

Figure 14.- FGB Install
(22: Base Elbow: -100, 0).

THC/ RHC Maneuver SSRMS per EVA GCA to Install the FGB on the P1 pump module.

8. PUMP MODULE REMOVAL
When the FGB is installed and on EVA Go,

THC/ RHC — Maneuver to Pump Module Removal position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-98.7	-190.0	-216.8	-95.3	-187.1	-190.3	+85.3
X	Y	Z	Pitch	Yaw	Roll	
+248	-962	+45	-171.5	-8.3	-178.2	
FOR	Unloaded – Ch12PPF6, SY Held					
Disp	ISS>ISSACS					

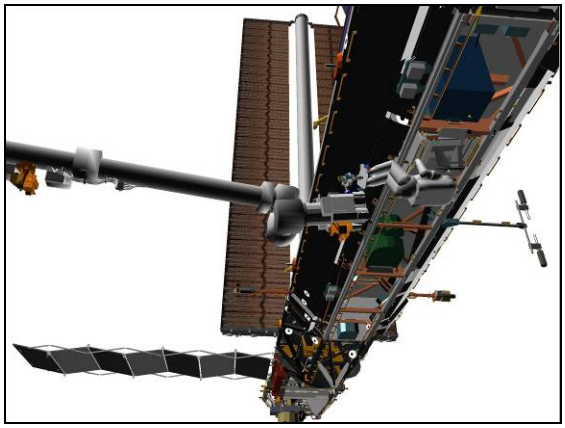

Figure 15.- Pump Module Removal (91: Camera A: +95, +35).

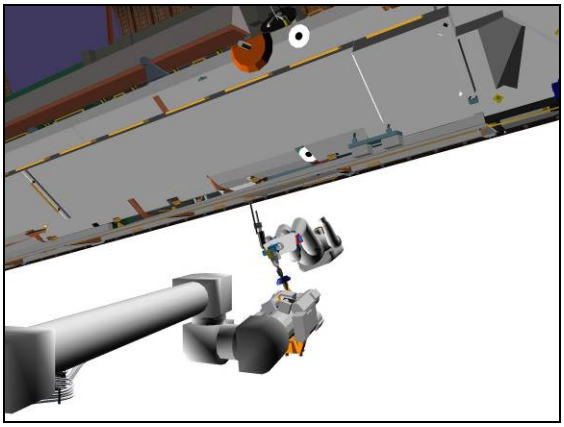

Figure 16.- Pump Module Removal (22: Base Elbow: -100, 0).

THC/ RHC — Maneuver in manual per EVA GCA to remove the P1 pump module from the truss.

9. PUMP MODULE REMOVAL CLEARANCE
When the Pump Module is clear of the truss and on EVA Go,

THC/ RHC — Maneuver to Pump Module Removal Clearance position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-84.5	-190.0	-218.7	-91.8	-189.0	-199.5	+96.3
X	Y	Z	Pitch	Yaw	Roll	
+458	-962	+45	-171.5	-8.3	-178.2	
FOR	Unloaded – Ch12PPF6, SY Held					
Disp	ISS>ISSACS					

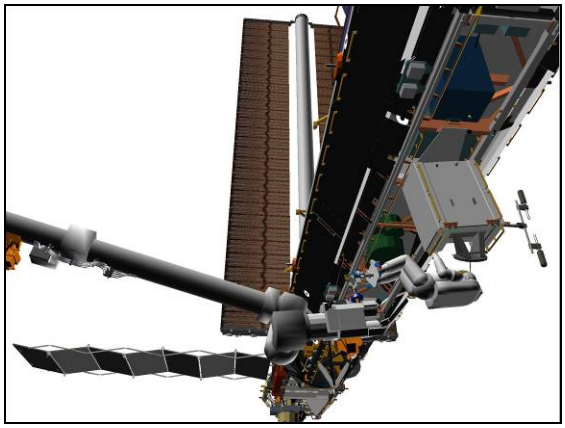

Figure 17.- Pump Module Removal Clearance
(91: Camera A: +95, +35).

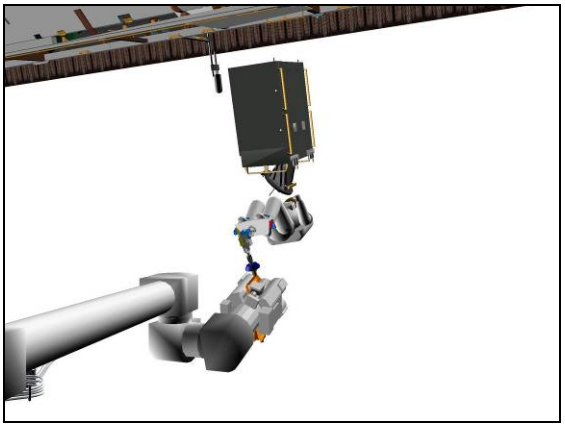

Figure 18.- Pump Module Removal Clearance
(22: Base Elbow: -100, 0).

Pause to allow EVA to reposition pump module to hold the bottom Handrails so that it is parallel to the EV and the FGB is at the EV's head.

10. FAILED PUMP MODULE GRAPPLE
When EVA reposition is complete and on EVA Go,

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for SRMS Handoff position.

SR	SY	SP	EP	WP	WY	WR
-54.0	-190.0	-175.4	-62.0	-70.0	+5.0	0.0

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)	-84.5	-190.0	-218.7	-91.8	-189.0	-199.5	+96.3
TGT	**-54.0**	**-190.0**	**-175.4**	**-62.0**	**-70.0**	**+5.0**	**0.0**
ERR	-30.5	0.0	-43.3	-29.8	-119.0	-204.5	+96.3

****
* If joint angles or errors are incorrect

PCS * | **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* | Input correct Dest joint angles per table above.
*
* | **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * | Verify joint angles and errors are correct on Joint Angle Position
* | overlay.

****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-54.0	-190.0	-175.4	-62.0	-70.0	+5.0	0.0

Give SRMS operator a Go to maneuver to pre-grapple and alert EVA to SRMS motion.

DCP BRAKES SSRMS → ON (Verify ON)

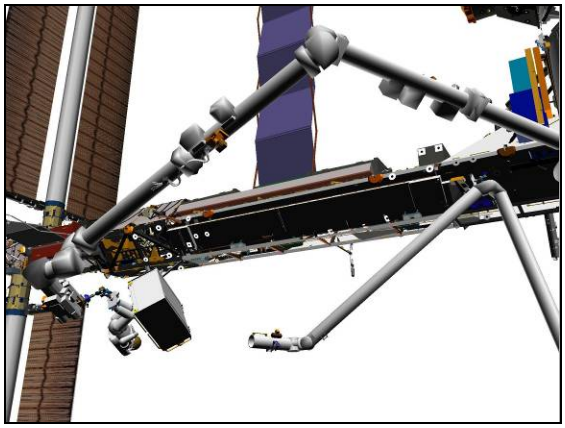

Figure 19.- Handoff
(92: Camera B: -30, +20).

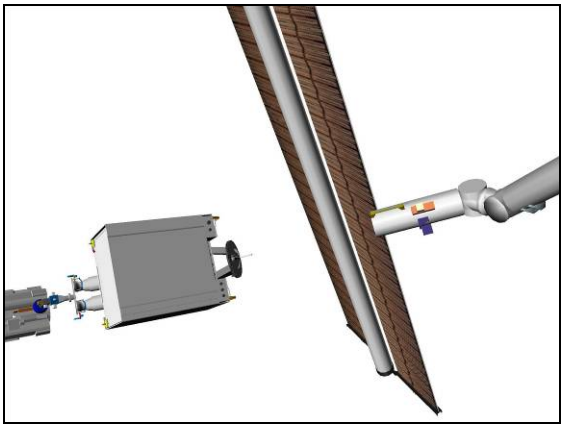

Figure 20.- Handoff
(22: Base Elbow: -105, 0).

Alert EVA to SRMS motion in for Grapple and, when grapple is complete, give EVA a go to release the pump module.
Give SRMS operator a go to start clearance maneuver when EVA has released the pump module.

Verify with SRMS operator that SRMS is in Clearance position before initiating SSRMS motion.

11. ESP2 CLEARANCE

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
92: Camera B (-35, +20) 91: Camera D (-20, +50)	09: P1 Lower Outboard (+120, +25) 03: S1 Lower Outboard (+90, +20)	22: Base Elbow (-105, 0) 13: LAB Stbd Zenith (+45, -20)

On SRMS Operator and EVA Go,

DCP BRAKES SSRMS → OFF (Verify OFF)

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for ESP2 Clearance position.

SR	SY	SP	EP	WP	WY	WR
-66.6	-190.0	-145.1	+134.7	-128.0	-205.8	+116.8

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)	-54.0	-190.0	-175.4	-62.0	-70.0	+5.0	0.0
TGT	**-66.6**	**-190.0**	**-145.1**	**+134.7**	**-128.0**	**-205.8**	**+116.8**
ERR	+12.6	0.0	-30.3	-196.7	+58.0	210.8	-116.8

NOTE
Expect singularity warning for EP between -15 and +15 deg.

****
* If joint angles or errors are incorrect
PCS * | **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* | Input correct Dest joint angles per table above.
*
* | **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * | Verify joint angles and errors are correct on Joint Angle Position
* | overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-66.6	-190.0	-145.1	+134.7	-128.0	-205.8	+116.8

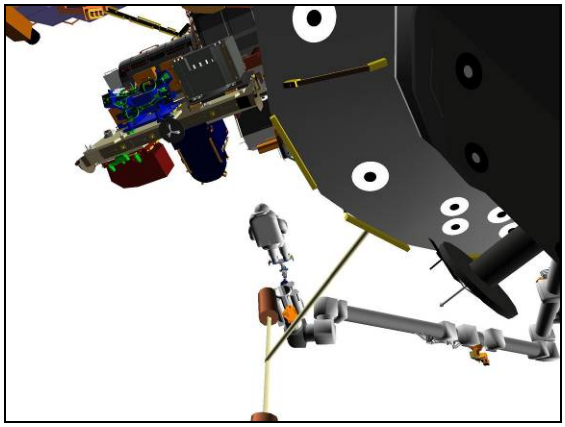

Figure 21.- ESP2 Clearance
(91: Camera D: -20, +60).

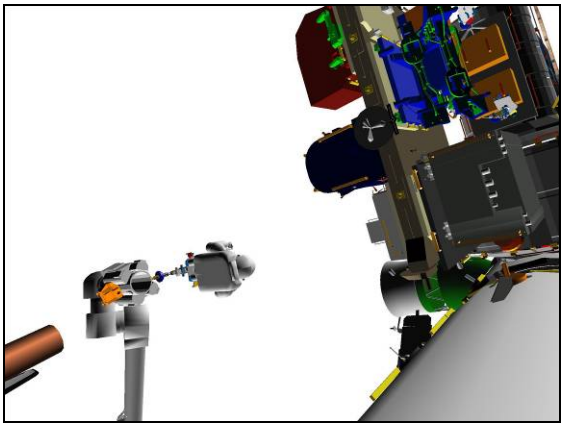

Figure 22.- ESP2 Clearance
(13: LAB Stbd Zenith: +50, -10).

12. SPARE PUMP MODULE RETRIEVAL

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: Camera D (-20, +50) 92: Camera B (+25, +25)	13: LAB Stbd Zenith (+45, -20) 37: MBS Mast (+50, -25)	03: S1 Lower Outboard (+90, +20) 24: Tip Elbow (+70, -10)

√Vernier

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC — Maneuver to Spare Pump Module Retrieval position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-52.6	-190.0	-111.8	+140.3	-170.6	-214.7	+129.0
X	Y	Z	Pitch	Yaw	Roll	
+160	+364	+500	-177.1	-1.1	-175.3	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	ISS>ISSACS					

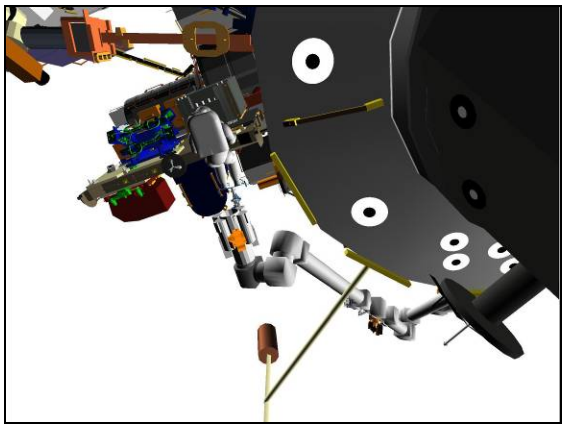

Figure 23.- Spare Pump Module Retrieval (91: Camera D: -20, +65).

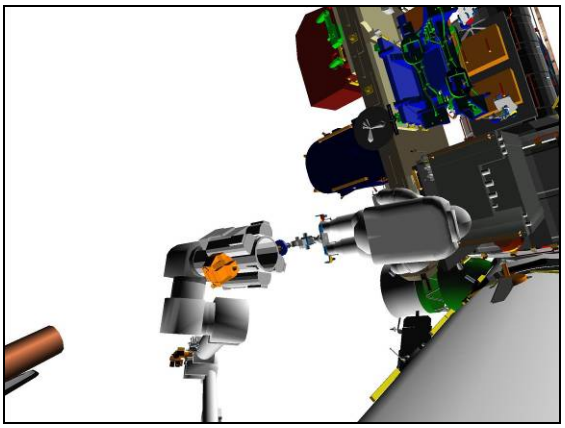

Figure 24.- Spare Pump Module Retrieval (13: LAB Stbd Zenith: +50, -10).

THC/ RHC — Maneuver SSRMS per EVA GCA to allow EVA to obtain a firm grip on the spare pump module.

13. ESP2 BACKOFF
On EVA Go,

THC/ RHC — Maneuver to Backoff position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-63.6	-190.0	-111.7	+140.9	-168.1	-207.8	+119.2
X	Y	Z	Pitch	Yaw	Roll	
+260	+364	+500	-177.1	-1.1	-175.3	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	ISS>ISSACS					

NOTE

1. At this position, the SSRMS Wrist cluster is approximately 10 inches away from the UHF Antenna on the LAB. This clearance can be monitored using the Tip Elbow Camera.

2. The Pump Module is approximately 2 inches away from the edge of the FRAM on ESP2. The MBS Mast Camera can be used to monitor this clearance.

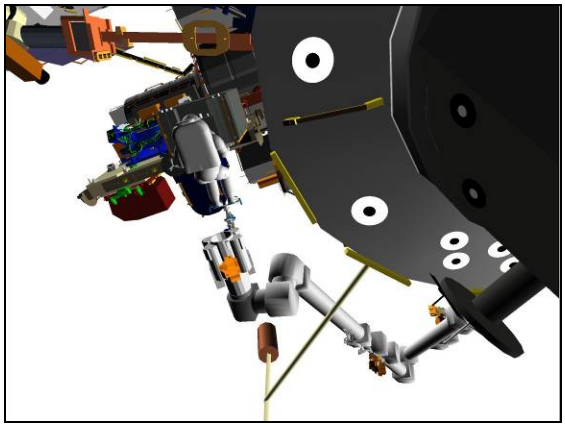

Figure 25.- Pump Module Backoff
(91: Camera D: -20, +65).

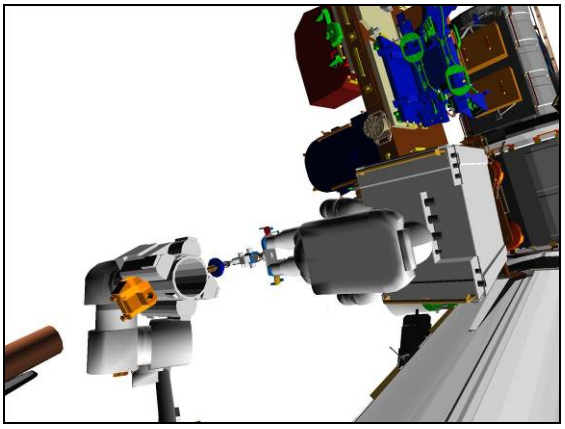

Figure 26.- Pump Module Backoff
(13: LAB Stbd Zenith: +50, -10).

Pause to allow EVA to reposition the pump module to hold the bottom Handrails. Some Zenith maneuvering may be necessary.

14. ESP2 CLEARANCE

When Pump Module reposition is complete and on EVA go,

THC/ RHC — Maneuver to ESP2 Clearance position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-78.3	-190.0	-154.2	+127.5	-110.1	-198.0	+107.6
X	Y	Z	Pitch	Yaw	Roll	
+260	+364	+950	-177.1	-1.1	-175.3	
FOR	Unloaded – Ch12PPF6, SY Held					
Disp	ISS>ISSACS					

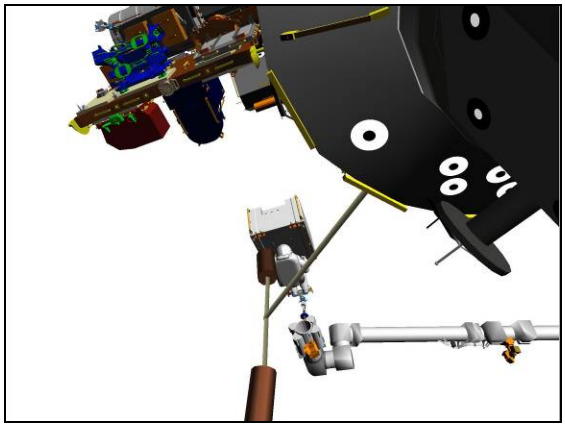

Figure 27.- ESP2 Clearance
(91: Camera D: -20, +55).

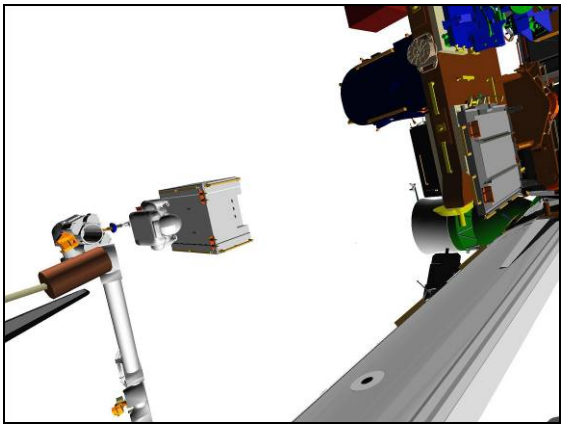

Figure 28.- ESP2 Clearance
(13: LAB Stbd Zenith: +50, -10).

15. PUMP MODULE INSTALL CLEARANCE

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
92: Camera B (+25, +20) 91: Camera A (+95, +30)	03: S1 Lower Outboard (+90, +20) 09: P1 Lower Outboard (+110, +20)	22: Base Elbow (+50, 0) 24: Tip Elbow (+80, -10)

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Pump Module Install Clearance position.

SR	SY	SP	EP	WP	WY	WR
-84.6	-190.0	-223.5	-87.9	-188.1	-199.4	+96.2

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)	-78.3	-190.0	-154.3	+127.5	-110.2	-198.0	+107.6
TGT	**-84.6**	**-190.0**	**-223.5**	**-87.9**	**-188.1**	**-199.4**	**+96.2**
ERR	+6.3	0.0	+69.2	+215.4	+77.9	+1.4	+11.4

NOTE
Expect singularity warning for EP between -15 and +15 deg.

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-84.6	-190.0	-223.5	-87.9	-188.1	-199.4	+96.2

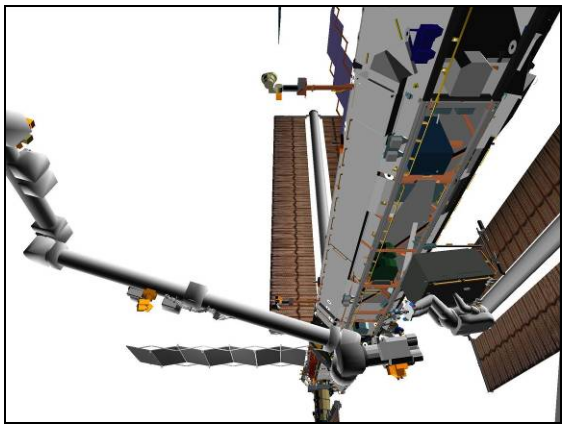

Figure 29.- Pump Module Install Clearance (91: Camera A: +95, +30).

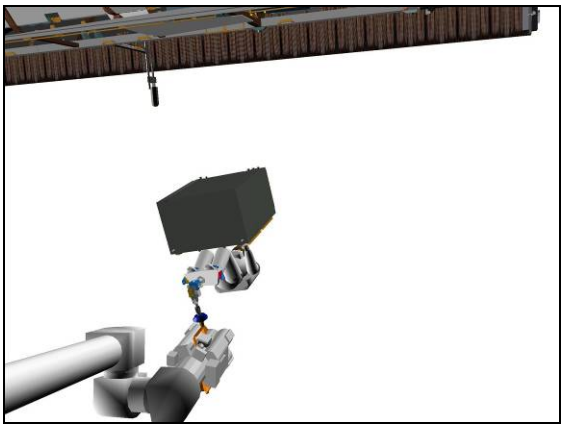

Figure 30.- Pump Module Install Clearance (22: Base Elbow: -100, +5).

Give EVA a Go to reposition the pump module.

16. SPARE PUMP MODULE INSTALL

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: Camera A (+95, +30) 92: Camera B (-20, +20)	09: P1 Lower Outboard (+110, 0) 37: MBS Mast (0, 0)	22: Base Elbow (-100, +5) 24: Tip Elbow (-100, -10)

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MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

On EVA Go,

THC/ RHC Maneuver to Pump Module Install position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-87.1	-190.0	-222.9	-89.1	-187.3	-197.7	+94.2
X	Y	Z	Pitch	Yaw	Roll	
+428	-962	-15	-171.5	-8.3	-178.2	
FOR	Unloaded – Ch12PPF6, SY Held					
Disp	ISS>ISSACS					

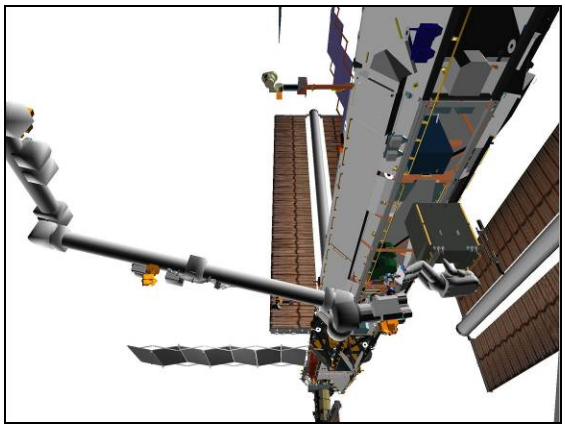

Figure 31.- Pump Module Install
(91: Camera A: +95, +30).

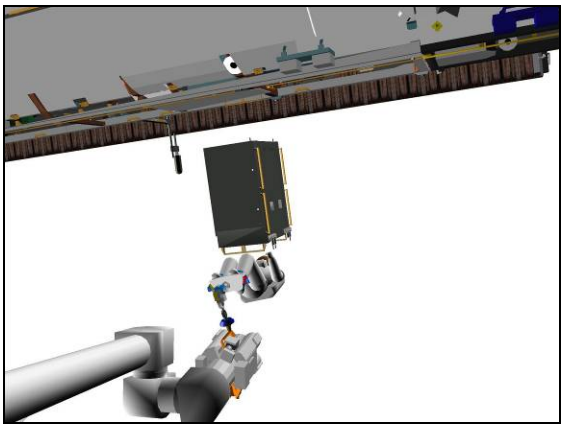

Figure 32.- Pump Module Install
(22: Base Elbow: -100, +5).

THC/ RHC Maneuver SSRMS per EVA GCA to install spare Pump Module in the truss.

17. TRUSS CLEARANCE

After pump module installed in truss and on EVA go,

THC/ RHC Maneuver to Truss Clearance position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-92.3	-190.0	-222.0	-90.8	-186.3	-194.4	+90.1
X	Y	Z	Pitch	Yaw	Roll	
+348	-962	-15	-171.5	-8.3	-178.2	
FOR	Unloaded – Ch12PPF6, SY Held					
Disp	ISS>ISSACS					

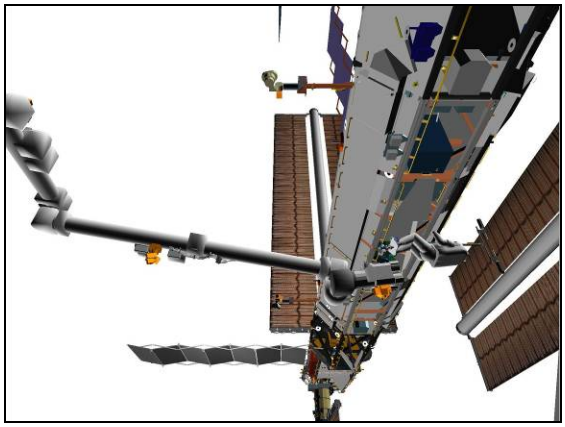

Figure 33.- Truss Clearance
(91: Camera A: +95, +30).

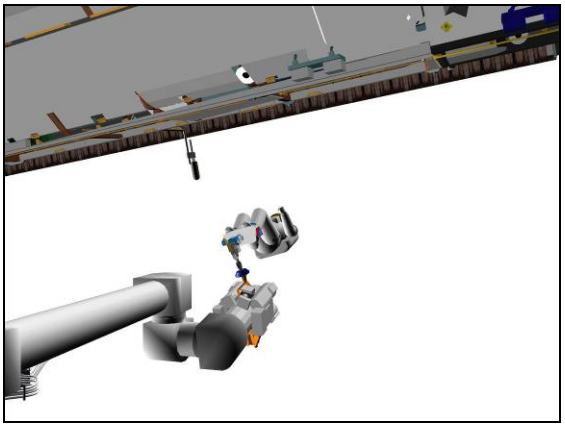

Figure 34.- Truss Clearance
(22: Base Elbow: -100, 0).

18. FAILED PUMP MODULE UNGRAPPLE
On EVA Go,

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Handoff Clearance position.

SR	SY	SP	EP	WP	WY	WR
-48.1	-190.0	-175.9	-53.8	-77.1	+9.6	+3.5

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)	-92.3	-190.0	-222.0	-90.8	-186.3	-194.4	+90.1
TGT	**-48.1**	**-190.0**	**-175.9**	**-53.8**	**-77.1**	**+9.6**	**+3.5**
ERR	-44.2	0.0	-46.1	-37.0	-109.2	-204.0	+86.6

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-48.1	-190.0	-175.9	-53.8	-77.1	+9.6	+3.5

Give the SRMS operator a Go to maneuver to the Handoff position and alert EVA to SRMS motion.

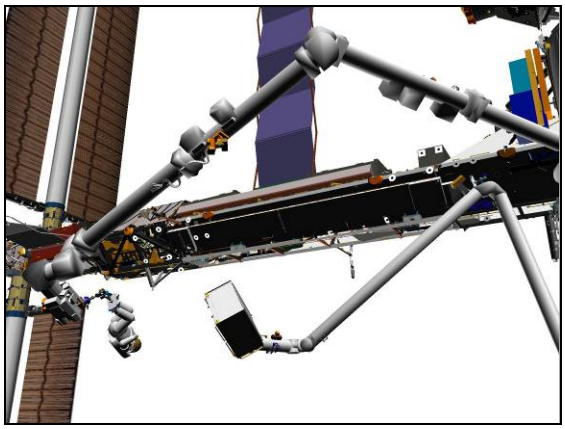

Figure 35.- Handoff Clearance (92: Camera B: -35, +20).

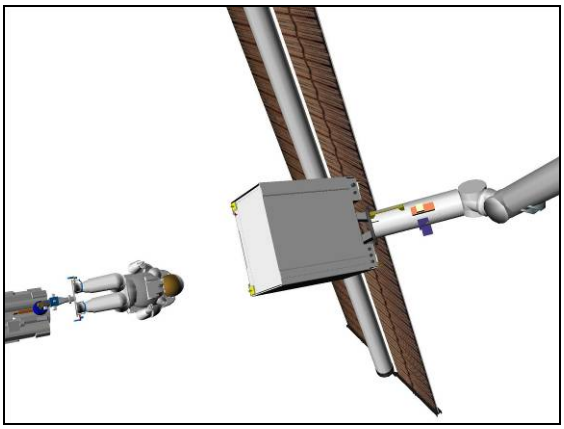

Figure 36.- Handoff Clearance (22: Base Elbow: -105, 0).

When the SRMS is in position,

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC Maneuver per EVA GCA to allow EVA to obtain a secure grip on the failed pump module.

When EVA has obtained a firm grip

> Give the SRMS operator a go to release the failed pump module and maneuver to the clearance position.

Verify that the SRMS is in the clearance position before initiating SSRMS motion.

19. AUTOSEQUENCE START
On EVA and SRMS Operator Go,

THC/ RHC — Maneuver to Autosequence Start position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-54.0	-190.0	-175.4	-62.0	-70.0	+5.0	0.0
X	Y	Z	Pitch	Yaw	Roll	
+723	-1250	+1139	+141.8	+52.2	-168.3	
FOR	Unloaded – Ch12PPF6, SY Held					
Disp	ISS>ISSACS					

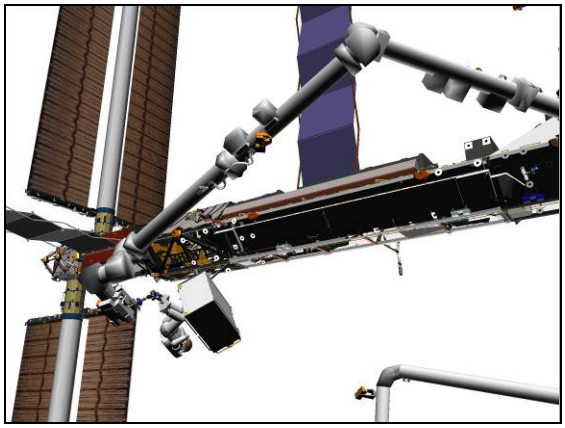

Figure 37.- Autosequence Start (92: Camera B: -35, +20).

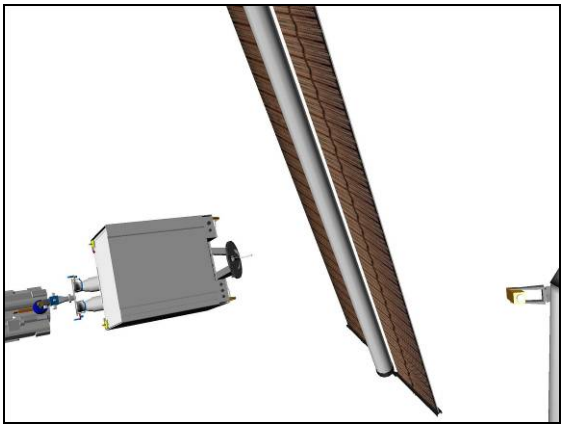

Figure 38.- Autosequence Start (22: Base Elbow: -105, 0).

20. ESP2 CLEARANCE
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
92: Camera B (-35, +20) 91: Camera D (-20, +50)	09: P1 Lower Outboard (+120, +25) 03: S1 Lower Outboard (+90, +20)	22: Base Elbow (-105, 0) 13: LAB Stbd Zenith (+45, -20)

PCS — MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for ESP2 Clearance position.

SR	SY	SP	EP	WP	WY	WR
-78.3	-190.0	-154.3	+127.5	-110.1	-198.0	+107.6

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)	-54.0	-190.0	-175.4	-62.0	-70.0	+5.0	0.0
TGT	**-78.3**	**-190.0**	**-154.3**	**+127.5**	**-110.1**	**-198.0**	**+107.6**
ERR	+24.3	0.0	-21.1	-189.5	+40.1	+203.0	-107.6

NOTE
Expect singularity warning for EP between -15 and +15 deg.

****
* If joint angles or errors are incorrect
PCS * | **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* | Input correct Dest joint angles per table above.
*
* | **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * | Verify joint angles and errors are correct on Joint Angle Position
* | overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-78.3	-190.0	-154.3	+127.5	-110.1	-198.0	+107.6

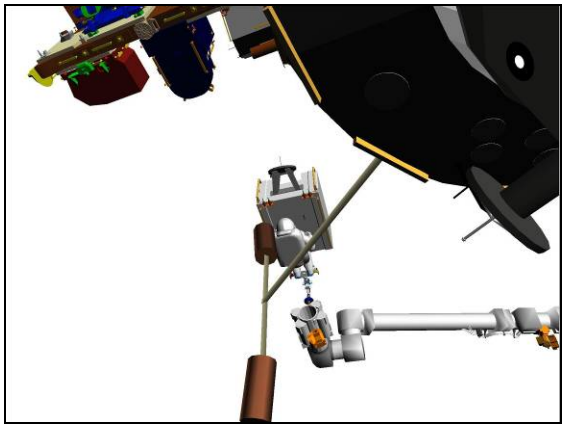

Figure 39.- ESP2 Clearance
(91: Camera D: -20, +50).

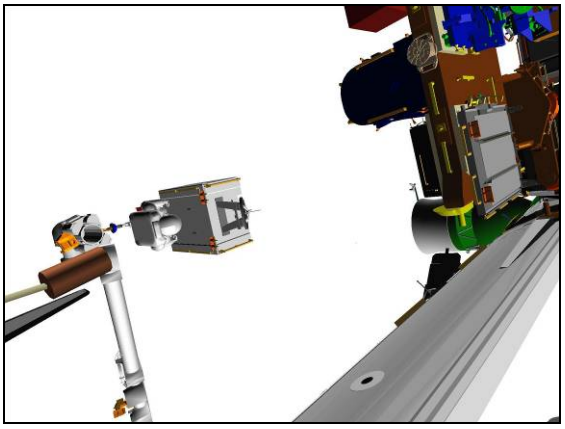

Figure 40.- ESP2 Clearance
(13: LAB Stbd Zenith: +45, -20).

21. FAILED PUMP MODULE INSTALL ON ESP2
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: Camera D (-20, +50) 92: Camera B (+25, +25)	13: LAB Stbd Zenith (+45, -20) 37: MBS Mast (+50, -25)	22: Base Elbow (+55, -5) 03: S1 Lower Outboard (+90, +20)

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

NOTE
During this maneuver, the clearance between the SSRMS Wrist Cluster and the UHF Antenna on the LAB can be as low as 17 inches when x = 260 cm and z = 500 cm and can be monitored with the SSRMS Tip Elbow Camera.

On EVA Go,

THC/ RHC — Maneuver to Pump Module Install position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-53.1	-190.0	-90.2	+137.3	-189.0	-214.3	+128.5
X	Y	Z	Pitch	Yaw	Roll	
+260	+364	+350	-177.2	-1.1	-175.3	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	ISS>ISSACS					

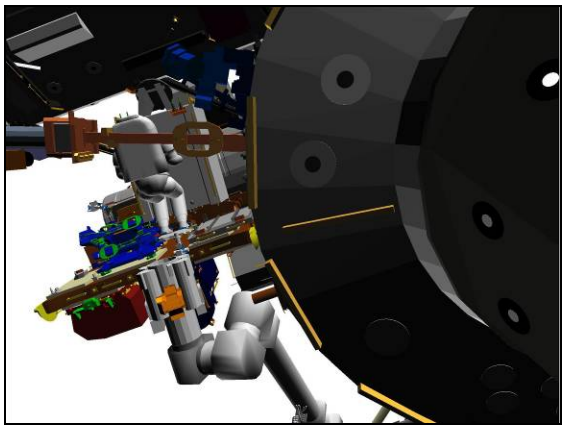

Figure 41.- Failed Pump Module Install (91: Camera D: -20, +80).

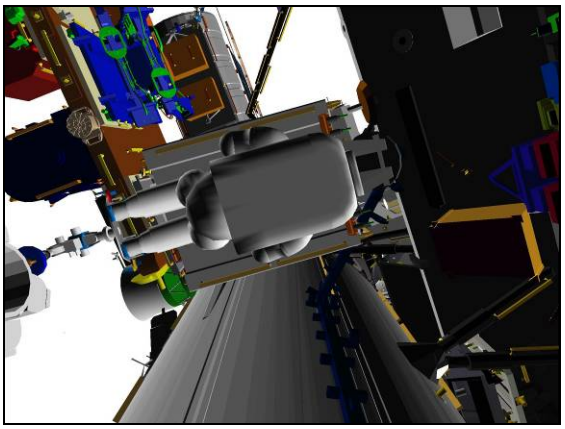

Figure 42.- Failed Pump Module Install (13: LAB Stbd Zenith: +90, -10).

Pause to allow EVA to reposition the pump module so that the FGB faces forward and the pump module will slide onto the FRAM on ESP2.

THC/ RHC — Maneuver SSRMS per EVA GCA to install failed Pump Module onto the ESP2.

22. APFR EGRESS

On EVA Go,

THC/ RHC — Maneuver to APFR Egress position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-64.0	-190.0	-106.6	+113.1	-145.3	-207.5	+118.9
X	Y	Z	Pitch	Yaw	Roll	
+160	+664	+550	-177.2	-1.1	-175.3	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

THC/ RHC — Maneuver SSRMS per EVA GCA to Egress the APFR.

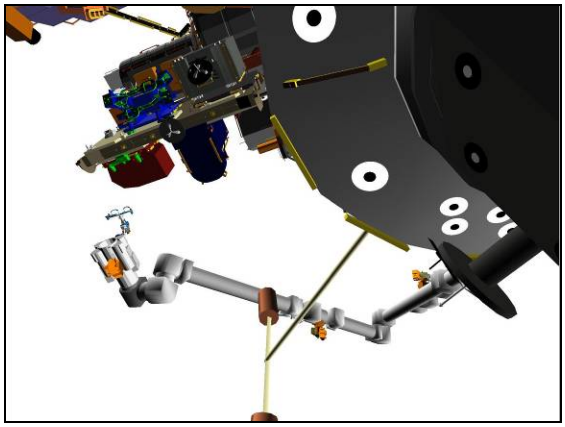

Figure 43.- APFR Egress
(91: Camera D: -20, +60).

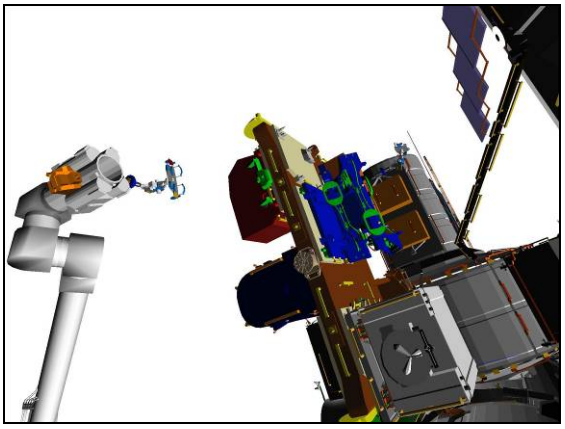

Figure 44.- APFR Egress
(13: LAB Stbd Zenith: +60, +10).

23. APFR REMOVAL
On EVA Go,

PCS MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

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

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC Maneuver to APFR Removal position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-48.1	-190.0	-85.6	+108.5	-166.7	-217.3	+133.4
X	Y	Z	Pitch	Yaw	Roll	
+185	+679	+455	+92.7	-4.7	-164.1	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

NOTE
The clearance between the Upper Boom and the FHRC is approximately 20 inches at this position and can be monitored with the S1 Lower Outboard Camera.

THC/ RHC Maneuver SSRMS per EVA GCA to remove the APFR.

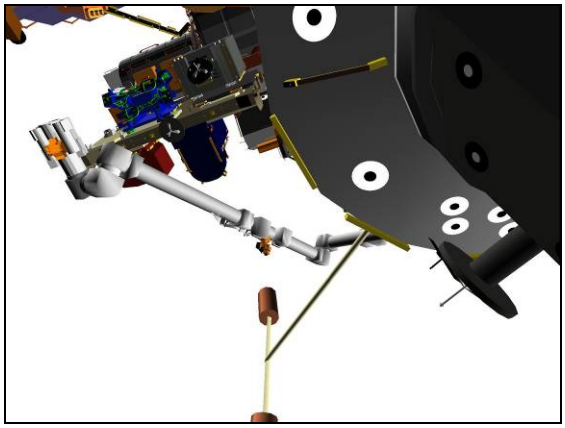

Figure 45.- APFR Removal
(91: Camera D: -20, +60).

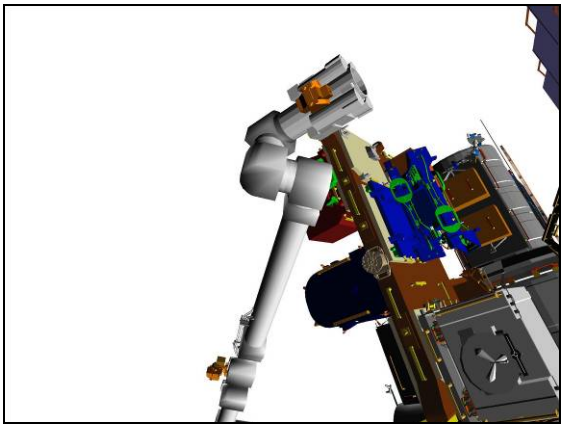

Figure 46.- APFR Removal
(13: LAB Stbd Zenith: +50, +10).

24. OVERNIGHT PARK
On EVA Go,

THC/ RHC Maneuver to Overnight Park position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-73.4	-190.0	-125.5	+107.3	-119.2	-201.3	+111.3
X	Y	Z	Pitch	Yaw	Roll	
+285	+679	+1003	+92.7	-4.7	-164.1	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

Figure 47.- SSRMS Overnight Park
(92: SRMS Elbow: -125, -10).

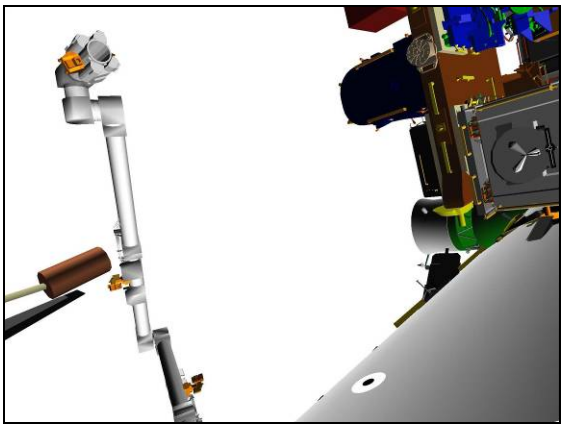

Figure 48.- SSRMS Overnight Park
(13: LAB Stbd Zenith: +45, -20).

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)

1. PREP FOR MT TRANSLATE

Configure cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: Camera C (-20, +15)	13: LAB Stbd Zenith (+160, +60)	03: S1 Lower Outboard (+75, -20)

PCS MSS: SSRMS: SSRMS

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

Verify Display – W3>ISSACS

Verify Command – W3>ISSACS/Internal

Verify SSRMS in EVA2 Stow position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
X	Y	Z	Pitch	Yaw	Roll	
+595	+578	-599	-144.7	-64.0	-26.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

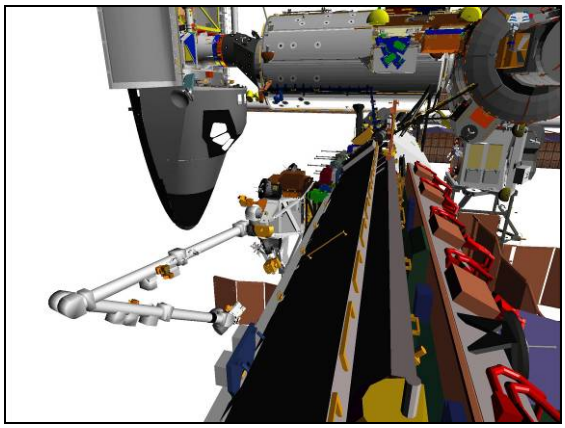

Figure 1.- EVA 2 Stow
(03: S1 Lower Outboard: +75, -20).

1.1 Maneuvering to MT Port Clearance

MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → SHOULDER PITCH (Verify SP – Selected on PCS)

THC Perform "+" Single Joint maneuver to SP: -107.4 (THC up).

Verify SSRMS in MT Port Clearance position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-107.4	+146.7	-131.1	+175.4	+125.4
X	Y	Z	Pitch	Yaw	Roll	
+500	+200	-260	-89.9	0.0	+17.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

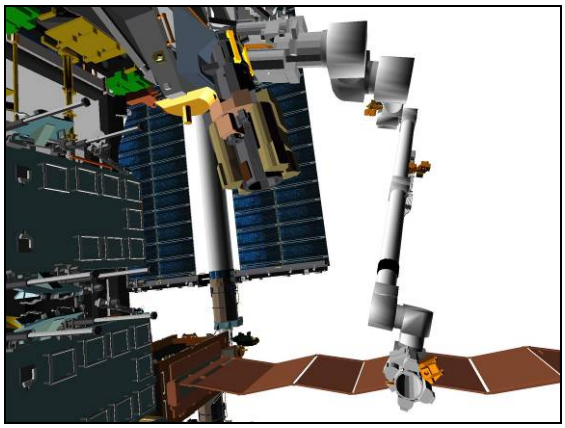

Figure 2.- MT Port Clearance
(13: LAB Stbd Zenith: +160, +27).

1.2 <u>Stowing for Translation</u>

PCS MSS: SSRMS: SSRMS

Enter Mode – FOR OCAS (Verify blue)

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

cmd Shoulder Roll (Verify SR – Locked)

SSRMS FOR OCAS

Input 'FOR' 'Destination' for Stow for Translation position.

X	Y	Z	Pitch	Yaw	Roll
+500	-700	-260	-89.9	0.0	+17.0

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	+500	+200	-260	-89.9	0.0	+17.0
TGT	**+500**	**-700**	**-260**	**-89.9**	**0.0**	**+17.0**
ERR	0	+900	0	0.0	0.0	0.0

****
* If FOR or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest FOR per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify FOR and errors are correct on FOR Position overlay.
****

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 Stow for Translation position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-180.0	+83.7	-36.4	+52.0	-106.3	+175.2	+112.8
X	Y	Z	Pitch	Yaw	Roll	
+500	-700	-260	-89.9	0.0	+17.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

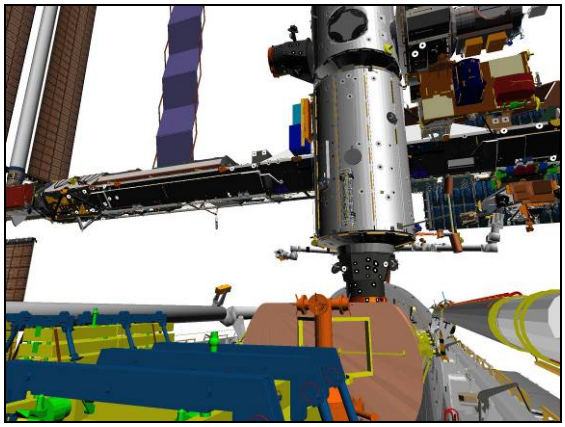

Figure 3.- Stow For Translation
(91: Camera C: -20, +15).

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)

2. SETUP
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: Camera C (-20, +15)	22: Base Elbow (+135, 0) 24: Tip Elbow (+130, -10)	09: P1 Lower Outboard (+110, -20) 37: MBS Mast (-15, 0)

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

Change Display ▶ W4 ▶ LAB PDGF (Verify W4>LAB PDGF)

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

Verify SSRMS in Stow for Translation position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-180.0	+83.7	-36.4	+52.0	-106.3	+175.2	+112.8
X	Y	Z	Pitch	Yaw	Roll	
+88	+1413	-148	+179.9	-37.7	-163.1	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W4>LAB PDGF					

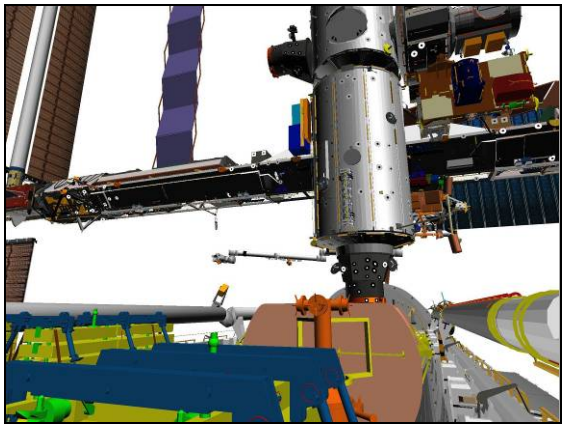

Figure 4.- Stow For Translation
(91: Camera C: -20, +15).

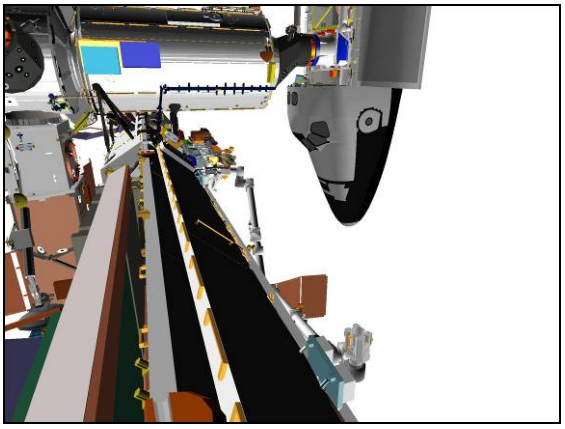

Figure 5.- Stow for Translation
(09: P1 Lower Outboard: +110, -20).

3. MANEUVERING TO LAB PDGF PRE-GRAPPLE

PCS MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → VERNIER (Verify Vernier on PCS)

3.1 Joint OCAS maneuver to Intermediate
MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

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

SR	SY	SP	EP	WP	WY	WR
-180.0	+83.7	-36.4	+52.0	-54.8	+162.4	+85.3

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	+83.7	-36.4	+52.0	-106.3	+175.2	+112.8
TGT	**-180.0**	**+83.7**	**-36.4**	**+52.0**	**-54.8**	**+162.4**	**+85.3**
ERR	0.0	0.0	0.0	0.0	-51.5	+12.8	+27.5

****
* If joint angles or errors are incorrect

PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*

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

****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-180.0	+83.7	-36.4	+52.0	-54.8	+162.4	+85.3

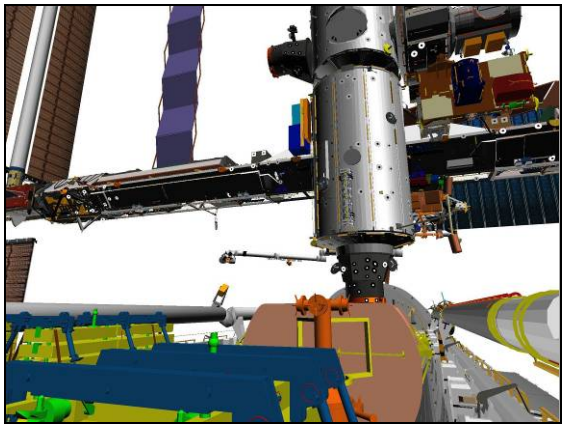

Figure 6.- Intermediate
(91: Camera C: -20, +15).

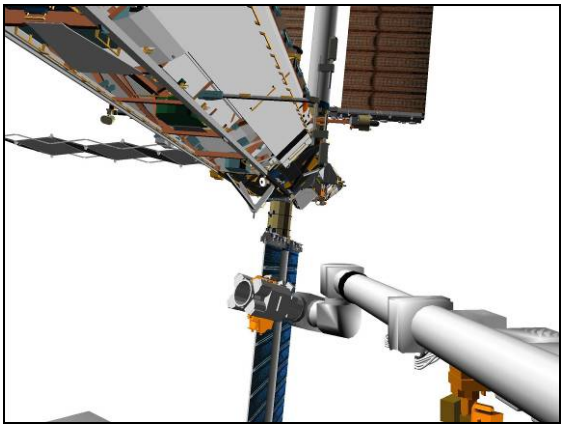

Figure 7.- Intermediate
(22: Base Elbow: +135, 0).

3.2 Single Joint Maneuver to LAB PDGF Pre-Grapple
MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

NOTE

At the end of this maneuver, the clearance between the SSRMS Elbow and the S0 Truss is approximately 52 inches. The clearance between the CETA Brake Handle and the base boom camera can be as low as 18 inches.

THC Perform Single Joint maneuver to Pre-Grapple position (within 1 deg).

	SR	SY	SP	EP	WP	WY	WR
Intermediate	-180.0	+83.7	-36.4	+52.0	-54.8	+162.4	+85.3
1: EP +				+84.3			
2: SP –			-59.3				
3: SR –	-260.4						
4: SY +		+106.0					
Pre-Grapple	-260.4	+106.0	-59.3	+84.3	-54.8	+162.4	+85.3
	X	Y	Z	Pitch	Yaw	Roll	
	150	0	0	0.0	0.0	0.0	
	FOR	Unloaded – LEE Tip, SR Held					
	Disp	W4>LAB PDGF					

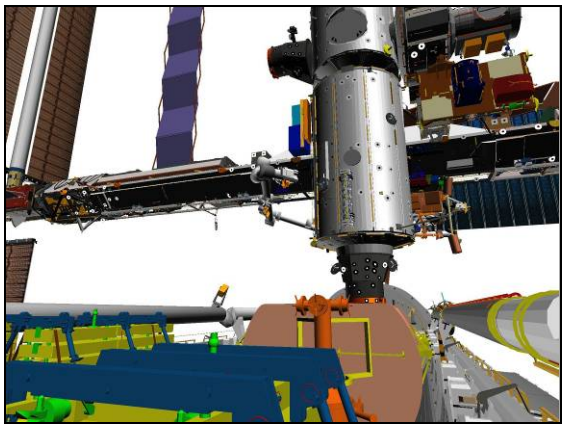

Figure 8.- Pre-Grapple
(91: Camera C: -20, +15).

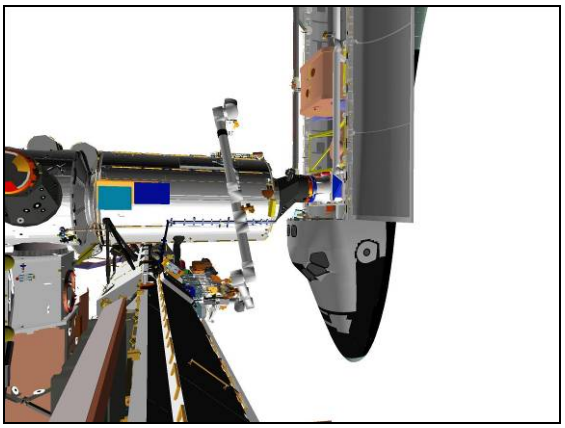

Figure 9.- Pre-Grapple
(09: P1 Lower Outboard: +110, 0).

4. LAB PDGF GRAPPLE SETUP AND CAPTURE

Configure Cameras and overlays for Grapple.

Monitor 1	Monitor 2	Monitor 3
91: Camera C (-20, +15) 09: P1 Lower Outboard (+110, 0)	25: Tip LEE	24: Tip Elbow (+15, 0) 22: Base Elbow (+175, 0)

NOTE

Tip LEE Camera must be fully zoomed out to correspond to target overlay.

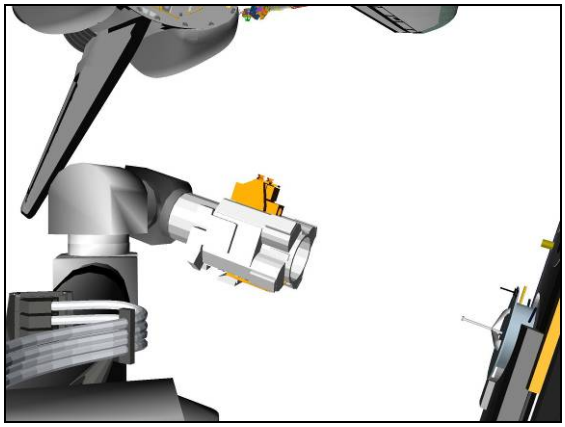

Figure 10.- Pre-Grapple
(24: Tip Elbow: +15, 0).

4.1 Setting Up for Grapple

MSS: SSRMS: Rate: SSRMS Rate

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

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

4.2 Slow Capture Commands

MSS: SSRMS: Tip LEE: SSRMS Tip LEE

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

Verify 'Confirm or Terminate' prompt.

CAUTION

Due to end-to-end system latency, the RHC Trigger is hot up to 3 seconds prior to receiving a Trigger Hot icon status on the PCS.

NOTE

Once the trigger is hot, only safing or trigger commands should be sent to the Robotics equipment. If a configuration change is required, including routing MSS Cameras, safe the system to exit LEE operations (SCR 23262, 14662).

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Capture

4.3 Maneuvering to Grapple

RHC/ THC — Maneuver to within grapple envelope.

NOTE

At the end of the Grapple maneuver, the clearance between the SSRMS Elbow and the S0 Truss is approximately 47 inches.

4.4 Grapple

RHC — TRIGGER → press (momentarily)

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

4.5 Umbilical Mate

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

NOTE

Expect '**R3L - SSRMS Pwr Flags Fail**' Robotics Advisory message to be in alarm while the Tip LEE is mated (SCR 19019).

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Mate

RHC — TRIGGER → press (momentarily)

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

4.6 Carriage Derigidize

cmd 'Carriage' Derigidize ▶ Slow (Verify Speed – Slow)

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

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Deridigize

RHC TRIGGER → press (momentarily) (SCR 19064)

PCS Verify 'Carriage' Derigidize – blue (90 s max)

4.7 Grapple Cleanup

Verify Loaded Parameters – √
Verify 'Loaded Parameters' (two) – LAB PDGF, SR Held

MSS: SSRMS: SSRMS

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

SR	SY	SP	EP	WP	WY	WR
-260.4	+108.9	-65.6	+100.6	-65.4	+159.9	+86.8
X	Y	Z	Pitch	Yaw	Roll	
0	0	0	0.0	0.0	0.0	
FOR	Loaded – LAB PDGF, SR Held					
Disp	W4>LAB PDGF					

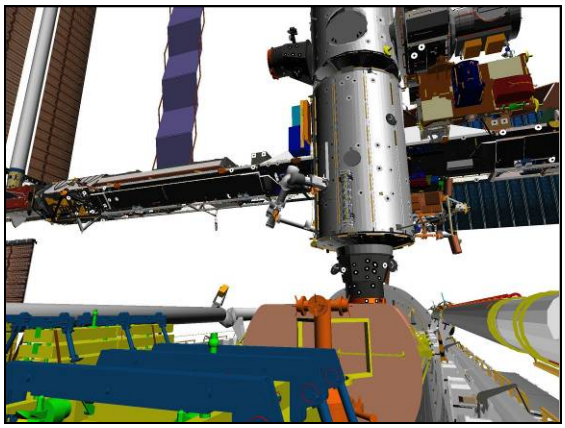

Figure 11.- Grapple
(91: Camera C: -20, +15).

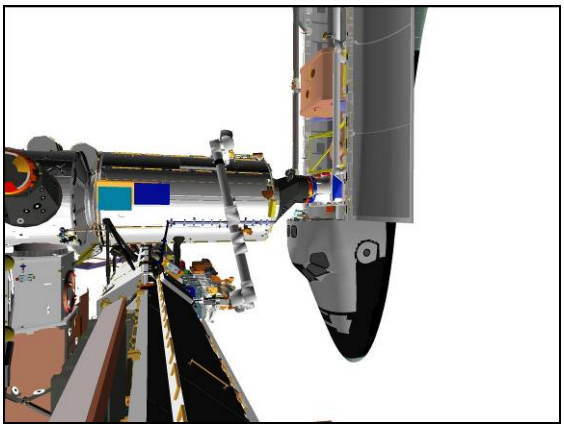

Figure 12.- Grapple
(09: P1 Lower Outboard: +110, 0).

5. SETTING UP FOR SSRMS BASE CHANGE

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

DCP SAFING → SAFE (Verify ON)

6. POWERDOWN TO OFF

NOTE
1. Expect the following messages when Off is commanded: '**R1E - MSS OCS SSRMS Redun(Prime) ACU SRT Comm Fail**' (SCR 17730) 'R1E **- LAB(CUP) RWS CEU PLB ACU Cmd Resp Sync Msg Err**' (SCR 31294) These messages should return to Norm. 2. Steps 6 to 10 may be performed by ground.

PCS MSS: SSRMS: Power: SSRMS Power

cmd 'SSRMS' Redundant(Prime) – Off (Verify Off)

7. OPERATING BASE CHANGE

MSS: SSRMS: SSRMS

MSS: SSRMS: Base LEE: Base

cmd B

MSS: SSRMS: SSRMS

Verify Base LEE – B

Verify PDGF – LAB

8. POWERUP PRIME(REDUNDANT) STRING TO KEEP-ALIVE

NOTE
It might take up to 30 seconds for the Keep-Alive status indication to appear on PCS.

MSS: SSRMS: Power: SSRMS Power

cmd 'SSRMS' Prime(Redundant) – Keep-Alive (Verify Keep-Alive)

9. POWERUP PRIME(REDUNDANT) STRING TO OPERATIONAL

NOTE
SSRMS transition from Keep-Alive to Operational will require at least 6 minutes to complete. The time is contingent on file transfer activity from the C&C MDM.

MSS: SSRMS: Power: [SSRMS Power]

cmd 'SSRMS' Prime(Redundant) – Operational

Verify 'Systems State' – Operational

10. VIDEO COMPONENTS POWERUP

MSS: SSRMS: Base LEE VDU icon: [MSS VDUs]

cmd 'SSRMS' 'Base LEE' On (Verify On)
cmd 'SSRMS' 'Base Elbow' On (Verify On)
cmd 'SSRMS' 'Tip Elbow' On (Verify On)
cmd 'SSRMS' 'Tip LEE' On (Verify On)

NOTE
The color balance and gamma setting feedback will not be available until the Camera is routed through a Camera Status Reader. The ground will route the SSRMS Cameras through the CSRs after the Camera setup in this step.

MSS: SSRMS: Base Elbow Camera icon: [SSRMS Base Elbow Camera]

sel [X] where [X] = [B-Elb 22] [T-Elb 24] [LEE 25]

cmd 'Power' On (Verify On)
cmd 'Color Bal' Metal
cmd 'Gamma' 0.45

Repeat

As required, power up the SSRMS lights.

11. SETUP

Configure Cameras and overlays for Ungrapple.

Monitor 1	Monitor 2	Monitor 3
37: MBS Mast (-30, -25) 09: P1 Lower Outboard (+110, 0)	25: Tip LEE	13: LAB Stbd Zenith (+160, -20)

MSS: SSRMS: SSRMS

Verify 'Loaded Parameters' (two) – MBS PDGF 3, SR Held

Change Display ▶ ISS ▶ W4MBS PDGF 3 (Verify ISS>W4MBS PDGF 3)

Verify Command – SSRMS>Internal

√Vernier

NOTE
At this position, the clearance between the SSRMS Elbow and the S0 Truss is approximately 47 inches.

Expected MBS PDGF3 Grapple position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+86.8	-159.9	-65.4	+100.6	-65.8	-108.9	-260.4
X	Y	Z	Pitch	Yaw	Roll	
0	0	0	0.0	0.0	0.0	
FOR	Loaded – MBS PDGF 3, SR Held					
Disp	ISS>W4MBS PDGF 3					

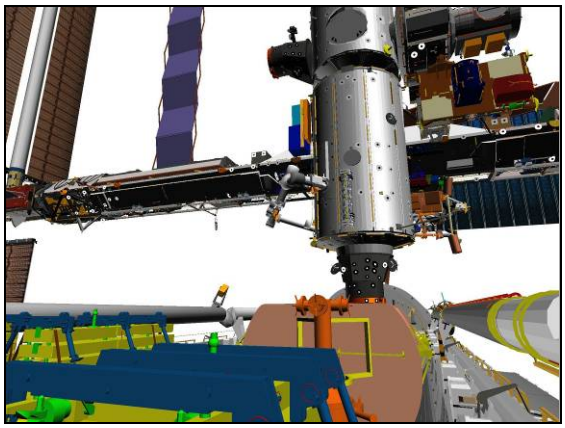

Figure 13.- Grapple
(91: Camera C: -20, +15).

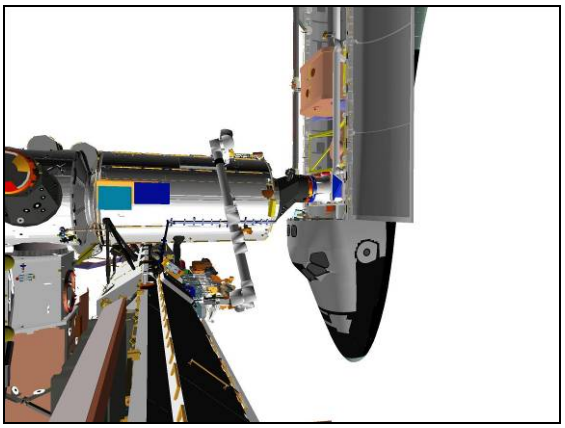

Figure 14.- Grapple
(09: P1 Lower Outboard: +110, 0).

12. WS4 MBS PDGF 3 SEMI-MANUAL RELEASE

MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

12.1 SSRMS Limp

PCS MSS: SSRMS: Limp: SSRMS Limp

cmd All Limp (Verify Limp – blue)

MSS: SSRMS: SSRMS

Verify all joints – Limped

Wait 30 seconds.

MSS: SSRMS: Limp: SSRMS Limp

cmd None Limp (Verify Standby – blue)

12.2 Entering Manual Mode

MSS: SSRMS: Rate: SSRMS Rate

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

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

12.3 WS4 MBS PDGF 3 Release

MSS: SSRMS: Tip LEE: SSRMS Tip LEE

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

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

CAUTION
Due to end-to-end system latency, the RHC Trigger is hot up to 3 seconds prior to receiving a Trigger Hot icon status on the PCS.

NOTE
Once the trigger is hot, only safing or trigger commands should be sent to the Robotics equipment. If a configuration change is required, including routing MSS Cameras, safe the system to exit LEE operations (SCR 23262, 14662).

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Rigidize

RHC TRIGGER → press (momentarily) (SCR 19064)

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

cmd Release ▶ Semi-manual ▶ Slow (Verify Speed – Slow)

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

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Semi-manual Release

RHC TRIGGER → press (hold until 'Umbilical' Demate – blue) (10 s max)

TRIGGER → press (hold until 'Latch' Unlatch – blue) (65 s max)

TRIGGER → press (hold until 'Carriage' Derigidize – blue) (90 s max)

TRIGGER → press (hold until 'Snare' Open – blue) (12 s max)

12.4 Maneuvering Away From MBS PDGF 3

THC Back off from grapple fixture until clear of pin.

12.5 WS4 MBS PDGF 3 Ungrapple Cleanup

RHC TRIGGER → press (hold until Motors – Inh) (90 s max)

PCS Verify 'Carriage' Extend – blue

THC Maneuver SSRMS to Grapple Fixture Backoff position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
+86.8	-151.3	-64.1	+95.8	-53.1	-116.6	-250.7
X	Y	Z	Pitch	Yaw	Roll	
-150	0	0	0.0	0.0	0.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	ISS>W4MBS PDGF 3					

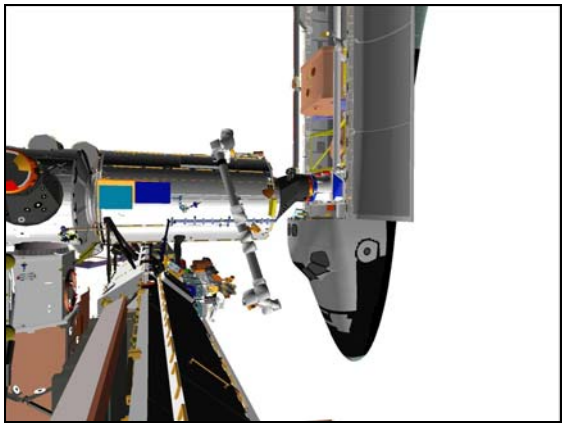

Figure 15.- Grapple Fixture Backoff (09: P1 Lower Outboard: +110, 0).

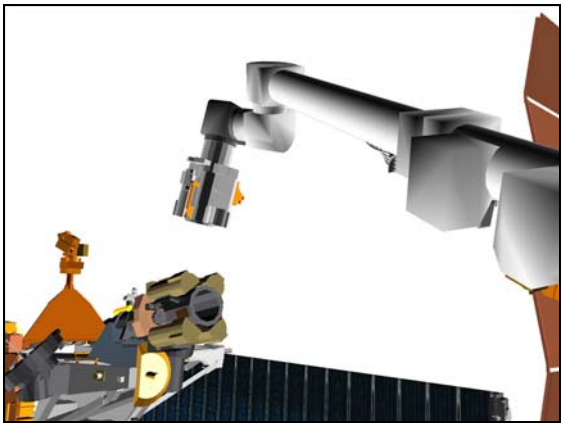

Figure 16.- Grapple Fixture Backoff (22: Base Elbow: +105, -20).

13. MANEUVERING TO SSRMS OVERNIGHT PARK

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
09: P1 Lower Outboard (+110, 0) 91: Camera C (-20, +15)	22: Base Elbow (+105, -20) 24: Tip Elbow (+175, 0)	37: MBS Mast (-15, 0) 13: LAB Stbd Zenith (+30, -30)

13.1 Single Joint Maneuver to Intermediate

PCS MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

THC Perform Single Joint maneuver to Intermediate 2 position (within 1 deg).

	SR	SY	SP	EP	WP	WY	WR
Grapple Fixture Backoff	+86.8	-151.3	-64.1	+95.8	-53.1	-116.6	-250.7
1: SP –			-90.0				
2: SR +	+105.0						
3: SP –			-180.0				
4: SY –		-190.0					
5: EP +				+107.3			
6: SR –	-73.4						
Intermediate 2	-73.4	-190.0	-180.0	+107.3	-53.1	-116.6	-250.7
	X	Y	Z	Pitch	Yaw	Roll	
	+158	+93	+1684	+177.3	-12.0	+3.5	
	FOR	Unloaded – LEE Tip, SR Held					
	Disp	ISS>W4MBS PDGF 3					

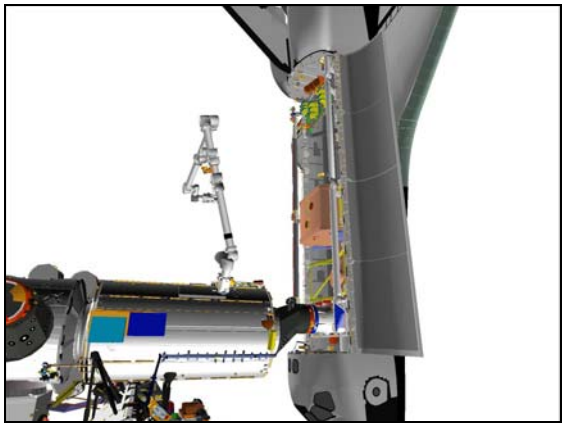

Figure 17.- Intermediate 2
(09: P1 Lower Outboard: +110, +20).

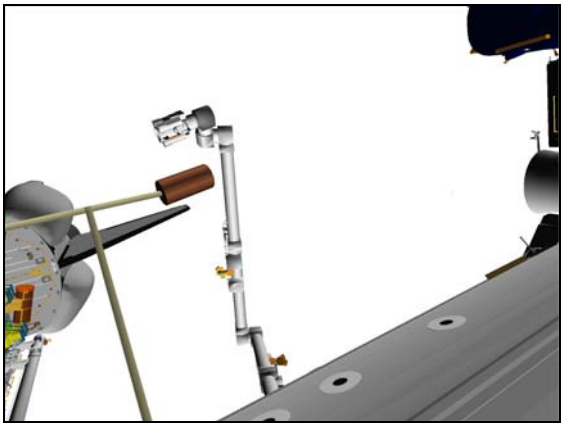

Figure 18.- Intermediate 2
(13: LAB Stbd Zenith: +30, -30).

13.2 Joint OCAS Maneuver to Overnight Park

MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for SSRMS Overnight Park position.

SR	SY	SP	EP	WP	WY	WR
-73.4	-190.0	-125.5	+107.3	-119.2	-201.3	+111.3

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)	-73.4	-190.0	-180.0	+107.3	-53.1	-116.6	-250.7
TGT	**-73.4**	**-190.0**	**-125.5**	**+107.3**	**-119.2**	**-201.3**	**+111.3**
ERR	0.0	0.0	-54.5	0.0	+66.1	+84.7	-362.0

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-73.4	-190.0	-125.5	+107.3	-119.2	-201.3	+111.3

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

SR	SY	SP	EP	WP	WY	WR
-73.4	-190.0	-125.5	+107.3	-119.2	-201.3	+111.3
X	Y	Z	Pitch	Yaw	Roll	
+281	-469	+1080	+93.0	+3.9	+3.7	
FOR	Unloaded – LEE Tip, SR Held					
Disp	ISS>W4MBS PDGF 3					

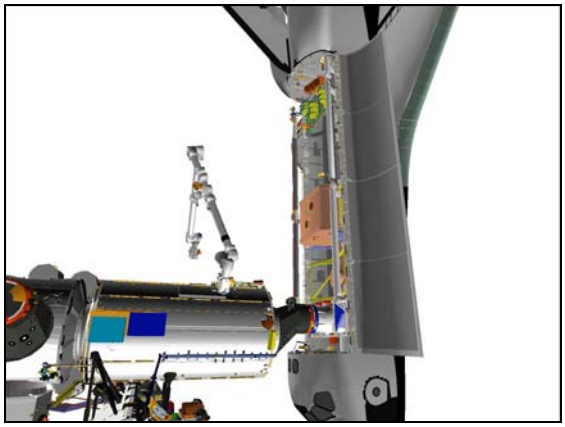

Figure 19.- SSRMS Overnight Park
(09: P1 Lower Outboard: +110, +20).

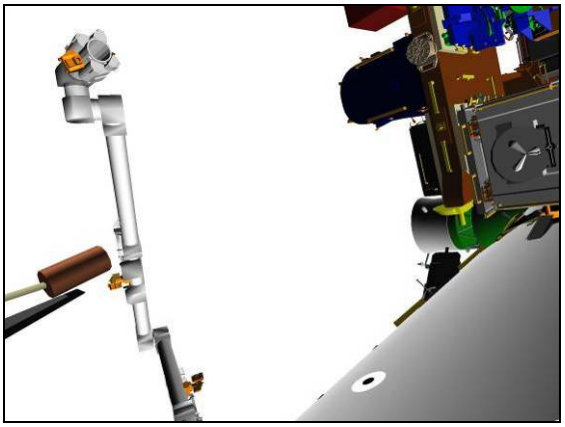

Figure 20.- SSRMS Overnight Park
(13: LAB Stbd Zenith: +45, -20).

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)

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5.104 P1 PUMP MODULE RETURN TO ICC

(RBT FS/12A.1/FIN) Page 1 of 15 pages

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
92: Camera B (+25, +30) 91: Camera D (-40, +65)	13: LAB Stbd Zenith (+45, -20) 37: MBS Mast (+100, -20)	22: Base Elbow (+95, 0) 03: S1 Lower Outboard (+90, +20)

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

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

Change Command ▶ ISS ▶ ISSACS/Internal (Verify ISS>ISSACS/Internal)

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

SR	SY	SP	EP	WP	WY	WR
-73.4	-190.0	-125.5	+107.3	-119.2	-201.3	+111.3
X	Y	Z	Pitch	Yaw	Roll	
+285	+679	+1003	+92.8	-4.7	-164.1	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

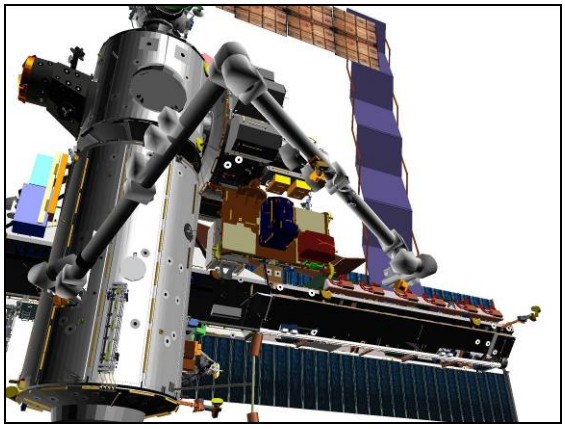

Figure 1.- SSRMS Overnight Park (92: Camera B: +25, +30).

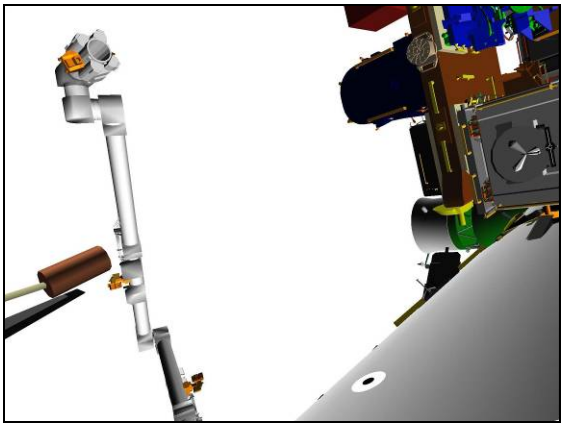

Figure 2.- SSRMS Overnight Park (13: LAB Stbd Zenith: +45, -20).

2. APFR INSTALL

PCS MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → VERNIER (Verify Vernier on PCS)

PCS MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

On EVA Go,

THC/ RHC Maneuver to APFR Install position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-48.0	-190.0	-85.5	+108.4	-166.9	-217.4	+133.5
X	Y	Z	Pitch	Yaw	Roll	
+185	+679	+454	+92.8	-4.7	-164.1	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

THC/ RHC Maneuver SSRMS per EVA GCA to install the APFR.

NOTE

1. APFR Setting is 12/PP/F/6.
2. The clearance between the Upper Boom and the FHRC is approximately 20 inches at this position and can be monitored with the S1 Lower Outboard Camera.

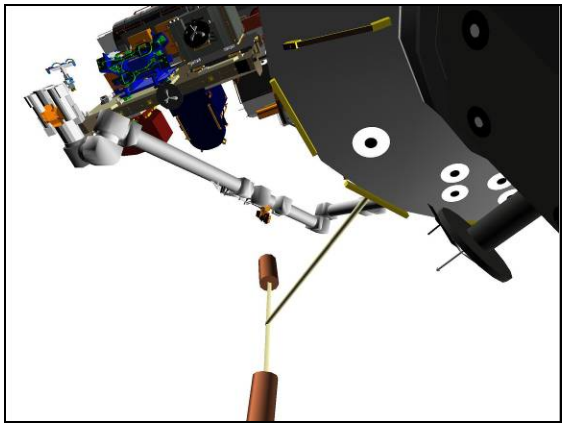

Figure 3.- APFR Install
(91: Camera D: -30, +50).

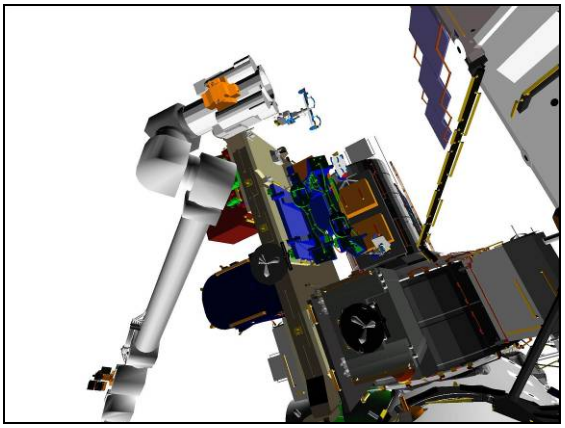

Figure 4.- APFR Install
(13: LAB Stbd Zenith: +65, +10).

3. APFR INGRESS
After APFR Installation and on EVA go,

THC/ RHC — Maneuver to APFR Ingress position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-63.9	-190.0	-106.4	+113.0	-145.5	-207.6	+118.9
X	Y	Z	Pitch	Yaw	Roll	
+255	+679	+703	+92.8	-4.7	+164.1	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

THC/ RHC — Maneuver SSRMS per EVA GCA to Ingress APFR.

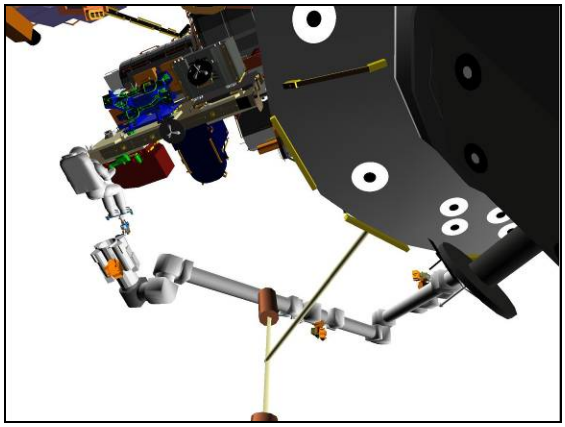

Figure 5.- APFR Ingress
(91: Camera D: -20, +60).

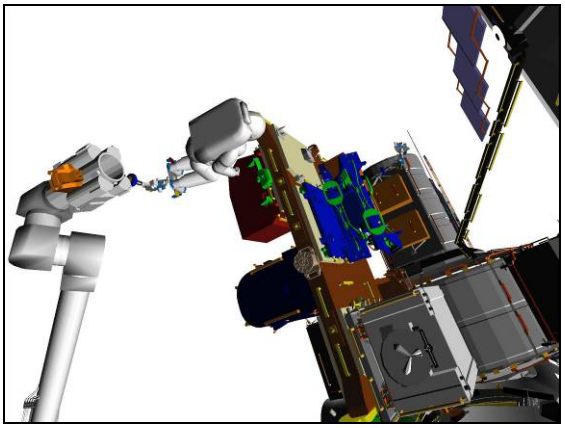

Figure 6.- APFR Ingress
(13: LAB Stbd Zenith: +60, +10).

4. FGB REMOVAL
When APFR ingress is complete and on EVA Go,

PCS — MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

Change Unloaded Parameters ▶ EVA ▶ Chest 12/PP/F/6 SYH
Verify 'Unloaded Parameters' (two) – Chest 12/PP/F/6, SY Held

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC — Maneuver to FGB Removal position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-52.6	-190.0	-111.8	+140.3	-170.6	-214.7	+129.0
X	Y	Z	Pitch	Yaw	Roll	
+160	+364	+500	-177.1	-1.1	-175.3	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	ISS>ISSACS					

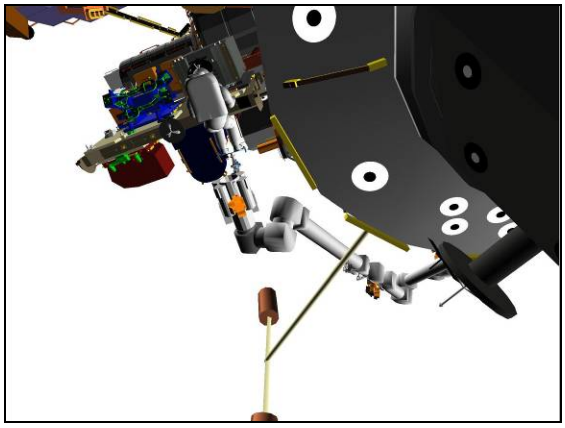

Figure 7.- FGB Removal
(91: Camera D: -20, +60).

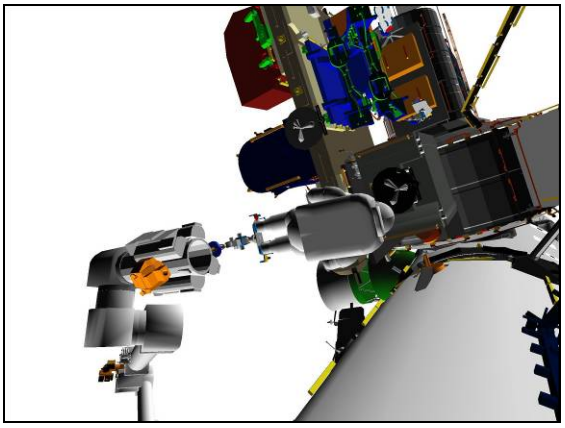

Figure 8.- FGB Removal
(13: LAB Stbd Zenith: +60, -10).

THC/ RHC — Maneuver SSRMS per EVA GCA to remove the FGB from the pump module.

5. FAILED PUMP MODULE REMOVAL

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: Camera D (-20, +50) 92: Camera B (20, +10)	13: LAB Stbd Zenith (+50, -10) 37: MBS Mast (+100, -20)	22: Base Elbow (+50, 0) 24: Tip Elbow (0, +10)

On EVA Go,

THC/ RHC — Maneuver to Failed Pump Module Removal position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-52.6	-190.0	-111.8	+140.3	-170.6	-214.7	+129.0
X	Y	Z	Pitch	Yaw	Roll	
+160	+364	+500	-177.1	-1.1	-175.3	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	ISS>ISSACS					

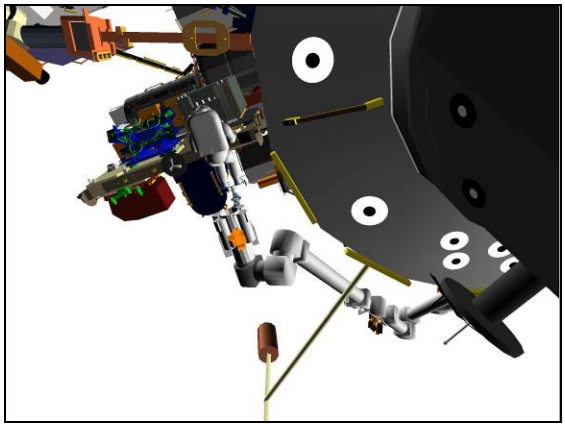

Figure 9.- Failed Pump Module Removal (91: Camera D: -20, +65).

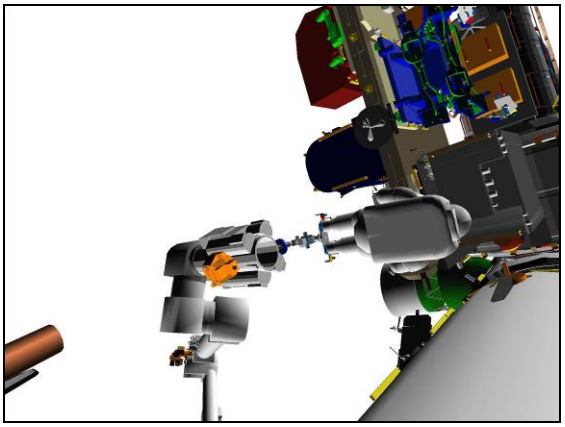

Figure 10.- Failed Pump Module Removal (13: LAB Stbd Zenith: +50, -10).

THC/ RHC — Maneuver SSRMS per EVA GCA to allow EVA to obtain a firm grip on the failed pump module.

6. ESP2 BACKOFF

NOTE
At the end of this maneuver, the SSRMS Wrist is approximately 15 inches from the UHF Antenna. This clearance can be monitored with the MBS Mast Camera.

On EVA Go,

THC/ RHC — Maneuver to Backoff position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-63.6	-190.0	-111.7	+140.9	-168.1	-207.8	+119.2
X	Y	Z	Pitch	Yaw	Roll	
+260	+364	+500	-177.1	-1.1	-175.3	
FOR	Unloaded – Chest 12/PP/F/6, SY Held					
Disp	ISS>ISSACS					

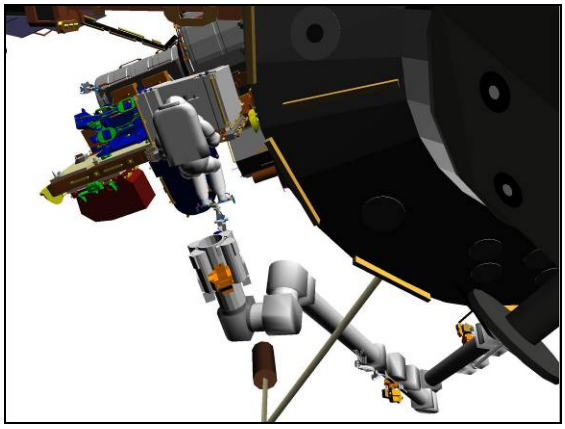

Figure 11.- ESP2 Backoff
(91: Camera D: -20, +65).

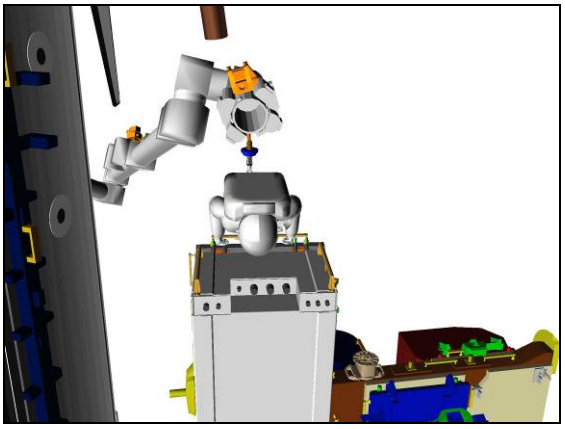

Figure 12.- ESP2 Backoff
(37: MBS Mast: +100, -20).

Pause to allow EVA to reposition the pump module to hold the bottom Handrails before maneuvering further.

7. ESP2 CLEARANCE
When Pump Module reposition is complete and on EVA go,

THC/ RHC — Maneuver to ESP2 Clearance position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-78.3	-190.0	-154.2	+127.5	-110.1	-198.0	+107.6
X	Y	Z	Pitch	Yaw	Roll	
+260	+364	+950	-177.1	-1.1	-175.3	
FOR	Unloaded – Ch12PPF6, SY Held					
Disp	ISS>ISSACS					

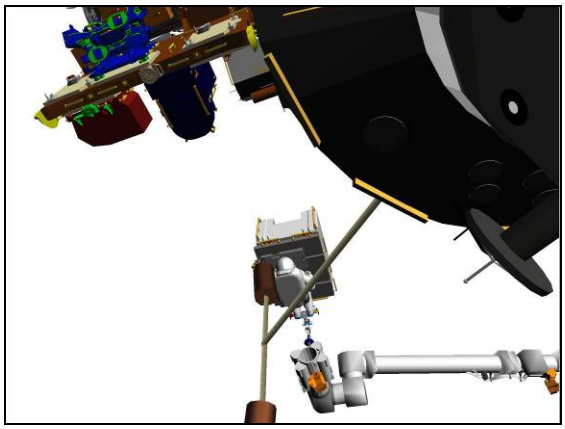

Figure 13.- ESP2 Clearance
(91: Camera D: -20, +55).

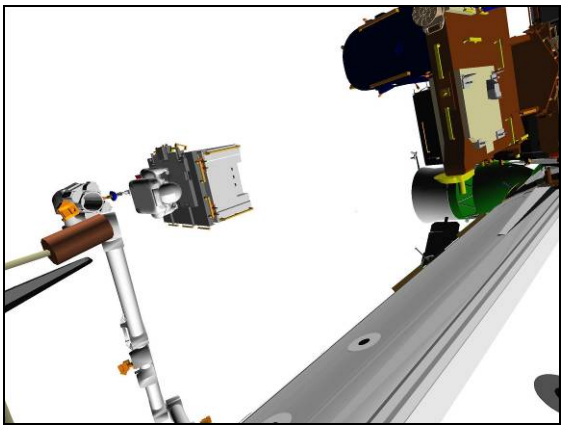

Figure 14.- ESP2 Clearance
(13: LAB Stbd Zenith: +45, -25).

8. ICC CLEARANCE

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
92: Camera B (+25, +30) 91: SRMS Elbow (-15, +35)	03: S1 Lower Outboard (+90, +20) 09: P1 Lower Outboard (+110, +20)	24: Tip Elbow (+10, 0) 22: Base Elbow (0, 0)

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Pump Module Install Clearance position.

SR	SY	SP	EP	WP	WY	WR
-91.3	-190.0	-183.8	+122.7	-186.4	-102.6	+185.3

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)	-78.3	-190.0	-154.3	+127.5	-110.2	-198.0	+107.6
TGT	**-91.3**	**-190.0**	**-183.8**	**+122.7**	**-186.4**	**-102.6**	**+185.3**
ERR	+13.0	0.0	+29.5	+4.8	+76.2	-95.4	-77.7

NOTE
Expect singularity warning for EP between -15 and +15 deg.

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-91.3	-190.0	-183.8	+122.7	-186.4	-102.6	+185.3

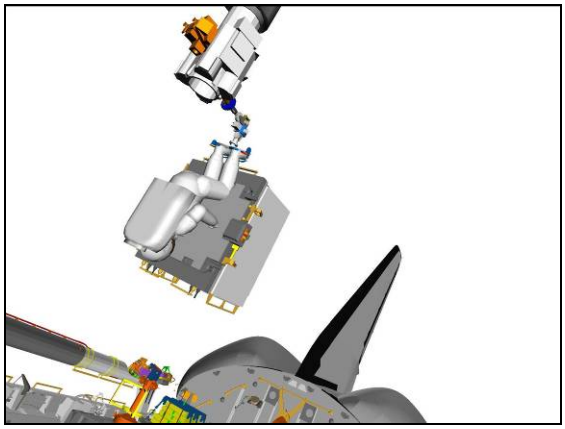

Figure 15.- ICC Clearance
(91: SRMS Elbow: -15, +35)

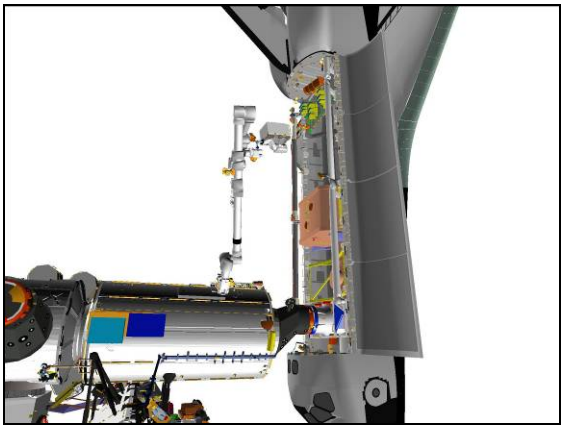

Figure 16.- ICC Clearance
(09: P1 Lower Outboard: +110, +20).

Give EVA a Go to reposition the pump module.

9. FAILED PUMP MODULE HANDOFF TO EV CREW
Configure cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (-15, +35) 92: Camera B (+25, +30)	09: P1 Lower Outboard (+110, +20) 03: S1 Lower Outboard (+90, +20)	24: Tip Elbow (-20, +20) 22: Base Elbow (0, 0)

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MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

On EVA Go,

THC/ RHC — Maneuver to Pump Module Handoff position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-97.6	-190.0	-181.7	+120.9	-194.6	-108.5	+178.2
X	Y	Z	Pitch	Yaw	Roll	
+800	+49	+1687	-100.0	-2.8	+5.2	
FOR	Unloaded – Ch12PPF6, SY Held					
Disp	ISS>ISSACS					

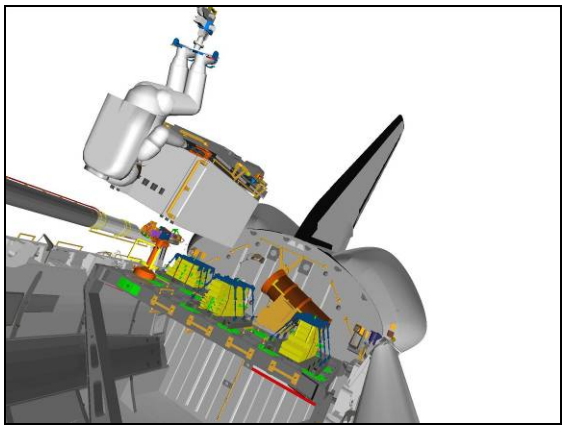

Figure 17.- Pump Module Handoff (91: SRMS Elbow: -15, +15).

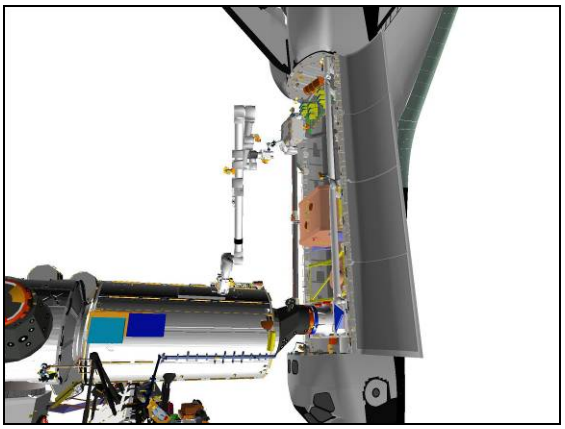

Figure 18.- Pump Module Handoff (09: P1 Lower Outboard: +110, +20).

THC/ RHC — Maneuver SSRMS per EVA GCA to Handoff the Pump Module to EV Crew.

After pump module handoff complete and on EVA go,

THC/ RHC — Maneuver to SSRMS per EVA GCA to egress the APFR then maneuver clear of structure.

DCP — BRAKES SSRMS → ON (Verify ON)

After pump module installation on the ICC is complete and on EVA go,

DCP — BRAKES SSRMS → OFF (Verify OFF)

PCS — MSS: SSRMS: [SSRMS]

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: [Joint Lock]

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC — Maneuver SSRMS per EVA GCA to ingress the APFR.

10. AUTOSEQUENCE START
On EVA Go,

THC/ RHC — Maneuver to Autosequence Start position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-97.6	-190.0	-181.7	+120.9	-194.6	-108.5	+178.2
X	Y	Z	Pitch	Yaw	Roll	
+800	+49	+1687	-100.0	-2.8	+5.2	
FOR	Unloaded – Ch12PPF6, SY Held					
Disp	ISS>ISSACS					

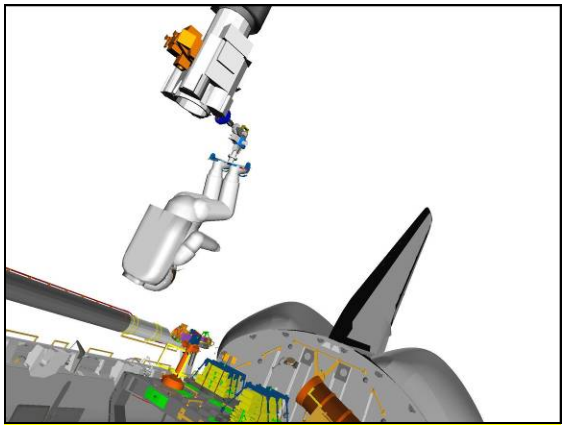

Figure 19.- Autosequence Start
(91: SRMS Elbow: -20, +30).

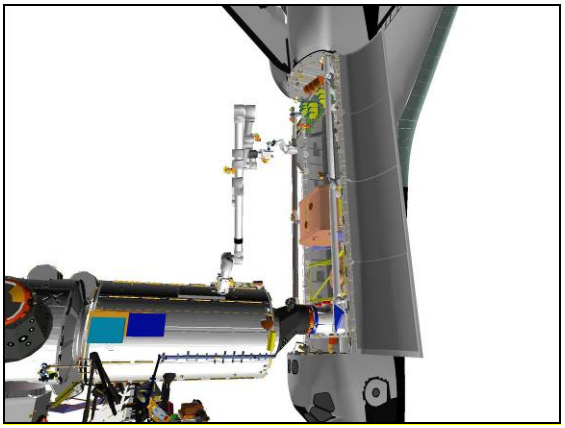

Figure 20.- Autosequence Start
(09: P1 Lower Outboard: +110, +20).

11. ESP2 CLEARANCE
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: SRMS Elbow (-20, +30) 91: Camera D (-20, +50)	09: P1 Lower Outboard (+110, 0) 03: S1 Lower Outboard (+90, +20)	24: Tip Elbow (-20, +20) 13: LAB Stbd Zenith (+45, -20)

PCS — MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for ESP2 Clearance position.

SR	SY	SP	EP	WP	WY	WR
-66.6	-190.0	-145.1	+134.7	-128.0	-205.8	+116.8

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)	-97.6	-190.0	-181.7	+120.9	-194.6	-108.5	+178.2
TGT	**-66.6**	**-190.0**	**-145.1**	**+134.7**	**-128.0**	**-205.8**	**+116.8**
ERR	-31.0	0.0	-36.6	-13.8	-66.6	+97.3	+61.4

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify Joint Angle values.

SR	SY	SP	EP	WP	WY	WR
-66.6	-190.0	-145.1	+134.7	-128.0	-205.8	+116.8

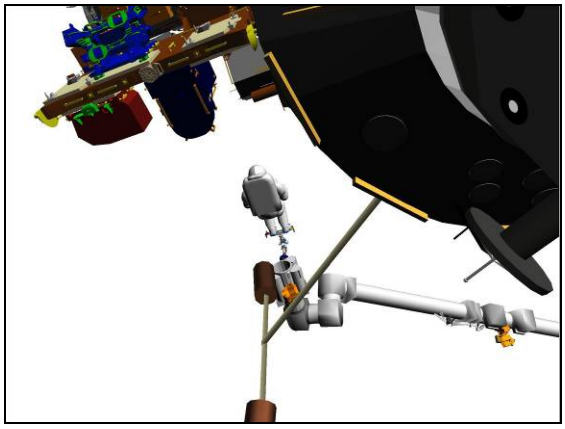

Figure 21.- ESP2 Clearance
(91: Camera D: -20, +55).

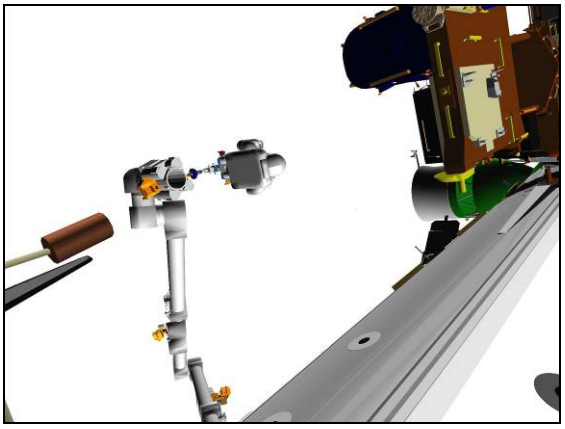

Figure 22.- ESP2 Clearance
(13: LAB Stbd Zenith: +45, -25).

12. APFR EGRESS

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
91: Camera D (-20, +55)	03: S1 Lower Outboard (+90, +20) 09: P1 Lower Outboard (+110, 0)	22: Base Elbow (+90, 0) 37: MBS Mast (+100, -20)

On EVA Go,

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC Maneuver to APFR Egress position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-64.0	-190.0	-106.6	+113.1	-145.3	-207.5	+118.9
X	Y	Z	Pitch	Yaw	Roll	
+160	+664	+550	-177.1	-1.1	-175.3	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

THC/ RHC Maneuver SSRMS per EVA GCA to Egress the APFR.

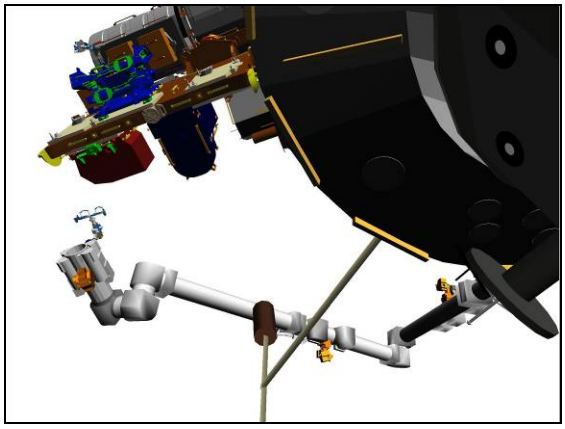

Figure 23.- APFR Egress
(91: Camera D: -20, +60).

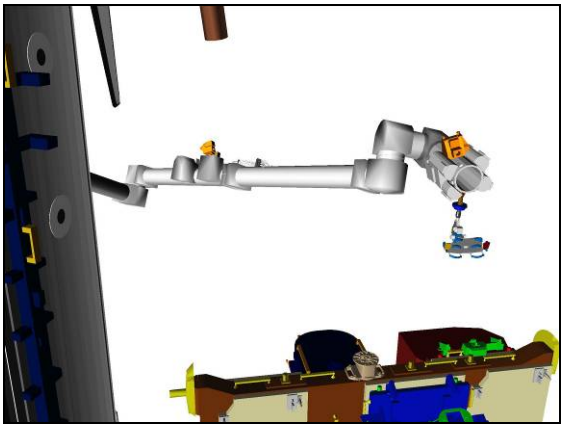

Figure 24.- APFR Egress
(37: MBS Mast: +100, -20).

13. APFR REMOVAL
On EVA Go,

PCS MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

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

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC Maneuver to APFR Removal position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-48.0	-190.0	-85.6	+108.4	-166.8	-217.4	+133.5
X	Y	Z	Pitch	Yaw	Roll	
+185	+679	+454	+92.7	-4.7	-164.1	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

THC/ RHC Maneuver SSRMS per EVA GCA to remove the APFR.

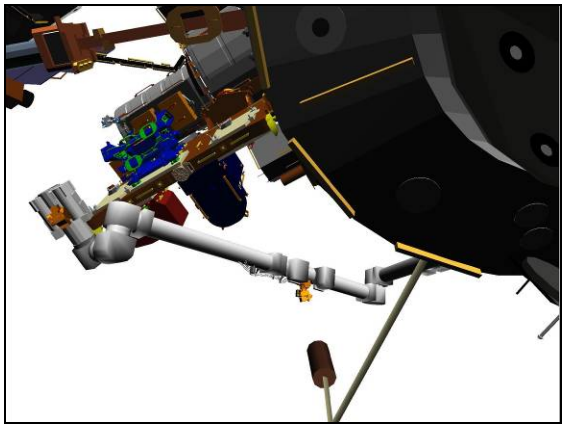

Figure 25.- APFR Removal
(91: Camera D: -30, +65).

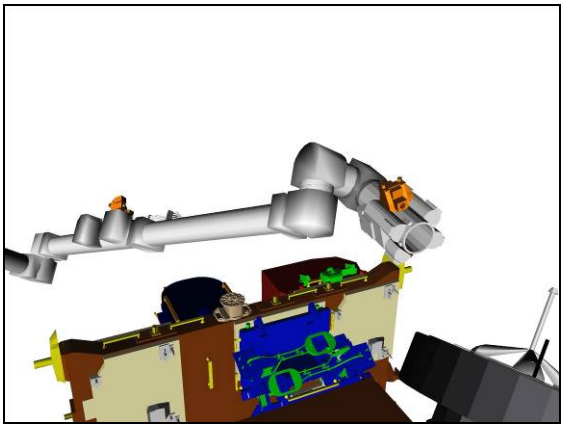

Figure 26.- APFR Removal
(37: MBS Mast: +115, -25).

14. OVERNIGHT PARK
On EVA Go,

THC/ RHC — Maneuver to Overnight Park position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-73.4	-190.0	-125.5	+107.3	-119.2	-201.3	+111.3
X	Y	Z	Pitch	Yaw	Roll	
+285	+679	+1003	+92.7	-4.7	-164.1	
FOR	Unloaded – LEE Tip, SY Held					
Disp	ISS>ISSACS					

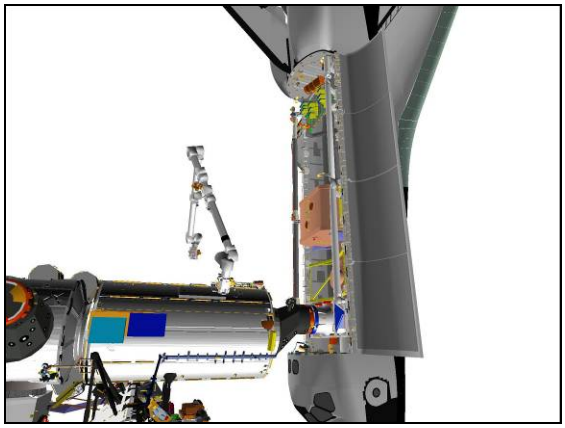

Figure 27.- SSRMS Overnight Park
(09: P1 Lower Outboard: +110, +20).

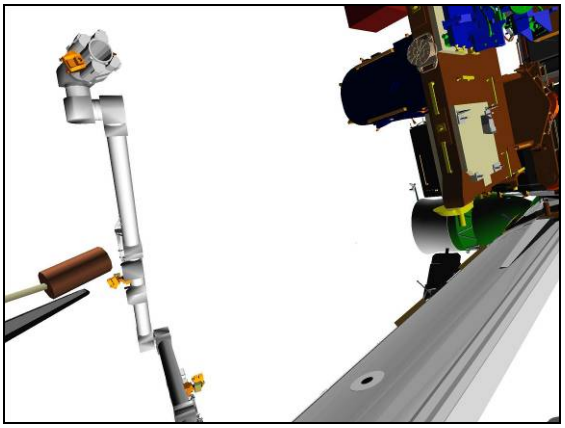

Figure 28.- SSRMS Overnight Park
(13: LAB Stbd Zenith: +45, -20).

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)

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1. SETUP

NOTE
1. During the channel 2/3 power reconfig on EVA 2, there is limited video capability available. Only one shuttle camera view (Channel 91) and three station camera views are available. Of the three station camera views available, only two SSRMS Cameras, or one SSRMS Camera and one MBS Camera, are available at the same time. 2. During the channel 1/4 power reconfig on EVA 3, there is limited video capability available. Only one shuttle camera view (Channel 92) and one station camera view are available. The one station camera view available can only be an SSRMS or MBS Mast Camera.

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
SRMS Elbow (+55, -55)	22: Base Elbow (+40, -5)	13: LAB Stbd Zenith (-180, +15) 03: S1 Lower Outboard (+60, -15)

If EVA 3, go to step 2.3.

PCS MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

Change Unloaded Parameters ▶ EVA ▶ Chest 12/PP/F/6 SYH
Verify 'Unloaded Parameters' (two) – Chest 12/PP/F/6, SY Held

Verify Display – W3>ISSACS
Verify Command – W3>ISSACS/Internal

Verify EVA at Truss Clearance position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-180.0	+97.8	-107.5	+146.9	-131.3	+175.5	+127.0
X	Y	Z	Pitch	Yaw	Roll	
+400	+200	-100	-179.9	0.0	0.0	
FOR	Chest 12/PP/F/6, SY Held					
Disp	W3>ISSACS					

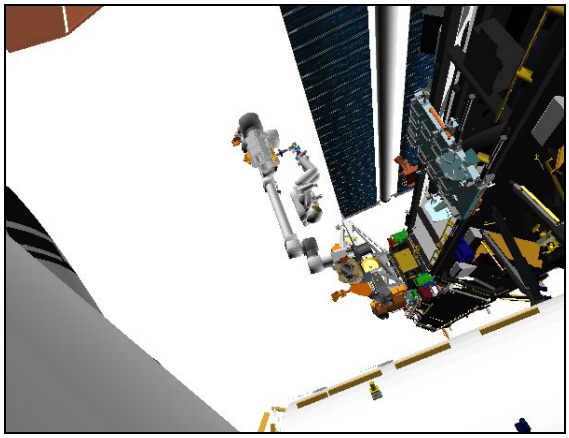

Figure 1.- Truss Clearance Position (SRMS Elbow: +55, -55).

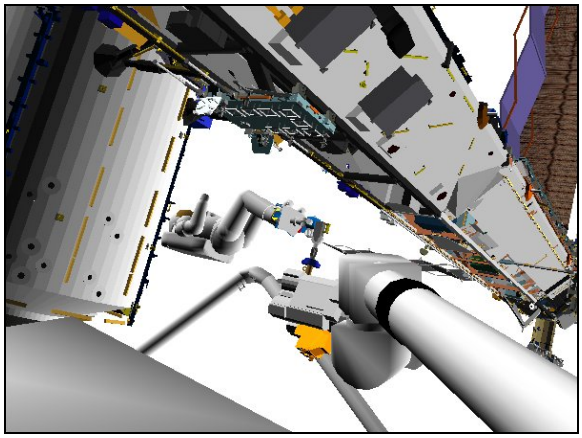

Figure 2.- Truss Clearance Position (22: Base Elbow: +40, -5).

2. SPARE MBSU REMOVAL FROM ESP-2

2.1 Single Joint Maneuver to Intermediate Position

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

THC Perform Single Joint maneuver to Intermediate position (within 1 deg).

	SR	SY	SP	EP	WP	WY	WR
Truss Clear	-180.0	+97.8	-107.5	+146.9	-131.2	+175.5	+127.0
1: SY –		0.0					
2: SP +			-30.0				
Intermediate	-180.0	0.0	-30.0	+146.9	-131.1	+175.5	+127.0
	X	Y	Z	Pitch	Yaw	Roll	
	+583	+686	+273	-92.9	-71.4	+156.6	
	FOR	Chest 12/PP/F/6, SY Held					
	Disp	W3>ISSACS					

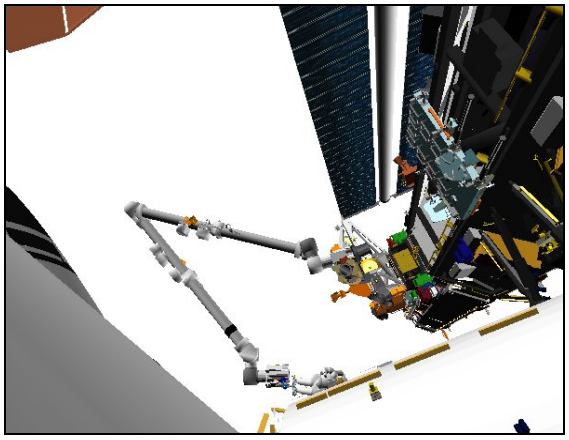

Figure 3.- Intermediate Position
(SRMS Elbow: +55, -55).

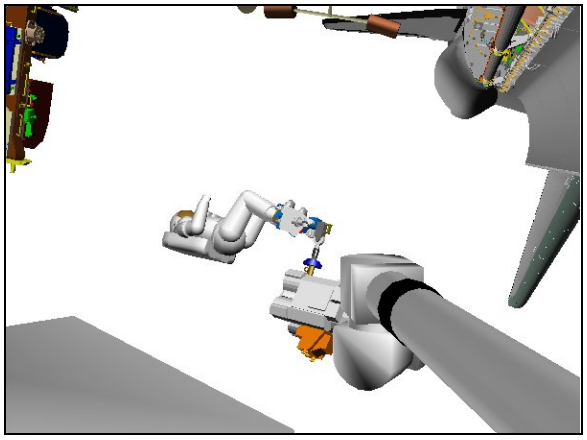

Figure 4.- Intermediate Position
(22: Base Elbow: +40, -5).

2.2 Joint OCAS to MBSU Removal Setup Position

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
SRMS Elbow (+55, -55) Camera D (-90, +10)	22: Base Elbow (+40, -5)	13: LAB Stbd Zenith (-60, +30) 03: S1 Lower Outboard (+60, -10)

NOTE

Monitor clearance between SSRMS Elbow and Orbiter Payload Bay Door with LAB Starboard Zenith or Base Elbow. During the maneuver to MBSU Removal Setup, the distance gets as close as ~122 cm (4 ft).

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PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for MBSU Removal Setup position.

SR	SY	SP	EP	WP	WY	WR
-189.4	0.0	+67.0	+117.5	-178.0	+169.6	+95.5

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	0.0	-30.0	+146.9	-131.3	+175.5	+127.0
TGT	**-189.4**	**0.0**	**+67.0**	**+117.5**	**-178.0**	**+169.6**	**+95.5**
ERR	+9.4	0.0	-97.0	+29.4	+46.7	+5.9	+31.5

****
* If joint angles or errors are incorrect
PCS * | **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* | Input correct Dest joint angles per table above.
*
* | **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * | Verify joint angles and errors are correct on Joint Angle Position
* | overlay.
****

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 MBSU Removal Setup position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-189.4	0.0	+67.0	+117.5	-178.0	+169.6	+95.5
X	Y	Z	Pitch	Yaw	Roll	
-122	+900	+496	135.9	-88.9	+45.5	
FOR	Chest 12/PP/F/6, SY Held					
Disp	W3>ISSACS					

Figure 5.- MBSU Removal Setup Position (Camera D: -70, +40).

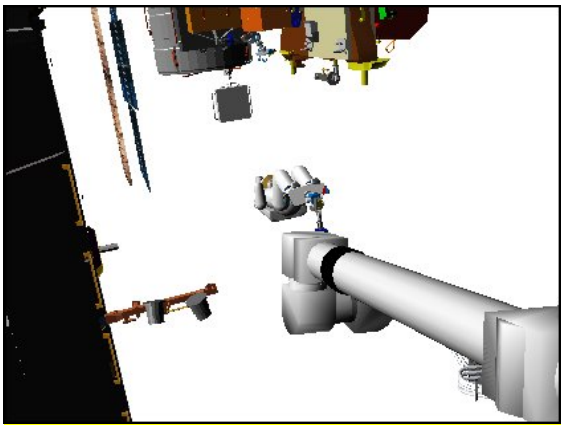

Figure 6.- MBSU Removal Setup Position (22: Base Elbow: +80, -5).

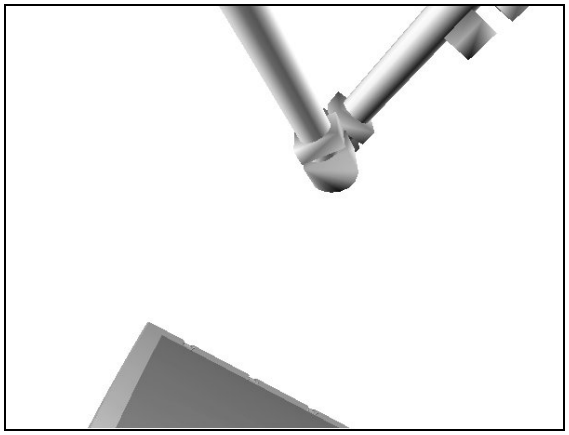

Figure 7.- MBSU Removal Setup Position (13: Lab Stbd Zenith: -60, +30).

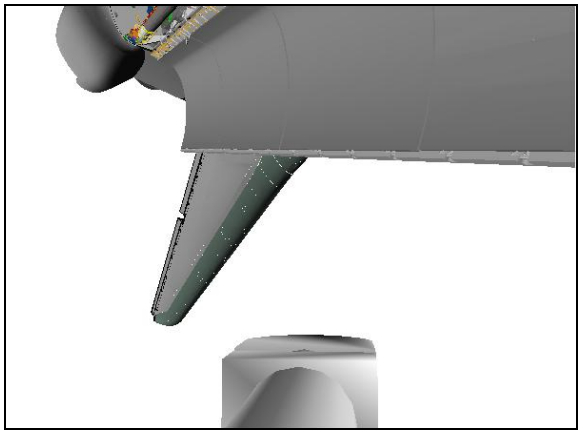

Figure 8.- MBSU Removal Setup Position (22: Base Elbow: +175, +5).

2.3 Spare MBSU Removal

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

On EVA GO, GCA as required to remove Spare MBSU.

When Spare MBSU Removal complete,

THC/ RHC — Maneuver EVA to Spare MBSU Removal Clearance position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-201.2	0.0	+49.7	+118.0	-159.2	+171.2	+83.6
X	Y	Z	Pitch	Yaw	Roll	
+100	+1000	+500	+179.4	-89.2	+88.3	*
FOR	Chest 12/PP/F/6, SY Held					
Disp	W3>ISSACS					

*display singularity

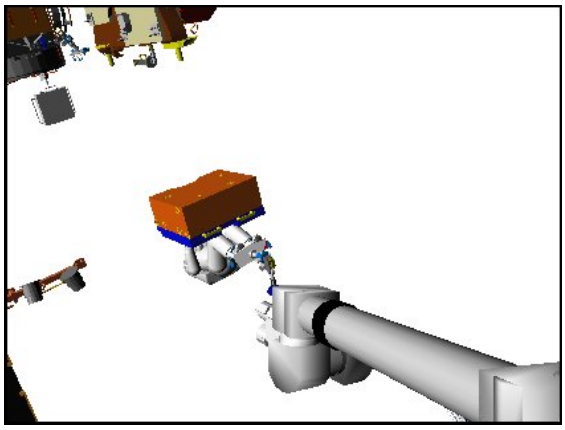

Figure 9.- MBSU Removal Clearance Position
(22: Base Elbow: +80, 0).

3. SPARE MBSU TEMPORARY STOW ON CETA CART

3.1 Joint OCAS to Intermediate Position

PCS — MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input ‘Joint Angles’ ‘Destination’ for Intermediate position.

SR	SY	SP	EP	WP	WY	WR
-180.0	0.0	-30.0	+146.9	-131.2	+175.5	+127.0

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)	-201.5	0.0	+49.5	+118.0	-159.2	+171.2	+83.6
TGT	-180.0	0.0	-30.0	+146.9	-131.2	+175.5	+127.0
ERR	-21.5	0.0	+79.5	-28.9	-28.0	-4.3	-43.4

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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 Intermediate position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-180.0	0.0	-30.0	+146.9	-131.2	+175.5	+127.0
X	Y	Z	Pitch	Yaw	Roll	
+582	+686	+273	-93.0	-71.3	+156.5	
FOR	Chest 12/PP/F/6, SY Held					
Disp	W3>ISSACS					

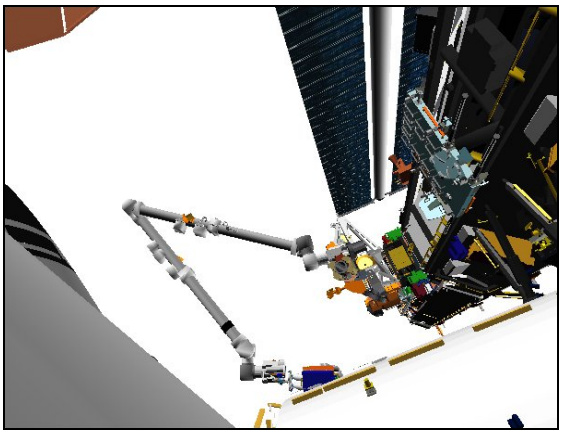

Figure 10.- Intermediate Position
(SRMS Elbow: +55, -55).

3.2 Single Joint Maneuver to Truss Clearance Position
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
SRMS Elbow (+55, -55)	22: Base Elbow (+40, 0)	13: LAB Stbd Zenith (-130, +50)

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

THC Perform Single Joint maneuver to Truss Clearance position (within 1 deg).

	SR	SY	SP	EP	WP	WY	WR
Intermediate	-180.0	0.0	-30.0	+146.9	-131.2	+175.5	+127.0
1: SP –			-107.5				
2: SY +		+97.8					
Truss Clear	-180.0	+97.8	-107.5	+146.9	-131.2	+175.5	+127.0
	X	Y	Z	Pitch	Yaw	Roll	
	+400	+201	-99	-179.9	0.0	+0.1	
	FOR	Chest 12/PP/F/6, SY Held					
	Disp	W3>ISSACS					

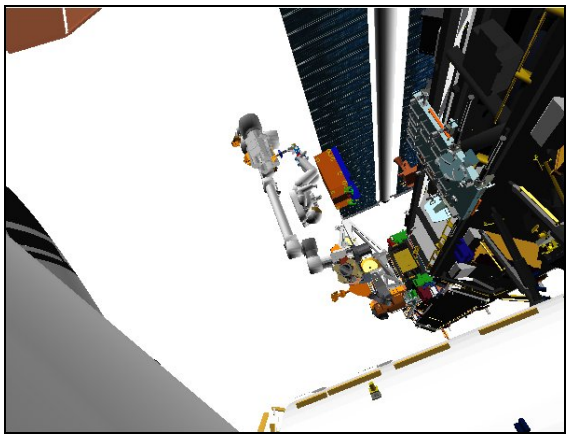

Figure 11.- Truss Clearance Position (SRMS Elbow: +55, -55).

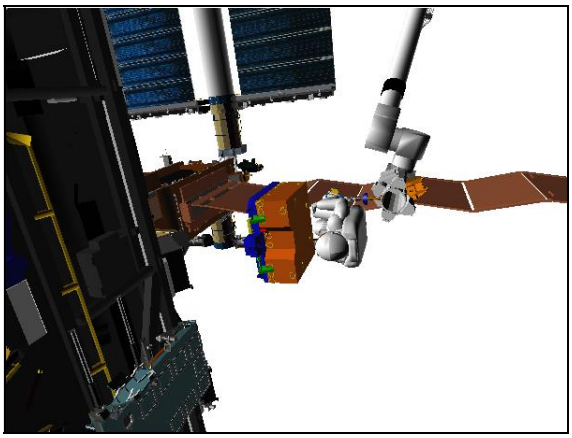

Figure 12.- Truss Clearance Position (13: LAB Stbd Zenith: +160, 0).

3.3 Maneuvering to Stow MBSU on CETA Cart

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
SRMS Elbow (+55, -55)	22: Base Elbow (+40, -5)	13: LAB Stbd Zenith (+160, 0)

PCS

MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

Change Unloaded Parameters ▶ EVA ▶ Chest 12/PP/F/6 SRH
Verify 'Unloaded Parameters' (two) – Chest 12/PP/F/6, SR Held

When CETA Cart Brake Handles have been deployed (down),

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

THC/ RHC

Maneuver EVA to CETA Cart Clearance position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+92.1	-80.0	+133.5	-144.9	+175.3	+121.3
X	Y	Z	Pitch	Yaw	Roll	
+400	0	0	-179.9	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

Maneuver SSRMS per EVA GCA to temporarily stow spare MBSU on CETA Cart.

When spare MBSU is stowed,

THC/ RHC

Maneuver EVA to CETA Cart Clearance position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+92.1	-80.0	+133.5	-144.9	+175.3	+121.3
X	Y	Z	Pitch	Yaw	Roll	
+400	0	0	-179.9	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

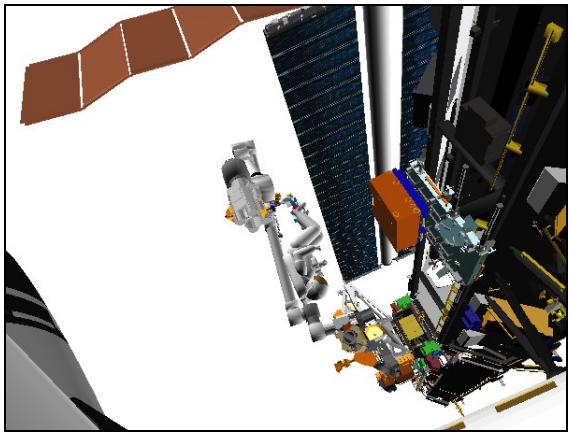

Figure 13.- CETA Cart Clearance Position (SRMS Elbow: +55, -45).

Figure 14.- CETA Cart Clearance Position (13: LAB Stbd Zenith: +160, -20).

4. FAILED MBSU REMOVAL

For Starboard Zenith MBSU (MBSU 1) removal, perform step 4.1.
For Starboard Nadir MBSU (MBSU 3) removal, perform step 4.2.
For Port Zenith MBSU (MBSU 4) removal, perform step 4.3.
For Port Nadir MBSU (MBSU 2) removal, perform step 4.4.

4.1 Starboard Zenith MBSU Removal

THC/ RHC

Maneuver EVA to Starboard Zenith MBSU Removal position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+128.3	-98.9	+121.2	-86.9	+199.7	+161.9
X	Y	Z	Pitch	Yaw	Roll	
+198	+122	-246	-143.3	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

GCA as required to remove MBSU.

Go to step 5.

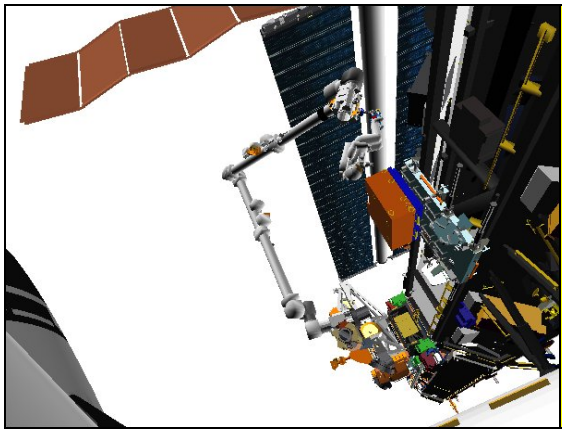

Figure 15.- Stbd Zenith MBSU Removal (SRMS Elbow: +55, -45).

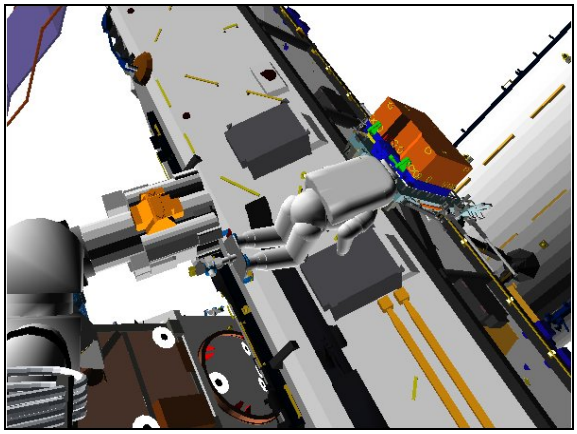

Figure 16.- Stbd Zenith MBSU Removal (24: Tip Elbow: +20, +5).

4.2 Starboard Nadir MBSU Removal

NOTE
1. Pitch must remain greater than +146.6 to avoid wrist self-collision.
2. Expect cross cluster self-collision flashing at EP +142 deg.

THC/ RHC

Maneuver EVA to Starboard Nadir MBSU Removal position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+112.4	-41.9	+146.0	-218.3	+149.5	+148.1
X	Y	Z	Pitch	Yaw	Roll	
+170	+201	+228	+146.8	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

GCA as required to remove MBSU.

Go to step 5.

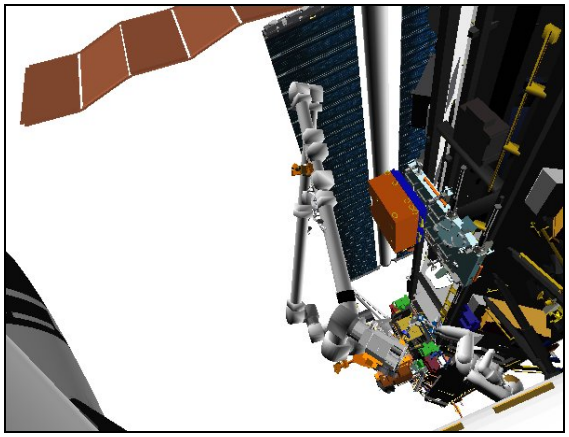

Figure 17.- Stbd Nadir MBSU Removal (SRMS Elbow: +55, -45).

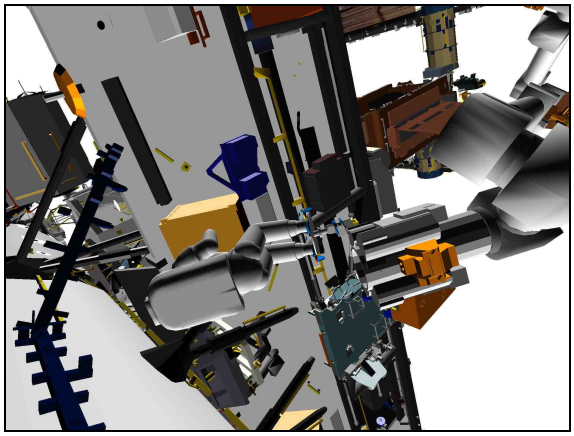

Figure 18.- Stbd Nadir MBSU Removal (13: LAB Stbd Zenith: +130, -10).

4.3 Port Zenith MBSU Removal

THC/ RHC

Maneuver EVA to Port Zenith MBSU Removal position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+114.8	-81.5	+104.2	-92.5	+205.0	+148.5
X	Y	Z	Pitch	Yaw	Roll	
+198	-122	-246	-143.3	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

GCA as required to remove MBSU.

Go to step 5.

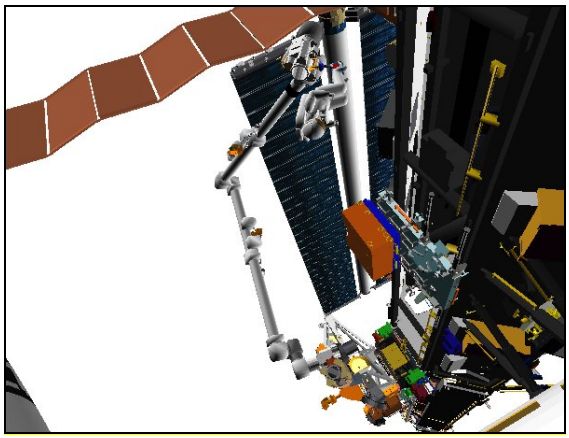

Figure 19.- Port Zenith MBSU Removal (SRMS Elbow: +60, -40).

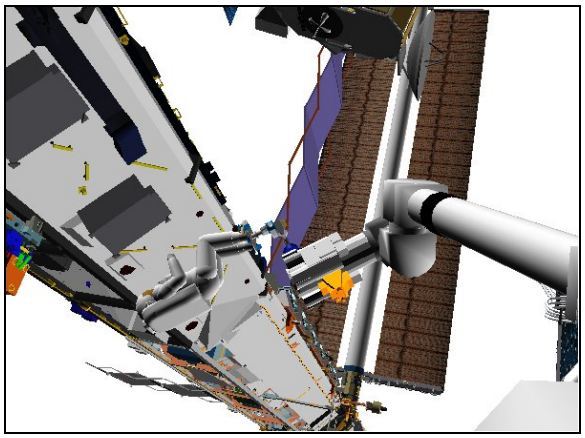

Figure 20.- Port Zenith MBSU Removal (22: Base Elbow: +85, -10).

4.4 Port Nadir MBSU Removal

THC/ RHC Maneuver EVA to Port Nadir MBSU Removal position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+94.2	-37.5	+111.5	-181.4	+134.8	+130.6
X	Y	Z	Pitch	Yaw	Roll	
+170	-201	+228	+137.2	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

GCA as required to remove MBSU.

Go to step 5.

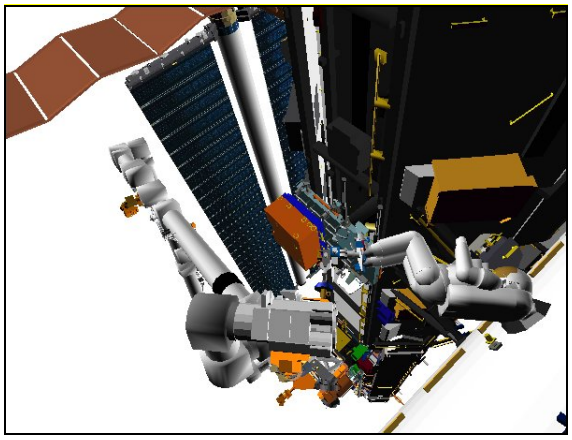

Figure 21.- Port Nadir MBSU Removal (SRMS Elbow: +75, -40).

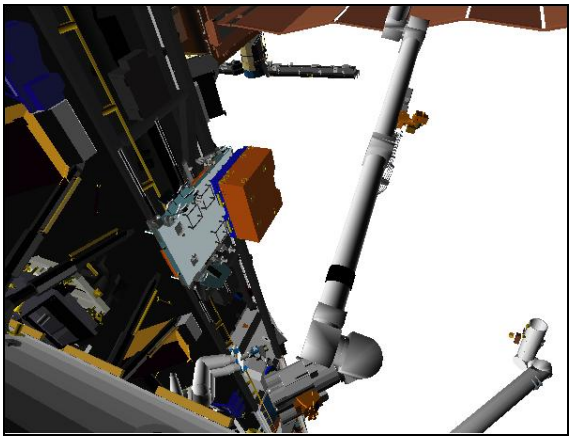

Figure 22.- Port Nadir MBSU Removal (13: LAB Stbd Zenith: +155, -25).

5. FAILED MBSU TEMPORARY STOW ON CETA CART

THC/ RHC Maneuver EVA to CETA Cart Clearance position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+92.1	-80.0	+133.5	-144.9	+175.3	+121.3
X	Y	Z	Pitch	Yaw	Roll	
+400	0	0	-179.9	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

GCA as required to stow failed MBSU.

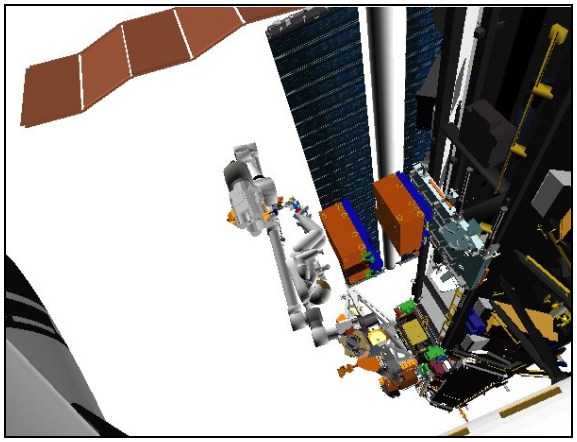

Figure 23.- CETA Cart Clearance Position (SRMS Elbow: +55, -45).

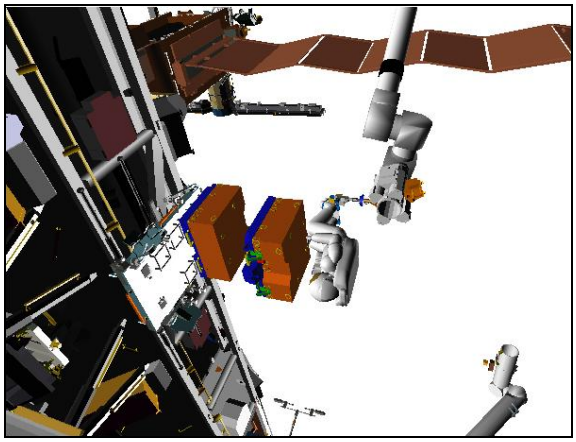

Figure 24.- CETA Cart Clearance Position (13: LAB Stbd Zenith: +160, -20).

6. SPARE MBSU INSTALL

6.1 Spare MBSU Retrieval

GCA as required to remove spare MBSU.

When spare MBSU is removed and on EVA GO,

THC/ RHC — Maneuver EVA to CETA Cart Clearance position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+92.1	-80.0	+133.5	-144.9	+175.3	+121.3
X	Y	Z	Pitch	Yaw	Roll	
+400	0	0	-179.9	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

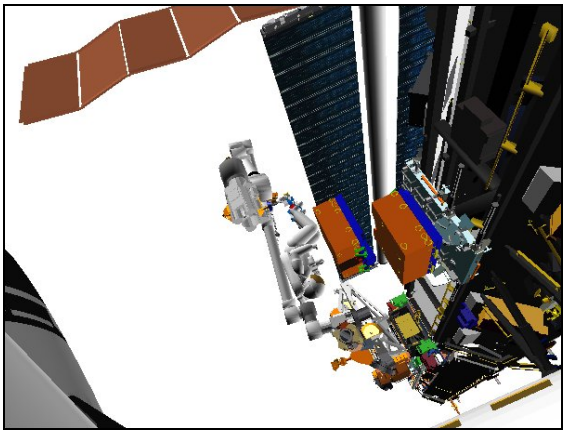

Figure 25.- CETA Cart Clearance Position (SRMS Elbow: +55, -45).

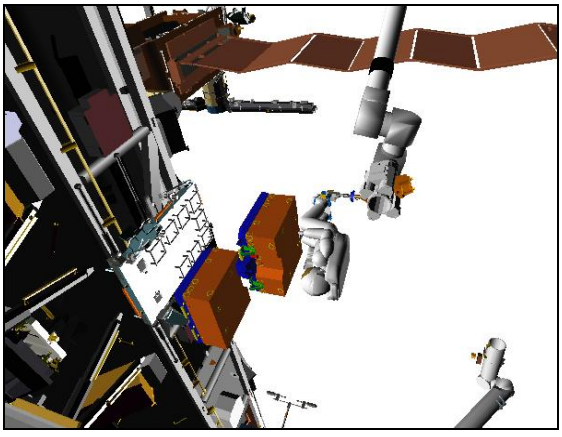

Figure 26.- CETA Cart Clearance Position (13: LAB Stbd Zenith: +160, -20).

For Starboard Zenith MBSU (MBSU 1) install, perform step 6.2.
For Starboard Nadir MBSU (MBSU 3) install, perform step 6.3.
For Port Zenith MBSU (MBSU 4) install, perform step 6.4.
For Port Nadir MBSU (MBSU 2) install, perform step 6.5.

6.2 Starboard Zenith MBSU Install

THC/ RHC Maneuver EVA to Starboard Zenith MBSU Install position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+128.3	-98.9	+121.2	-86.9	+199.7	+161.9
X	Y	Z	Pitch	Yaw	Roll	
+198	+122	-246	-143.3	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

GCA as required to install MBSU.

Go to step 7.

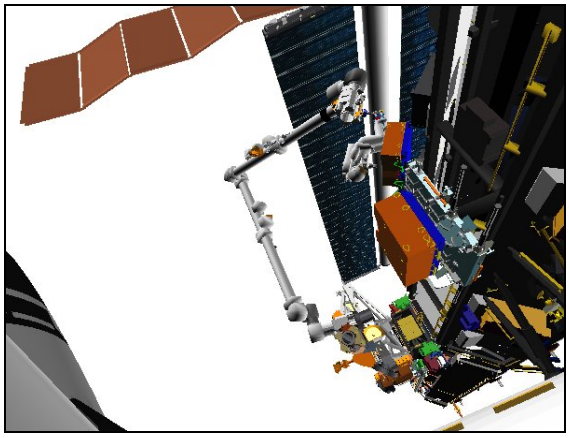

Figure 27.- Stbd Zenith MBSU Install (SRMS Elbow: +55, -45).

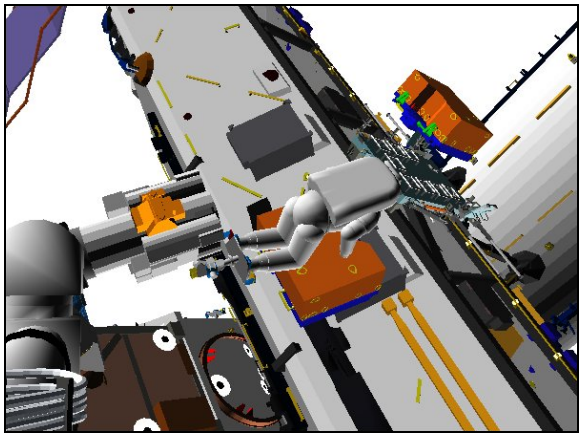

Figure 28.- Stbd Zenith MBSU Install (24: Tip Elbow: +20, +5).

6.3 Starboard Nadir MBSU Install

NOTE
1. Pitch must remain greater than +146.6 to avoid wrist self-collision. 2. Expect cross cluster self-collision flashing at EP +142 deg.

THC/ RHC

Maneuver EVA to Starboard Nadir MBSU Install position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+112.4	-41.9	+146.0	-218.3	+149.5	+148.1
X	Y	Z	Pitch	Yaw	Roll	
+170	+201	+228	+146.8	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

GCA as required to install MBSU.

Go to step 7.

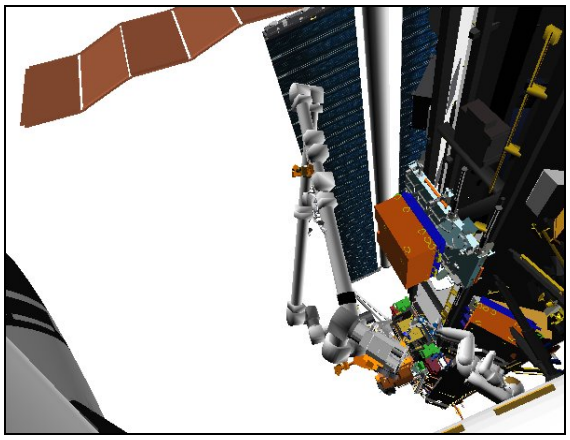

Figure 29.- Stbd Nadir MBSU Install (SRMS Elbow: +55, -45).

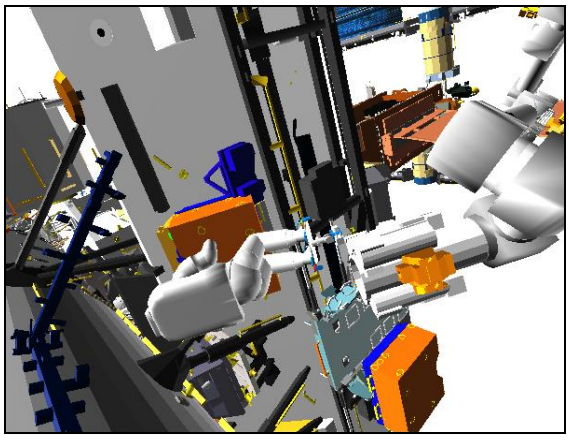

Figure 30.- Stbd Nadir MBSU Install (13: LAB Stbd Zenith: +130, -10).

6.4 Port Zenith MBSU Install

THC/ RHC Maneuver EVA to Port Zenith MBSU Install position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+114.8	-81.5	+104.2	-92.5	+205.0	+148.5
X	Y	Z	Pitch	Yaw	Roll	
+198	-122	-246	-143.3	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

GCA as required to install MBSU.

Go to step 7.

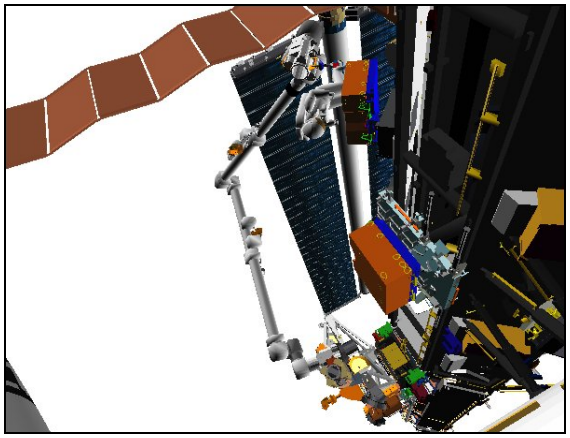

Figure 31.- Port Zenith MBSU Install (SRMS Elbow: +60, -40).

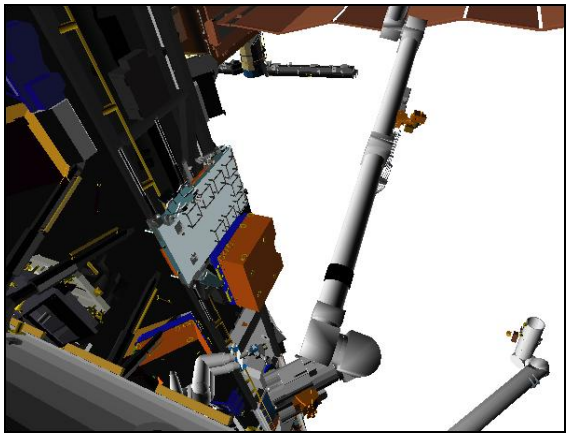

Figure 32.- Port Zenith MBSU Install (22: Base Elbow: +85, -10).

6.5 Port Nadir MBSU Install

THC/ RHC Maneuver EVA to Port Nadir MBSU Install position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+94.2	-37.5	+111.5	-181.4	+134.8	+130.6
X	Y	Z	Pitch	Yaw	Roll	
+170	-201	+228	+137.2	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

GCA as required to install MBSU.

Go to step 7.

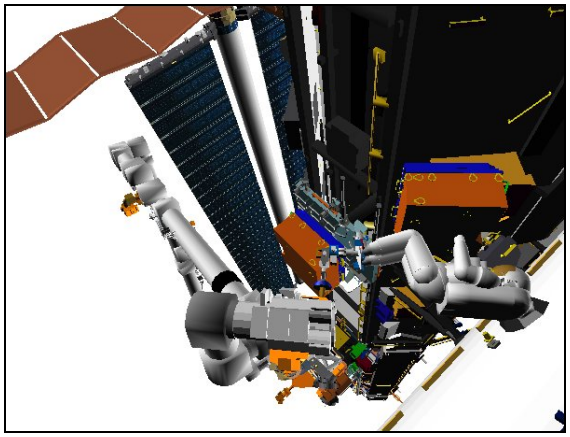

Figure 33.- Port Nadir MBSU Install (SRMS Elbow: +75, -40).

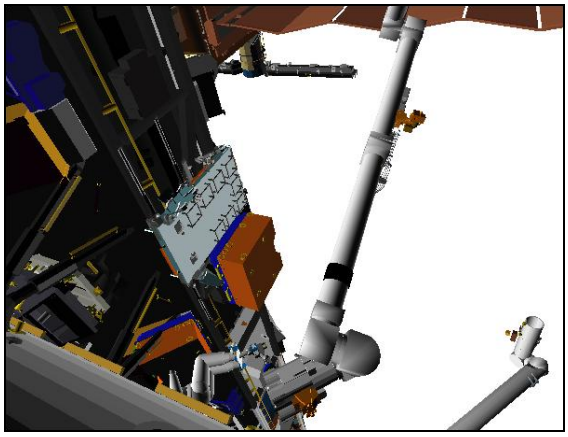

Figure 34.- Port Nadir MBSU Install (13: LAB Stbd Zenith: +155, -25).

7. EVA EGRESS AND APFR REMOVAL
CETA Cart Clearance Position,

THC/ RHC Maneuver EVA to CETA Cart Clearance position (within 5 cm/1deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+92.1	-80.0	+133.5	-144.9	+175.3	+121.3
X	Y	Z	Pitch	Yaw	Roll	
+400	0	0	-179.9	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

GCA as required to stow failed MBSU on FRAM.

When failed MBSU is stowed on FRAM,

THC/ RHC Maneuver EVA to CETA Cart Clearance position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+92.1	-80.0	+133.5	-144.9	+175.3	+121.3
X	Y	Z	Pitch	Yaw	Roll	
+400	0	0	-179.9	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

When the CETA Cart is coupled to the MT,

THC/ RHC — Maneuver EVA to Egress position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+105.5	-73.1	+132.9	-152.3	+175.8	+134.7
X	Y	Z	Pitch	Yaw	Roll	
+250	0	+75	-179.9	0.0	0.0	
FOR	Chest 12/PP/F/6, SR Held					
Disp	W3>ISSACS					

GCA as required to egress and remove APFR.

PCS — MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

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

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

On EVA GO,

THC/ RHC — Maneuver SSRMS to Final Clearance position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-180.0	+100.2	-73.1	+133.8	-152.1	+175.3	+128.9
X	Y	Z	Pitch	Yaw	Roll	
+400	0	-83	-89.9	+0.8	+16.5	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>ISSACS					

NOTE
Expect the following message when safing is commanded:
'**R3Z - MSS OCS SSRMS Prime(Redun) ACU SRT Cat-1 Brk Stat Fail**' (SPN 2388)
This message should return to Norm.

DCP — SAFING → SAFE (Verify ON)

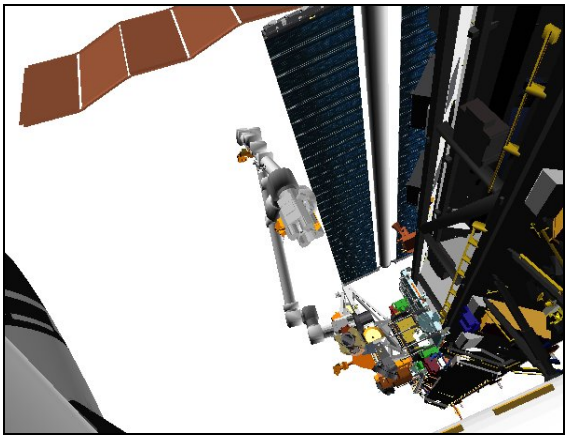

Figure 35.- Final Clearance
(SRMS Elbow: +55, -45).

5.202 MBSU R&R SETUP ON EVA 3

(RBT FS/12A.1/FIN 1) Page 1 of 6 pages

1. HAND CONTROLLER CALIBRATION

1.1 Translational Hand Controller (THC) Calibration

THC

Deflect [X] Axis to positive hard stop where [X] = [X] [Y] [Z]

Deflect [X] Axis to negative hard stop.

Repeat

1.2 Rotational Hand Controller (RHC) Calibration

RHC

Deflect [X] Axis to positive hard stop where [X] = [P] [Y] [R]

Deflect [X] Axis to negative hard stop.

Repeat

2. SETUP

NOTE

During the channel 1/4 power reconfig on EVA 3, there is limited video capability available. Only one shuttle camera view (Channel 92) and one station camera view are available. The one station camera view available can only be an SSRMS or MBS Mast Camera.

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
92: SRMS Elbow (+55, -45)	22: Base Elbow (+40, -5)	

PCS

MSS: SSRMS: [SSRMS]

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

√Display – W3>ISSACS
√Command – W3>ISSACS/Internal

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

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
X	Y	Z	Pitch	Yaw	Roll	
+599	+579	-601	-144.8	-64.0	-25.8	
FOR	Unloaded - LEE Tip, SY Held					
Disp	W3>ISSACS					

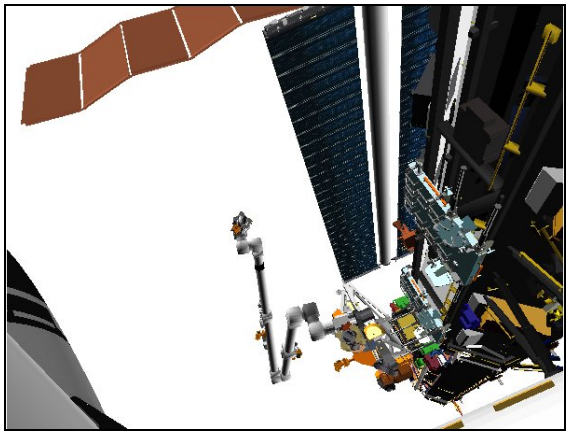

Figure 1.- SSRMS Stow
(92: SRMS Elbow: +55, -45).

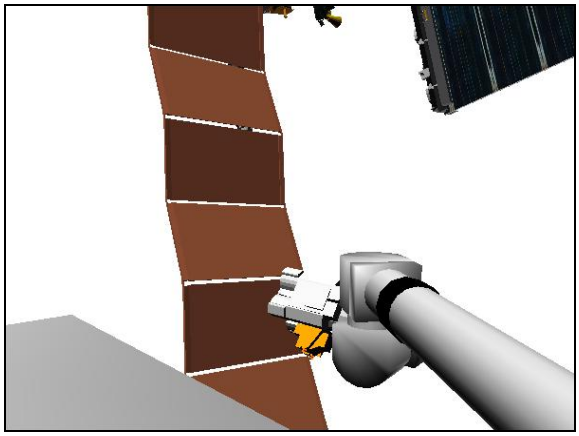

Figure 2.- SSRMS Stow
(22: Base Elbow: +40, -5).

MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

3. APFR INSTALL AND INGRESS

3.1 Single Joint Maneuver to Intermediate Position

PCS MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

THC Perform Single Joint maneuver to Intermediate position (within 1 deg).

	SR	SY	SP	EP	WP	WY	WR
Stow Position	-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
1: SP +			-107.5				
2: SY –		0.0					
3: SP +			-30.0				
Intermediate	-180.0	0.0	-30.0	+146.7	-131.1	+175.4	+125.4
	X	Y	Z	Pitch	Yaw	Roll	
	+736	+748	+194	-160.6	+7.2	+122.6	
	FOR	Unloaded – LEE Tip, SY Held					
	Disp	W3>ISSACS					

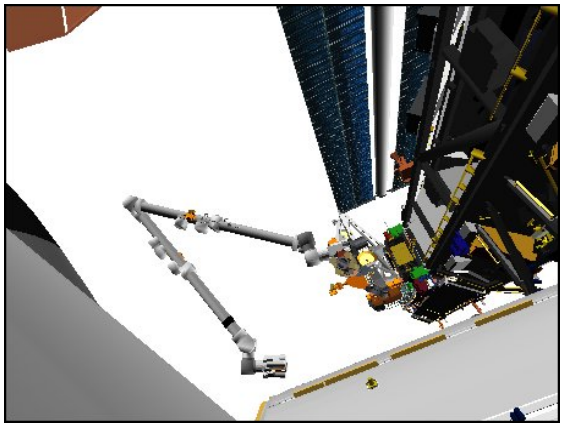

Figure 3.- Intermediate
(92: SRMS Elbow: +55, -55).

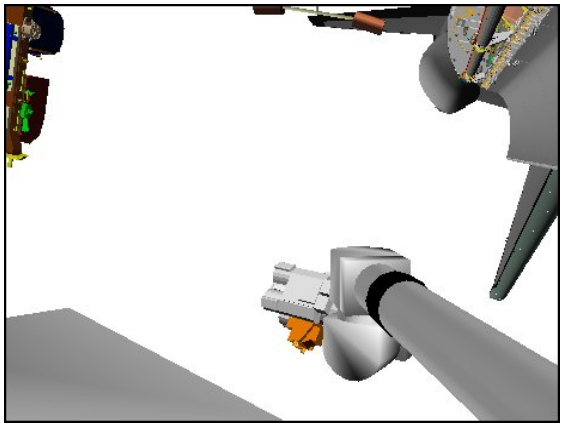

Figure 4.- Intermediate
(22: Base Elbow: +40, -5).

3.2 Maneuvering to APFR Ingress and Install

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3
92: SRMS Elbow (+55, -55) 92: Camera D (-90, +10)	22: Base Elbow (+40, -5) 22: Base Elbow (+170, +5)	

NOTE
Monitor clearance between SSRMS Elbow and Orbiter Payload Bay Door with Base Elbow. During the maneuver to MBSU Removal Setup the distance gets as close as ~122 cm (4 ft).

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for APFR Install/Ingress Setup position.

SR	SY	SP	EP	WP	WY	WR
-189.4	0.0	+67.0	+117.5	-178.0	+169.6	+95.5

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	0.0	-30.0	+146.7	-131.1	+175.4	+125.4
TGT	**-189.4**	**0.0**	**+67.0**	**+117.5**	**-178.0**	**+169.6**	**+95.5**
ERR	+9.4	0.0	-97.0	+29.2	+46.9	+5.8	+29.9

****
* If joint angles or errors are incorrect

PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.

****

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

DCP AUTO SEQ → PROC

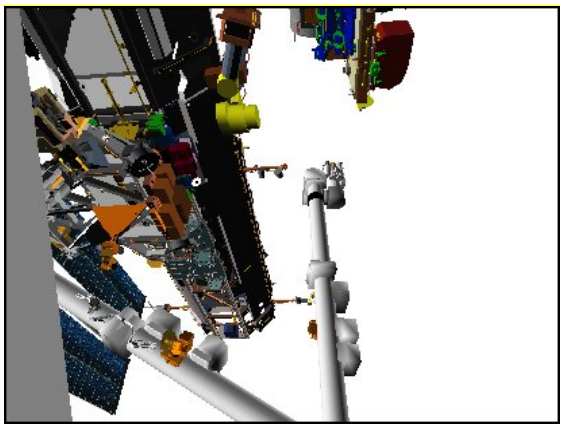

Figure 5.- APFR Install/Ingress Setup
(92: Camera D: -95, +40).

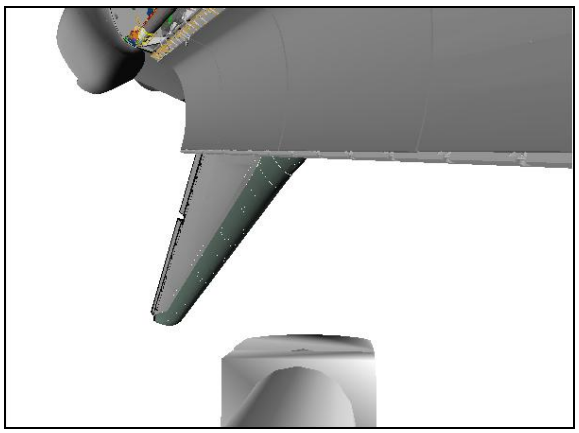

Figure 6.- APFR Install/Ingress Setup
(22: Base Elbow: +175, +5).

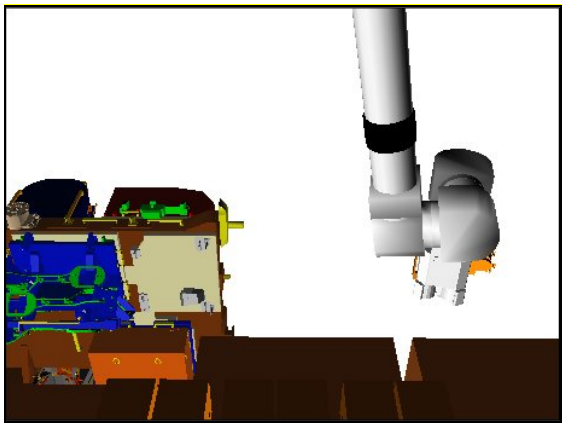

Figure 7.- APFR Install/Ingress Setup
(37: MBS Mast: +90, -35).

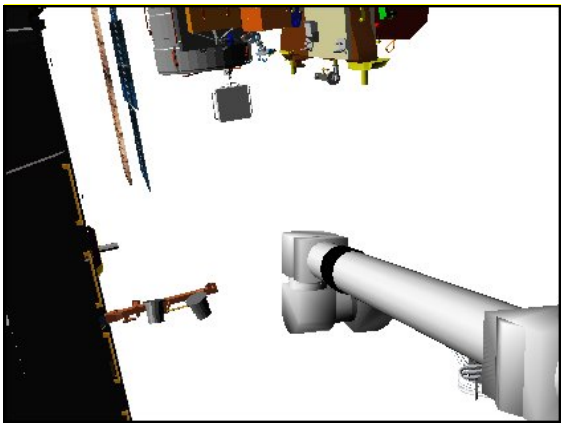

Figure 8.- APFR Install/Ingress Setup
(22: Base Elbow: +80, -5).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at APFR Install/Ingress Setup position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-189.4	0.0	+67.0	+117.5	-178.0	+169.6	+95.5
X	Y	Z	Pitch	Yaw	Roll	
+39	+986	+496	-179.6	+0.8	+106.2	
FOR	Unloaded – LEE Tip, SY Held					
Disp	W3>ISSACS					

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

THC/ RHC GCA as required to install and ingress the APFR.

PCS MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

Change Unloaded Parameters ▶ EVA ▶ Chest 12/PP/F/6 SYH
Verify 'Unloaded Parameters' (two) – Chest 12/PP/F/6, SY Held

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

4. TRUSS CLEARANCE

THC/ RHC Maneuver EVA to MBSU Removal Setup position (within 5 cm/1 deg).

	Locked					
SR	SY	SP	EP	WP	WY	WR
-189.4	0.0	+67.0	+117.5	-178.0	+169.6	+95.5
X	Y	Z	Pitch	Yaw	Roll	
-122	+900	+496	+135.9	-88.9	+45.5	
FOR	Chest 12/PP/F/6, SY Held					
Disp	W3>ISSACS					

PCS MSS: SSRMS: SSRMS

Enter Mode – Standby (Verify blue)

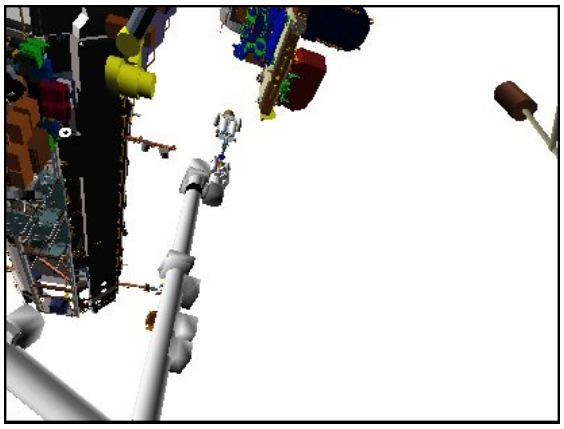

Figure 9.- MBSU Removal Setup
(92: Camera D: -70, +40).

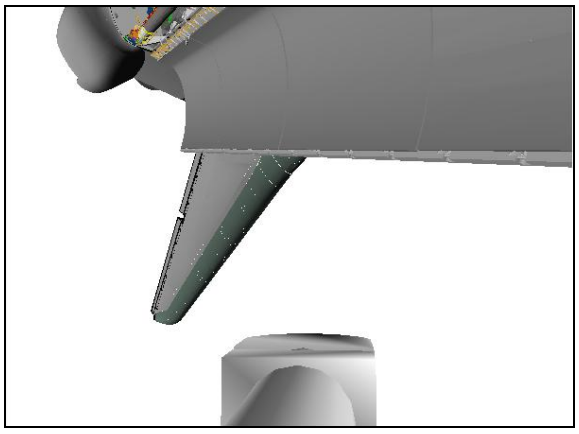

Figure 10.- MBSU Removal Setup
(22: Base Elbow: +175, +5).

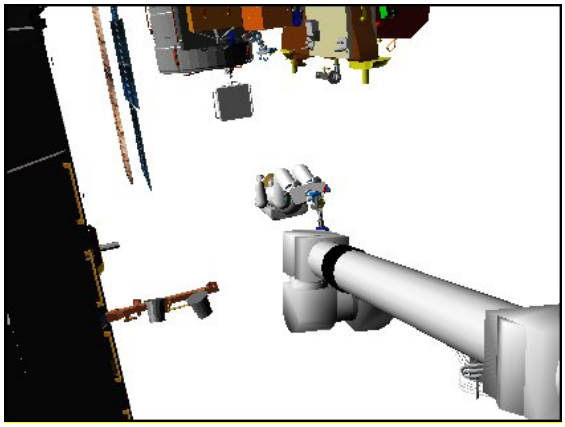

Figure 11.- MBSU Removal Setup
(22: Base Elbow: +80, -5).

5.301 P5 INSTALL SOFTDOCK ACQUISITION

1. SSRMS LIMP AND DELIMP

PCS MSS: SSRMS: SSRMS

Verify 'Loaded Parameters' (two) – P5 Install, SY Held

√Command – SSRMS>Internal

Enter Mode – Standby (Verify blue)

MSS: SSRMS: Limp: SSRMS Limp

cmd All Limp (Verify Limp – blue)

MSS: SSRMS: SSRMS

Verify all joints – Limped

Wait 30 seconds.

MSS: SSRMS: Limp: SSRMS Limp

cmd None Limp (Verify Standby – blue)

2. MANUAL MODE SETUP

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Yaw (Verify SY – Locked)

If at least one softdock indicator is already acquired

MSS: SSRMS: SSRMS Manual: POHS: SSRMS POHS

cmd All DOFs Off

MSS: SSRMS: Manual: SSRMS Manual

Verify 'X' 'Y' 'Z' 'Pitch' 'Yaw' 'Roll' (six) – Off

3. SOFTDOCK ACQUISITION

NOTE

1. If the SSRMS stalls (EV crew cannot see motion), ramp out the hand controller inputs within 10 seconds, and repeat steps 1 to 3 to obtain the remaining softdock indicators.

2. If only opposite diagonal softdock indicators are engaged, use the table to obtain missing softdock indicators one at a time. After obtaining the first missing softdock indicator, repeat steps 1 to 3 to obtain the final softdock indicator.

3. If no softdocks indicators are acquired, use EVA GCA to correct alignment and continue +Y motion, or use the table below to acquire closest softdock indicator.

4. Order of inputs in the table below is arbitrary. Simultaneous inputs can be used.

THC/ RHC — Using Table 1, input commands to obtain remaining softdocks.

Table 1. Inputs to Acquire Softdocks

Missing Softdock	THC/RHC Input
1	+Roll,+Yaw
2	-Roll,+Yaw
3	+Roll,-Yaw
4	-Roll,-Yaw
1,3	+Roll
2,4	-Roll
1,2	+Yaw
3,4	-Yaw
1,2,3	+Roll,+Yaw
1,2,4	-Roll,+Yaw
1,3,4	+Roll,-Yaw
2,3,4	-Roll,-Yaw
All	Refer to note 3

When all four softdock indicators are acquired

Perform {2.101 P5 INSTALL AND UNGRAPPLE}, steps 4 and 5 (SODF: RBT FS: P5 INSTALL - EVA 1), then:

Refer to Figure 1.

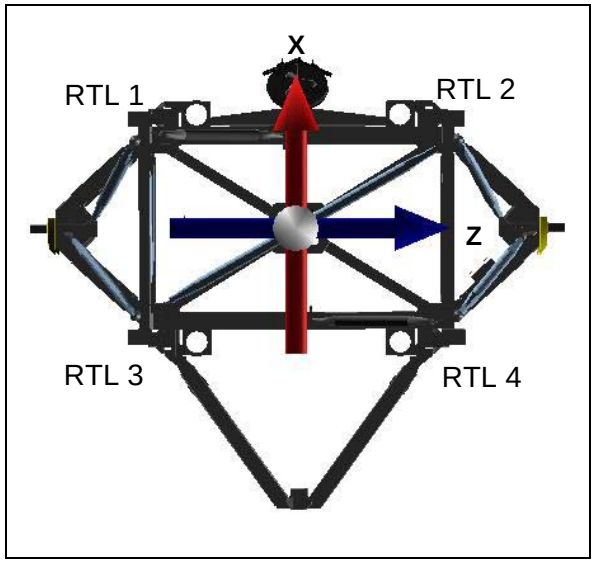

Figure 1.- P5 Install FOR.

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OBSS

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5.401 MNVR FROM MT TRANS STOW TO BERTHED OBSS PRE-GRAPPLE

(RBT FS/12A.1/FIN 1) Page 1 of 7 pages

1. HAND CONTROLLER CALIBRATION

1.1 Translational Hand Controller (THC) Calibration

THC

Deflect [X] Axis to positive hard stop where [X] = [X] [Y] [Z]

Deflect [X] Axis to negative hard stop.

Repeat

1.2 Rotational Hand Controller (RHC) Calibration

RHC

Deflect [X] Axis to positive hard stop where [X] = [P] [Y] [R]

Deflect [X] Axis to negative hard stop.

Repeat

2. SETUP

ODS Hatch

√V10 Cables connected

Verify SRMS is at the OBSS Pre-Grapple at Handoff position.

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
09: P1 Lower Outboard (+100, -20)	13: LAB Stbd Zenith (-175, +30)	37: MBS Mast (-15, 0) 22: Base Elbow (-155, -10)	SRMS Elbow (-145, -5)

PCS

MSS: SSRMS: [SSRMS]

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

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

Change Display ▶ W3 ▶ Berth OBSS FRGF NSP (Verify W3>Berth OBSS FRGF NSP)

Verify Command – SSRMS>Internal

Verify SSRMS at MT Translation Stow position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-155.0	+35.0	-34.2	+204.3	-84.5
X	Y	Z	Pitch	Yaw	Roll	
-721	+613	+2067	+140.4	-65.9	-117.7	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS FRGF NSP					

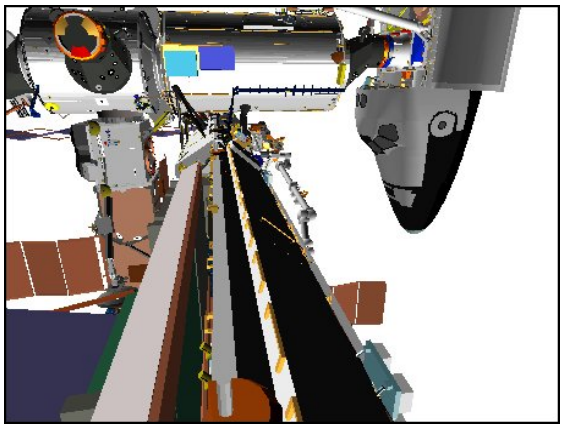

Figure 1.- MT Translation Stow
(09: P1 Lower Outboard: +100, -20).

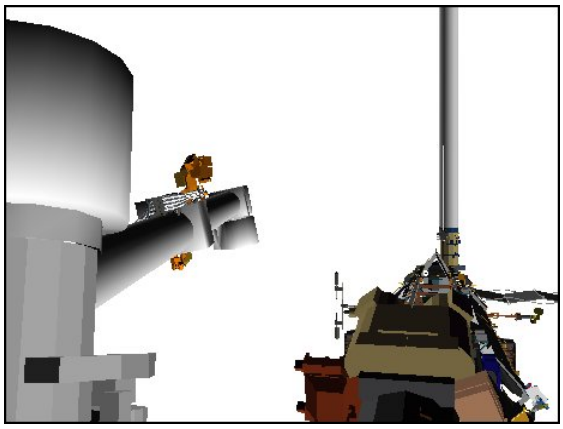

Figure 2.- MT Translation Stow
(37: MBS Mast: -15, 0).

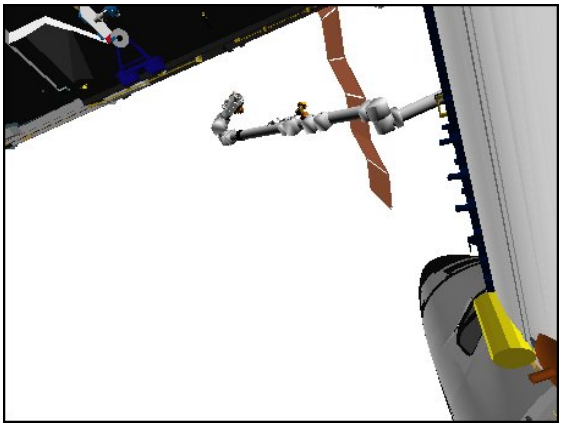

Figure 3.- MT Translation Stow
(V10: SRMS Elbow: -145, -5).

3. MANEUVERING CLEARANCE
MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → COARSE (Verify Coarse on PCS)

NOTE
Expect singularity warning for EP between -15 and +15 deg.

MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input ‘Joint Angles’ ‘Destination’ for Clearance position.

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-137.0	-30.0	-154.8	+184.9	-61.5

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)	-194.4	+250.4	-155.0	+35.0	-34.2	+204.3	-84.5
TGT	**-194.4**	**+250.4**	**-137.0**	**-30.0**	**-154.8**	**+184.9**	**-61.5**
ERR	0.0	0.0	-18.0	+65.0	+120.6	+19.4	-23.0

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

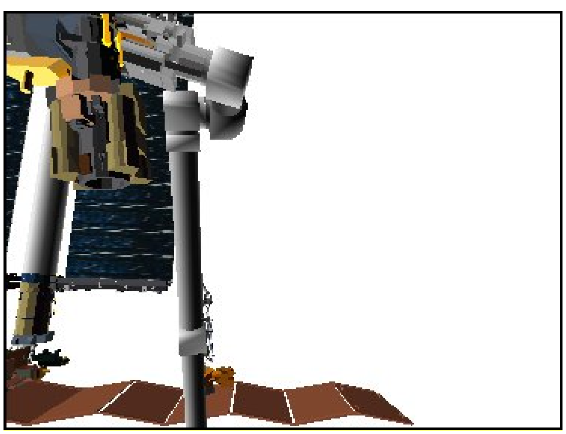

Figure 4.- Clearance
(13: LAB Stbd Zenith: -175, +30).

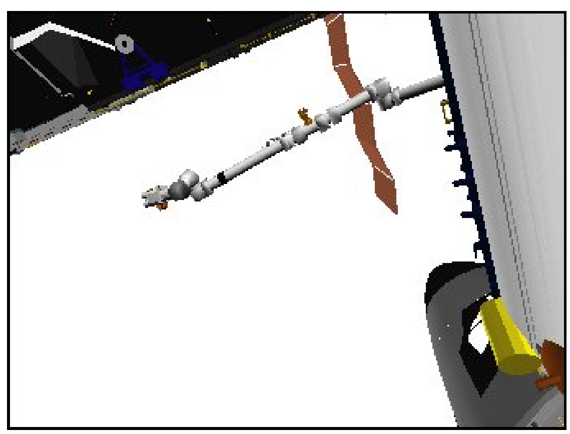

Figure 5.- Clearance
(V10: SRMS Elbow: -145, -5).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-137.0	-30.0	-154.8	+184.9	-61.5
X	Y	Z	Pitch	Yaw	Roll	
-645	+1051	+1717	-118.2	+63.3	+46.8	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS FRGF NSP					

4. SINGLE JOINT TO INTERMEDIATE POSITION

MSS: SSRMS: Rate: SSRMS Rate

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

RHC RATE → VERNIER (Verify Vernier on PCS)

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

NOTE

Monitor clearance to Orbiter Nose and P6 Radiator with P1 Outboard Lower or MBS Mast Camera. The closest clearance to the P6 Radiator during the maneuver is about 140 cm (4.6 ft). The closest clearance to the Orbiter Nose during the maneuver is about 145 cm (4.7 ft).

DCP JOINT SELECT → SHOULDER YAW (Verify SY – Selected on PCS)

THC Perform "– " Single Joint maneuver to SY: +85.2 (THC down).

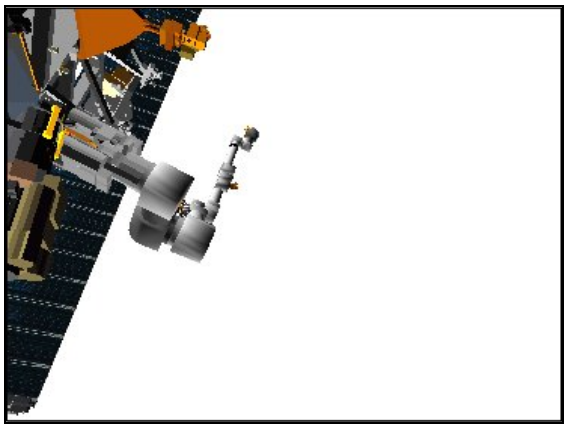

Figure 6.- Intermediate
(13: LAB Stbd Zenith: -160, +50).

5. MANEUVERING TO BERTHED OBSS PRE-GRAPPLE

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+50, -50)	13: LAB Stbd Zenith (-160, +50)	22: Base Elbow (-170, -10)	SRMS Elbow (-35, -10)

NOTE

1. Expect singularity warning for WY between +100 and +80 deg.
2. Expect singularity warning for WY between -80 and -100 deg.
3. Monitor clearance to UHF Antenna with the SRMS Elbow Camera. Clearance at Pre-Grapple is approximately 117 cm (3.8 ft).

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Berthed OBSS Pre-Grapple position.

SR	SY	SP	EP	WP	WY	WR
-27.7	+85.2	-112.4	-50.4	-51.1	-117.1	-5.0

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)	-194.4	+85.2	-137.0	-30.0	-154.8	+184.9	-61.5
TGT	**-27.7**	**+85.2**	**-112.4**	**-50.4**	**-51.1**	**-117.1**	**-5.0**
ERR	-166.7	0.0	-24.6	+20.4	-103.7	+302.0	-56.5

	**********
	* If joint angles or errors are incorrect
PCS	* **cmd** Cancel (Verify Sequence Status – Waiting Destination)
	*
	* Input correct Dest joint angles per table above.
	*
	* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
	*
MON	* Verify joint angles and errors are correct on Joint Angle Position
	* overlay.
	**********
PCS	**cmd** Confirm (Verify Sequence Status – Auto Seq sw - Hot)
DCP	AUTO SEQ → PROC

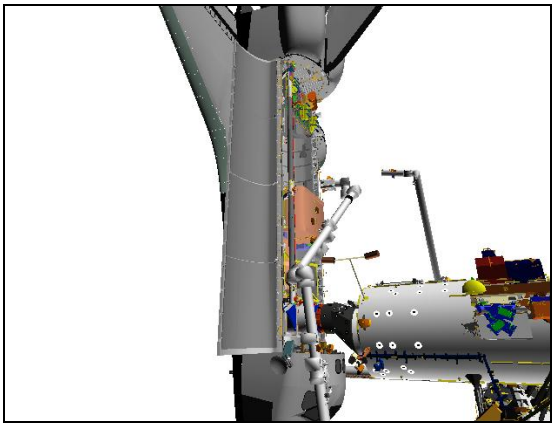

Figure 7.- Berthed OBSS Pre-Grapple (03: S1 Lower Outboard: +60, +20).

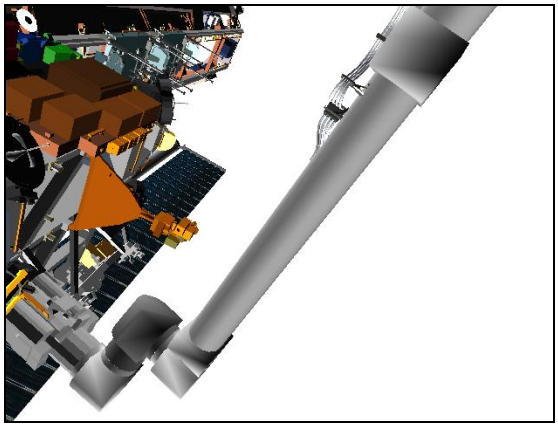

Figure 8.- Berthed OBSS Pre-Grapple (13: LAB Stbd Zenith: -150, +80).

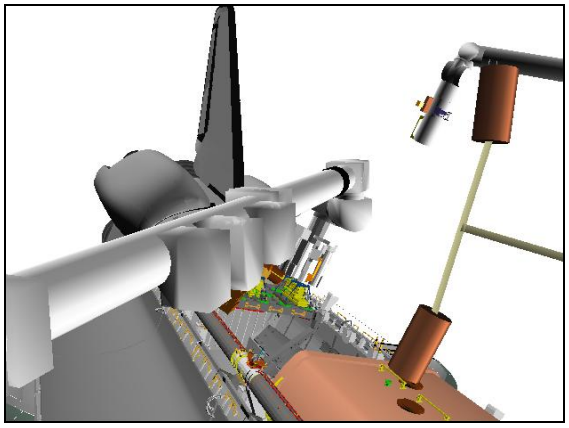

Figure 9.- Berthed OBSS Pre-Grapple (22: Base Elbow: -150, -10).

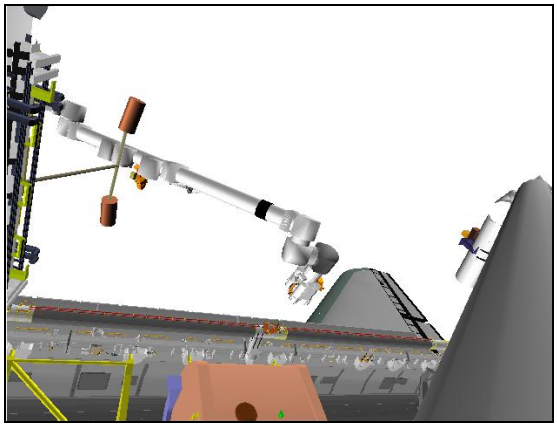

Figure 10.- Berthed OBSS Pre-Grapple (V10: SRMS Elbow: -35, -10).

5.401 MNVR FROM MT TRANS STOW TO BERTHED OBSS PRE-GRAPPLE

(RBT FS/12A.1/FIN 1) Page 7 of 7 pages

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

SR	SY	SP	EP	WP	WY	WR
-27.7	+85.2	-112.4	-50.4	-51.1	-117.1	-5.0
X	Y	Z	Pitch	Yaw	Roll	
-151	0	0	0.0	0.0	0.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS FRGF NSP					

DCP BRAKES SSRMS → ON (Verify ON)

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5.402 MNVR FROM SSRMS STOW TO BERTHED OBSS PRE-GRAPPLE

(RBT FS/12A.1/FIN 1) Page 1 of 4 pages

1. HAND CONTROLLER CALIBRATION

1.1 Translational Hand Controller (THC) Calibration

THC
- Deflect [X] Axis to positive hard stop where [X] = [X] [Y] [Z]
- Deflect [X] Axis to negative hard stop.
- Repeat

1.2 Rotational Hand Controller (RHC) Calibration

RHC
- Deflect [X] Axis to positive hard stop where [X] = [P] [Y] [R]
- Deflect [X] Axis to negative hard stop.
- Repeat

2. SETUP

ODS Hatch √V10 Cables connected

Verify SRMS is at the OBSS Handoff Pre-Grapple position.

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+35, -30)	13: LAB Stbd Zenith (-150, +60)	22: Base Elbow (+60, -10)	SRMS Elbow (-35, -10)

PCS MSS: SSRMS: [SSRMS]

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

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

Change Display ▶ W3 ▶ Berth OBSS FRGF NSP (Verify W3>Berth OBSS FRGF NSP)

Verify Command – SSRMS>Internal

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

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
X	Y	Z	Pitch	Yaw	Roll	
-225	-351	+1849	+153.7	+54.7	+144.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS FRGF NSP					

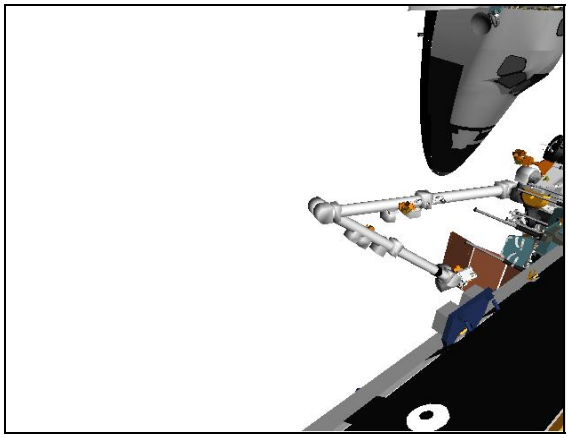

Figure 1.- SSRMS Stow
(03: S1 Lower Outboard: +35, -30).

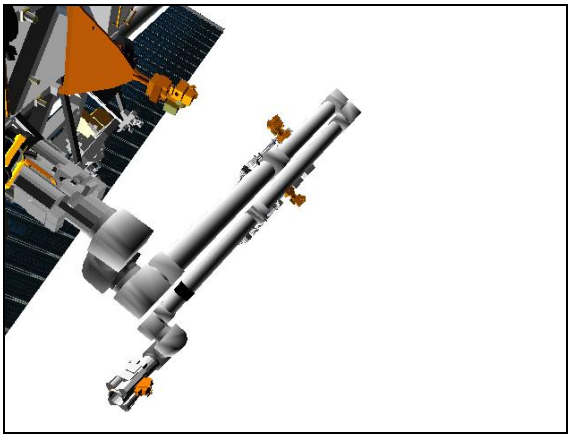

Figure 2.- SSRMS Stow
(13: LAB Stbd Zenith: -150, +60).

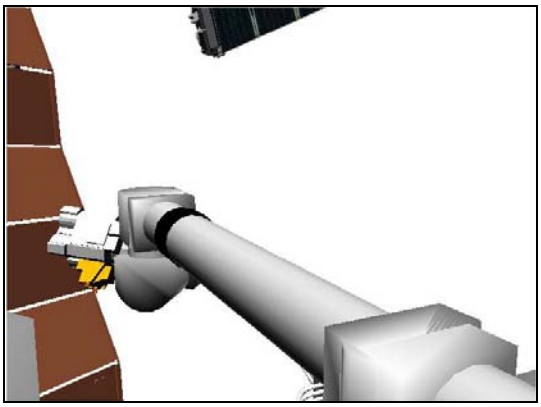

Figure 3.- SSRMS Stow
(22: Base Elbow: +60, -10).

3. MANEUVERING TO OBSS PRE-GRAPPLE

MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

PCS MSS: SSRMS: Rate: SSRMS Rate

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

MSS: SSRMS: SSRMS

√Vernier

MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

NOTE

1. Expect singularity warning for WY between +100 and +80.
2. Expect singularity warning for EP between +15 and -15 deg.
3. Expect singularity warning for WY between -80 and -100.
4. Monitor clearance to UHF Antenna with the SRMS Elbow Camera. Clearance at Pre-grapple is approximately 117 cm (3.8 ft).

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Berthed OBSS Pre-Grapple position.

SR	SY	SP	EP	WP	WY	WR
-27.7	+85.2	-112.4	-50.4	-51.1	-117.1	-5.0

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)	-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
TGT	**-27.7**	**+85.2**	**-112.4**	**-50.4**	**-51.1**	**-117.1**	**-5.0**
ERR	-152.3	+10.8	-70.6	+197.1	-80.0	+292.5	+130.4

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

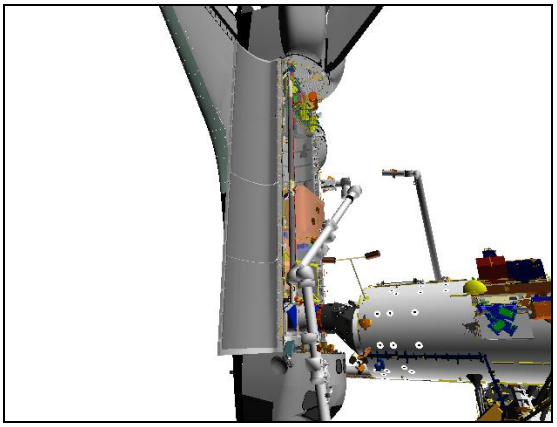

Figure 4.- Berthed OBSS Pre-Grapple
(03: S1 Lower Outboard: +60, +20).

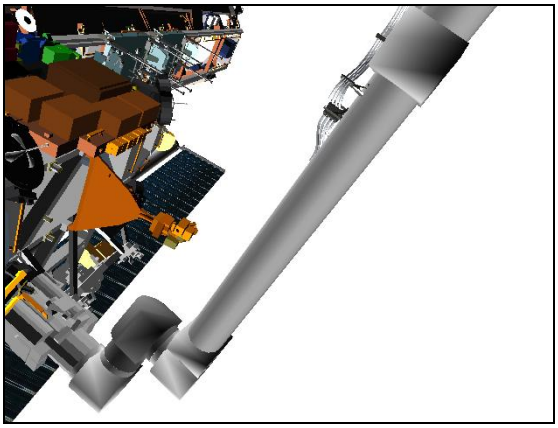

Figure 5.- Berthed OBSS Pre-Grapple
(13: LAB Stbd Zenith: -150, +80).

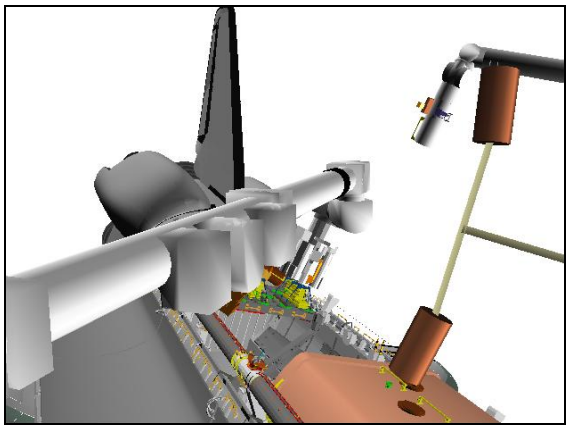

Figure 6.- Berthed OBSS Pre-Grapple
(22: Base Elbow: -150, -10).

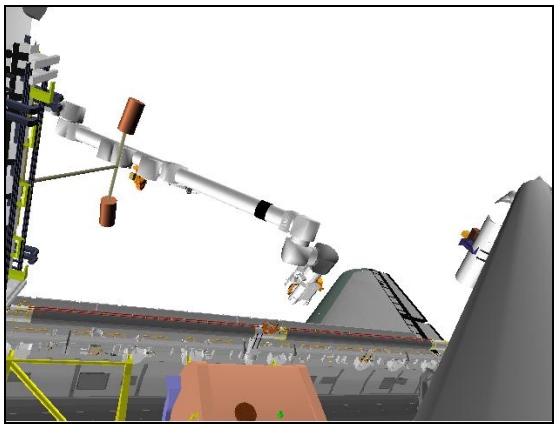

Figure 7.- Berthed OBSS Pre-Grapple
(V10: SRMS Elbow: -35, -10).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

SR	SY	SP	EP	WP	WY	WR
-27.7	+85.2	-112.4	-50.4	-51.1	-117.1	-5.0
X	Y	Z	Pitch	Yaw	Roll	
-151	0	0	0.0	0.0	0.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS FRGF NSP					

DCP BRAKES SSRMS → ON (Verify ON)

5.403 BERTHED OBSS GRAPPLE FROM WS3

(RBT FS/12A.1/FIN 1) Page 1 of 4 pages

1. SETUP

Configure Cameras and overlays for grapple.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +5)	25: Tip LEE	92: Camera D (-6, +7) 22: Base Elbow (-150, -10)	SRMS Elbow (-35, -10)

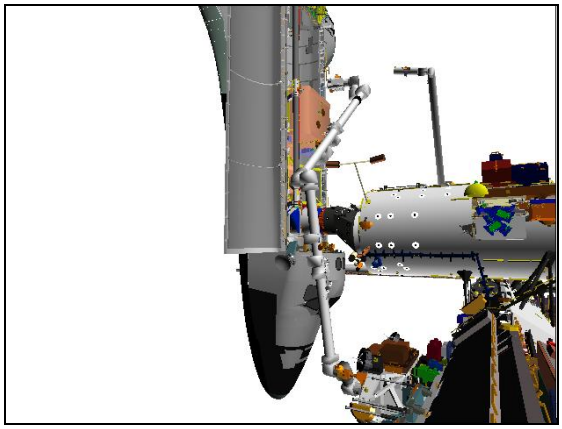

Figure 1.- Berthed OBSS Pre-Grapple (03: S1 Lower Outboard: +60, +5).

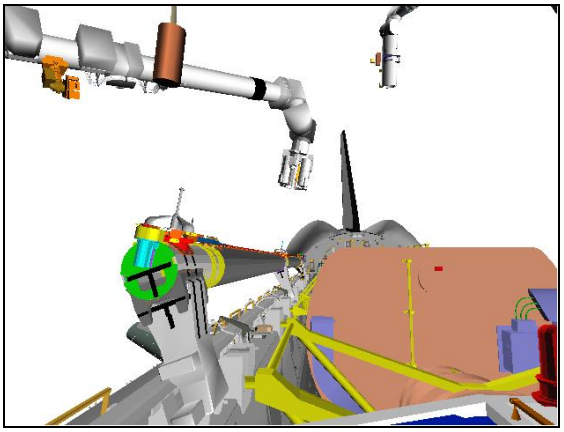

Figure 2.- Berthed OBSS Pre-Grapple (92: Camera D: -6, +7).

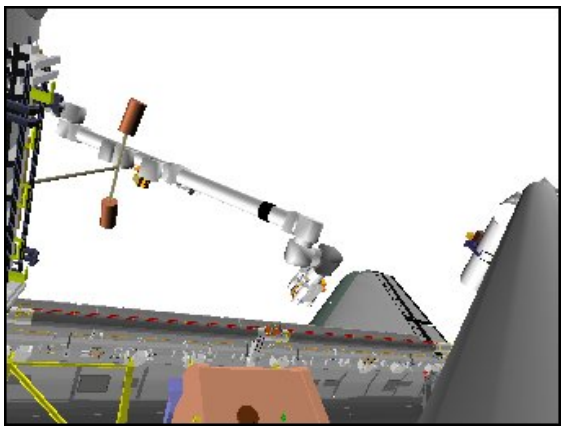

Figure 3.- Berthed OBSS Pre-Grapple (V10: SRMS Elbow: -35, +10).

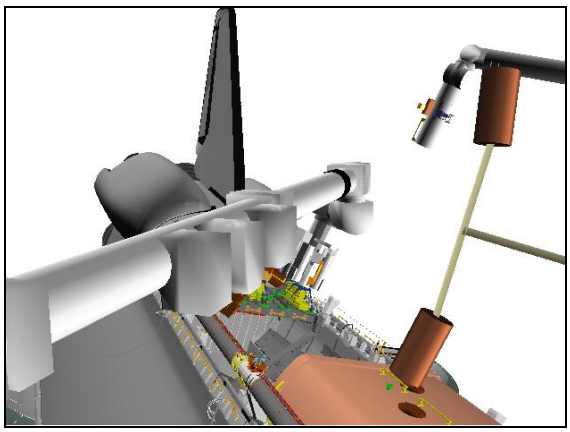

Figure 4.- Berthed OBSS Pre-Grapple (22: Base Elbow: -150, -10).

2. OBSS GRAPPLE SETUP AND CAPTURE

NOTE
Tip LEE Camera must be fully zoomed out to correspond to target overlay.

2.1 Setup

DCP BRAKES SSRMS → OFF (Verify OFF)

PCS MSS: SSRMS: SSRMS

√Vernier

MSS: SSRMS: Rate: SSRMS Rate

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

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

2.2 Slow Capture Commands

MSS: SSRMS: Tip LEE: SSRMS Tip LEE

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

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

CAUTION

Due to end-to-end system latency, the RHC Trigger is hot up to 3 seconds prior to receiving a Trigger Hot icon status on the PCS.

NOTE

Once the trigger is hot, only safing or trigger commands should be sent to the Robotics equipment. If a configuration change is required, including routing MSS Cameras, safe the system to exit LEE operations (SCR 23262, 14662).

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Capture

2.3 Maneuvering to Within Grapple Envelope

RHC/ THC Maneuver to within grapple envelope.

2.4 Grapple

RHC TRIGGER → press (momentarily)

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

2.5 Grapple Cleanup
Verify Posn Hold – orange

Verify Loaded Parameters – √
Verify 'Loaded Parameters' (two) – OBSS Mid MPM, SR Held

DCP BRAKES SSRMS → ON (Verify ON)

MSS: SSRMS: SSRMS

Change Display ▶ W3 ▶ Berth OBSS Mid NSP (Verify W3>Berth OBSS Mid NSP)

Change Command ▶ W3 ▶ Berth OBSS Mid NSP(Verify W3>Berth OBSS Mid NSP)

Review {SSRMS LEE CUE CARD}, all (SODF: RBT GEN: REFERENCE).

Expected Berthed OBSS Grapple joint angles and FOR.

SR	SY	SP	EP	WP	WY	WR
-27.7	+93.3	-110.4	-49.1	-66.1	-110.8	-17.8
X	Y	Z	Pitch	Yaw	Roll	
0	0	0	0.0	0.0	0.0	
FOR	Loaded – OBSS Mid MPM, SR Held					
Disp	W3>Berth OBSS Mid NSP					

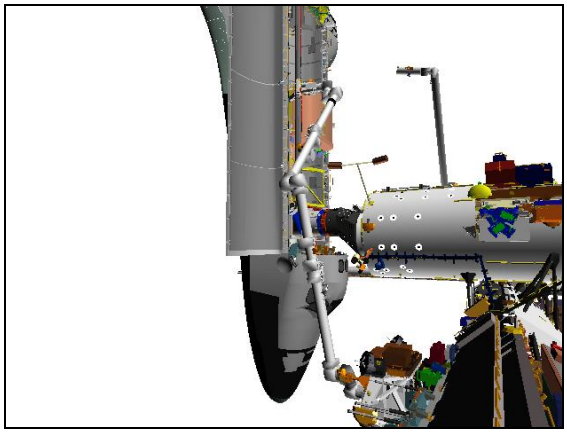

Figure 5.- Berthed OBSS Grapple Position (03: S1 Lower Outboard: +60, +5).

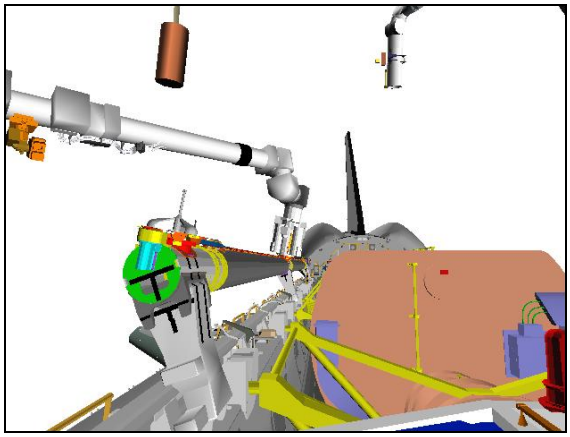

Figure 6.- Berthed OBSS Grapple Position (92: Camera D: -6, +7).

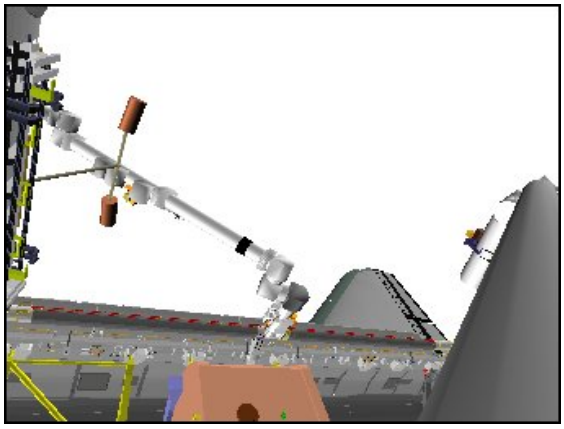

Figure 7.- Berthed OBSS Grapple Position (V10: SRMS Elbow: -35, -10).

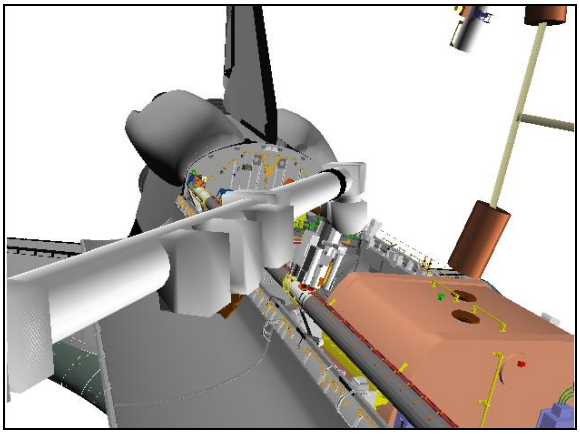

Figure 8.- Berthed OBSS Grapple Position (22: Base Elbow: -150, -10).

5.404 OBSS UNBERTH

(RBT FS/12A.1/FIN 1) Page 1 of 5 pages

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +5)	24: Tip Elbow (-90, +35) 13: LAB Stbd Zenith (-20, -5)	92: SRMS Elbow (-35, -10) Camera D (-20, +15)	Camera C (+25, -5)

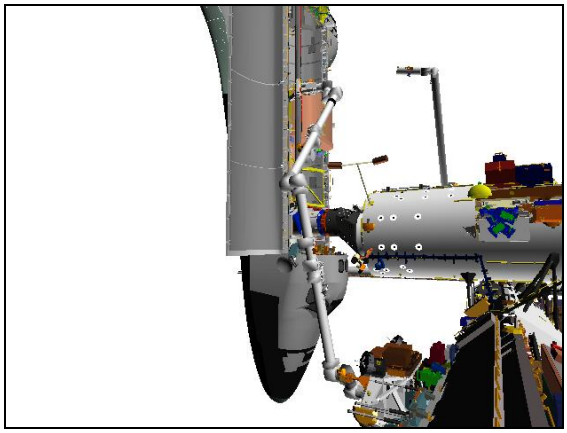

Figure 1.- Berthed OBSS Grapple (03: S1 Lower Outboard: +60, +5).

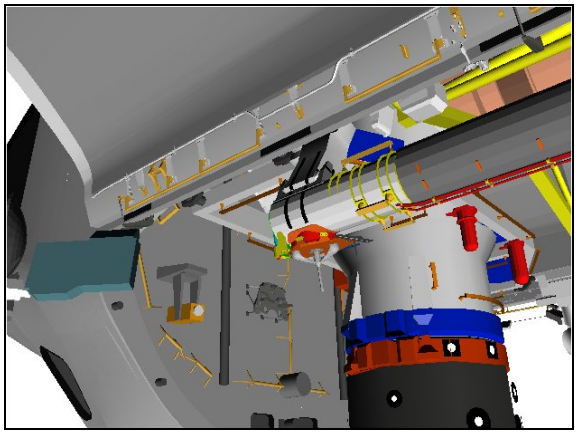

Figure 2.- Berthed OBSS Grapple (24: Tip Elbow: -90, +35).

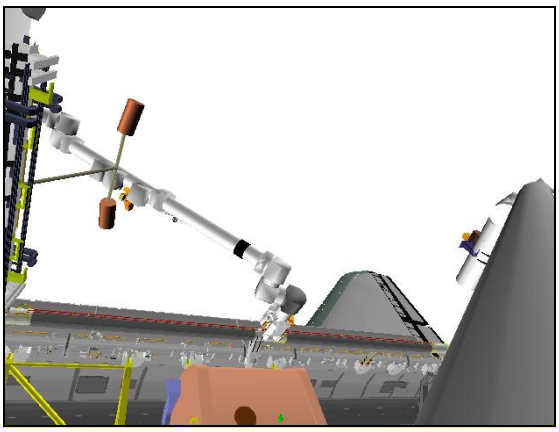

Figure 3.- Berthed OBSS Grapple (92: SRMS Elbow: -35, -10).

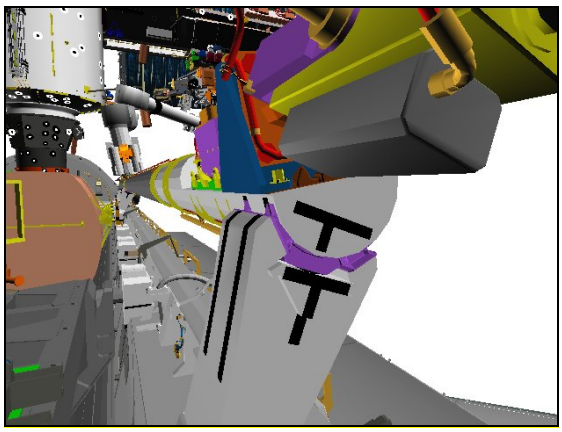

Figure 4.- Berthed OBSS Grapple (V10: Camera C: +25, -5).

PCS MSS: SSRMS: Rate: SSRMS Rate

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

2. VERIFICATION OF DESAT REQUEST

MSS: SSRMS: Thrusters: Thruster Controls for MSS Ops

Verify 'Desat Request:' – Inh

3. MRL RELEASE
Give shuttle crew GO for STBD MRL Release.

NOTE
Standby for OBSS thermal clock start time: _____ / ____ : ____ : ____ SRMS SPEE power must be applied within 90 minutes to prevent sensor damage.

****
* If '**R3Q - SSRMS LEE Uncommanded Derigidize**' Caution was annunciated
*
* MSS: SSRMS: Tip LEE: [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 (90 s max)
* Verify 'Carriage' Retract – blue
****

4. MANEUVERING TO LOW HOVER POSITION
On shuttle crew GO for OBSS Unberth,

DCP BRAKES SSRMS → OFF (Verify OFF)

PCS MSS: SSRMS: [SSRMS]

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: [Joint Lock]

cmd Shoulder Roll (Verify SR – Locked)

NOTE
Monitor clearance to UHF Antenna with the SRMS Elbow Camera. Clearance at Low Hover is approximately 92 cm (3.0 ft).

5.404 OBSS UNBERTH

(RBT FS/12A.1/FIN 1) Page 3 of 5 pages

THC/ RHC — Maneuver OBSS to Low Hover position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-27.7	+87.3	-107.8	-53.3	-55.3	-115.4	-7.7
X	Y	Z	Pitch	Yaw	Roll	
0	0	-100	0.0	0.0	0.0	
FOR	Loaded – OBSS Mid MPM, SR Held					
Disp	W3>Berth OBSS Mid NSP					

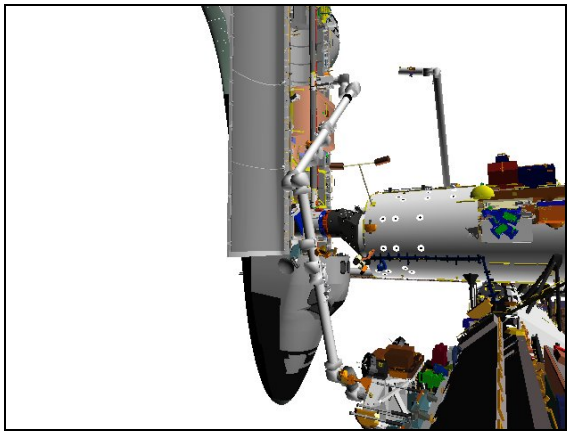

Figure 5.- OBSS Low Hover
(03: S1 Lower Outboard: +60, +5).

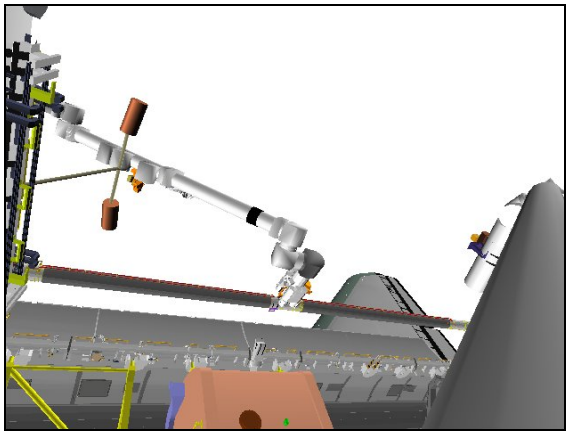

Figure 6.- OBSS Low Hover
(92: SRMS Elbow: -35, -10).

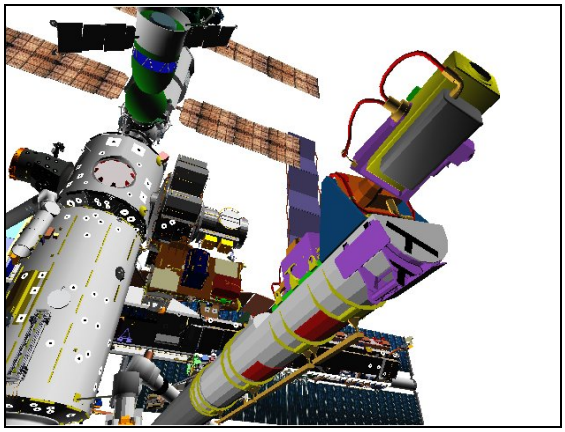

Figure 7.- OBSS Low Hover
(V10: Camera C: +25, +40).

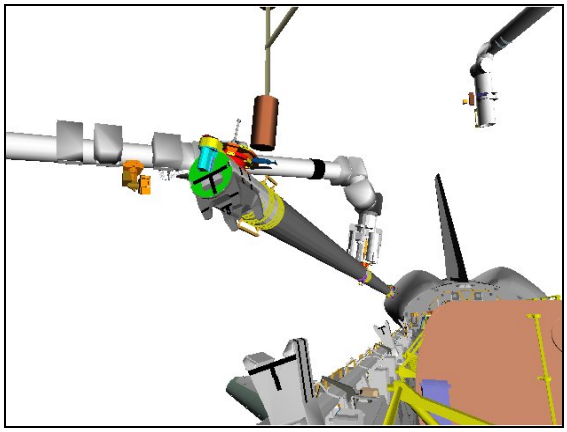

Figure 8.- OBSS Low Hover
(92: Camera D: -20, +15).

5. MANEUVERING CLEAR OF UHF ANTENNA

PCS MSS: SSRMS: Rate: SSRMS Rate

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

MSS: SSRMS: SSRMS

Enter Mode – FOR OCAS (Verify blue)

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

cmd Shoulder Roll (Verify SR – Locked)

SSRMS FOR OCAS

Input 'FOR' 'Destination' for Clear UHF Antenna position.

X	Y	Z	Pitch	Yaw	Roll
0	-190	-167	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	-100	0.0	0.0	0.0
TGT	0	**-190**	**-167**	0.0	0.0	0.0
ERR	0	+190	+67	0.0	0.0	0.0

****
* If FOR or errors are incorrect
PCS * | **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* | Input correct Dest FOR per table above.
*
* | **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * | Verify FOR and errors are correct on FOR Position overlay.
****

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

DCP AUTO SEQ → PROC

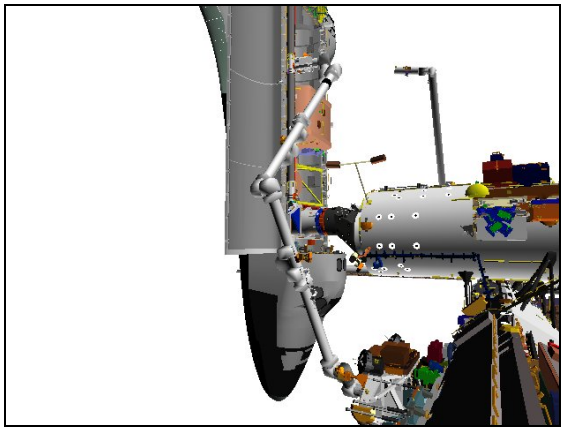

Figure 9.- Clear UHF Antenna
(03: S1 Lower Outboard: +60, +5).

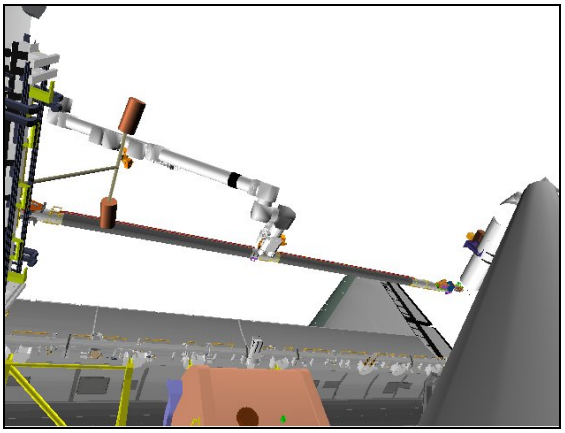

Figure 10.- Clear UHF Antenna
(92: SRMS Elbow: -35, +10).

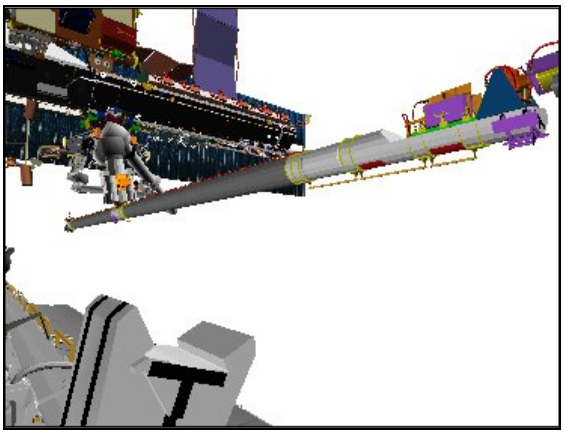

Figure 11.- Clear UHF Antenna
(V10: Camera C: +40, +5).

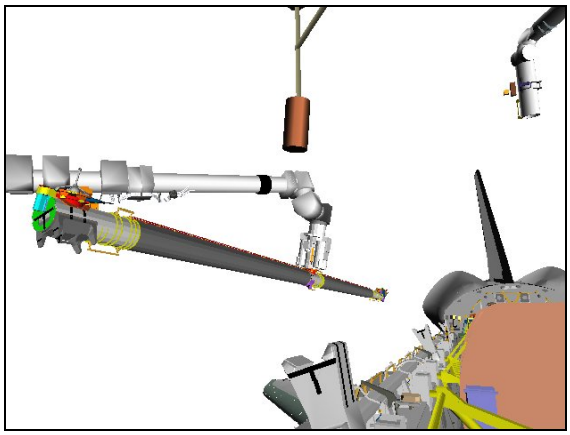

Figure 12.- Clear UHF Antenna
(92: Camera D: -25, +15).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at Clear UHF Antenna position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-27.7	+83.5	-95.2	-60.8	-56.1	-118.5	-3.0
X	Y	Z	Pitch	Yaw	Roll	
0	-190	-167	0.0	0.0	0.0	
FOR	Loaded – OBSS Mid MPM, SR Held					
Disp	W3>Berth OBSS Mid NSP					

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5.405 OBSS MANEUVER TO HANDOFF

(RBT FS/12A.1/FIN 1) Page 1 of 7 pages

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +5)	13: LAB Stbd Zenith (-20, -5)	92: SRMS Elbow (-35, -10)	Camera C (+40, +5)

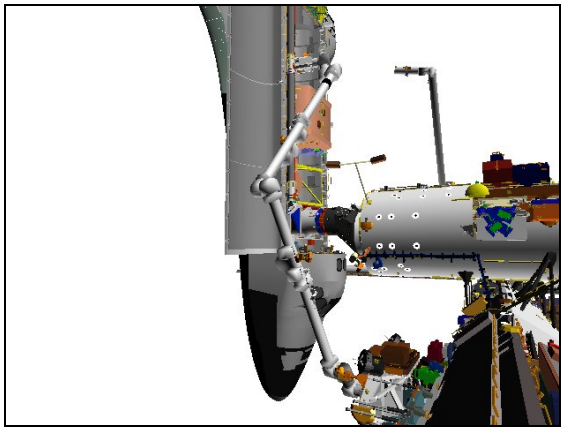

Figure 1.- Clear UHF Antenna (03: S1 Lower Outboard: +60, +5).

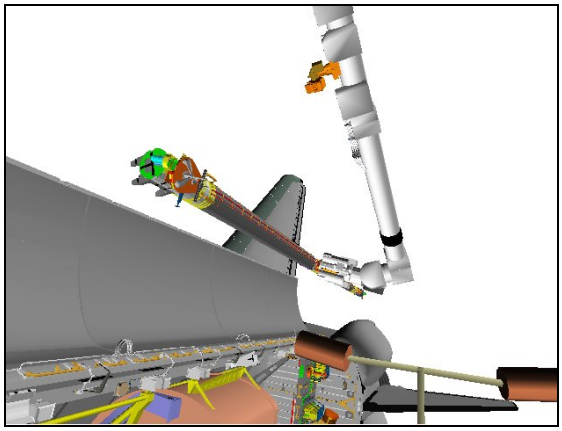

Figure 2.- Clear UHF Antenna (13: LAB Stbd Zenith: -20, -5).

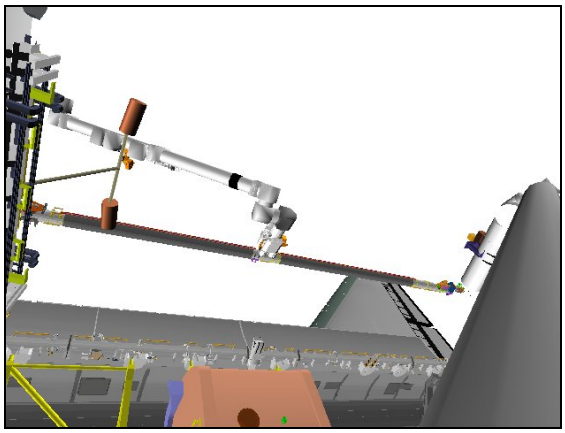

Figure 3.- Clear UHF Antenna (92: SRMS Elbow: -35, -10).

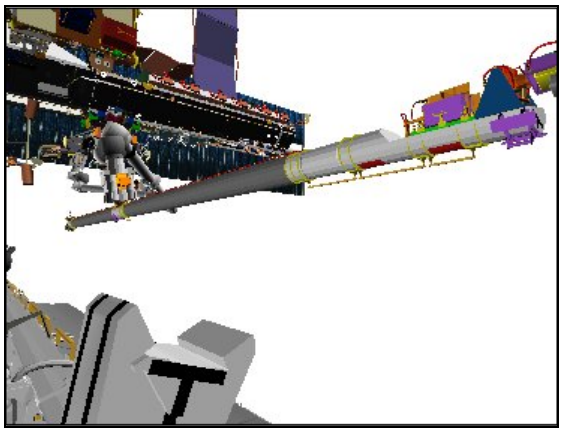

Figure 4.- Clear UHF Antenna (V10: Camera C: +40, +5).

2. MANEUVERING TO STARBOARD POSITION

RHC RATE → COARSE (Verify Coarse on PCS)

PCS MSS: SSRMS: SSRMS

Verify SR – Locked

SSRMS FOR OCAS

Input 'FOR' 'Destination' for Starboard position.

X	Y	Z	Pitch	Yaw	Roll
+100	-690	-367	+20	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	-190	-167	0.0	0.0	0.0
TGT	**+100**	**-690**	**-367**	**+20**	0.0	0.0
ERR	-100	+500	+200	-20.0	0.0	0.0

****

* If FOR or errors are incorrect

PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)

*

* Input correct Dest FOR per table above.

*

* **cmd** Load (Verify Sequence Status – Confirm or Cancel)

*

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

****

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

DCP AUTO SEQ → PROC

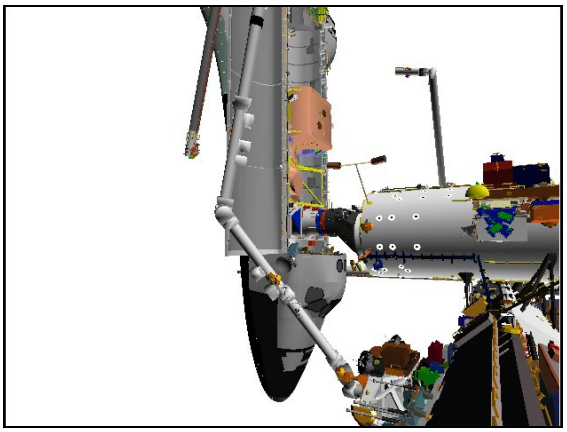

Figure 5.- Starboard Position
(03: S1 Lower Outboard: +60, +5).

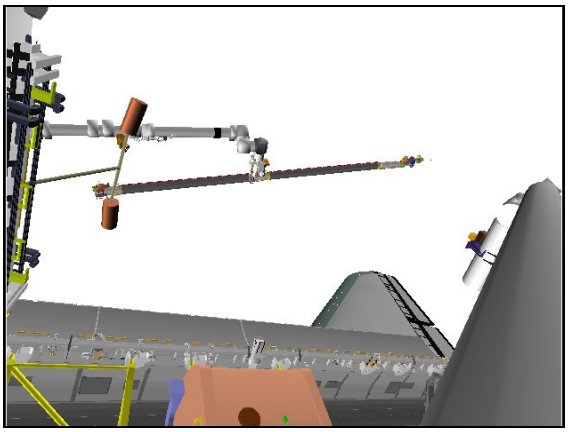

Figure 6.- Starboard Position
(92: SRMS Elbow: -35, -10).

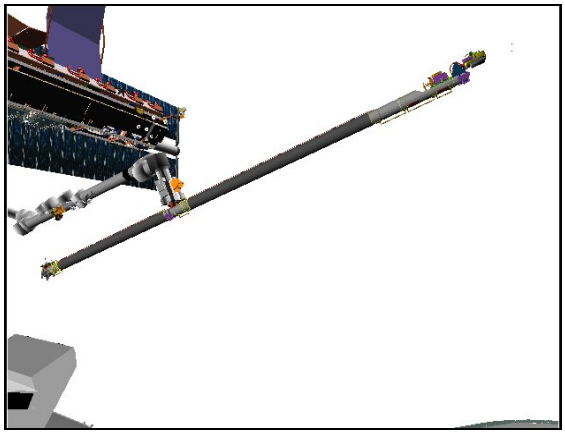

Figure 7.- Starboard Position
(V10: Camera C: +60, +5).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

Locked						
SR	SY	SP	EP	WP	WY	WR
-27.7	+50.2	-77.7	-46.5	-93.3	-147.3	-3.9
X	Y	Z	Pitch	Yaw	Roll	
+100	-690	-367	+20.0	0.0	0.0	
FOR	Loaded – OBSS Mid MPM, SR Held					
Disp	W3>Berth OBSS Mid NSP					

3. MANEUVERING TO HANDOFF INTERMEDIATE POSITION
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +5)	22: Base Elbow (-155, -20)	92: SRMS Elbow (-35, -10)	91: Camera C (+60, +5) Camera A (-10, +20)

MSS: SSRMS: SSRMS

Verify SR – Locked

SSRMS FOR OCAS

Input ‘FOR’ ‘Destination’ for Handoff Intermediate position.

X	Y	Z	Pitch	Yaw	Roll
+100	-690	-367	+90	-70	+45

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	+100	-690	-367	+20.0	0.0	0.0
TGT	+100	-690	-367	**+90.0**	**-70.0**	**+45.0**
ERR	0	0	0	-70.0	+70.0	-45.0

****

* If FOR or errors are incorrect

PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)

*

* Input correct Dest FOR per table above.

*

* **cmd** Load (Verify Sequence Status – Confirm or Cancel)

*

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

****

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

DCP AUTO SEQ → PROC

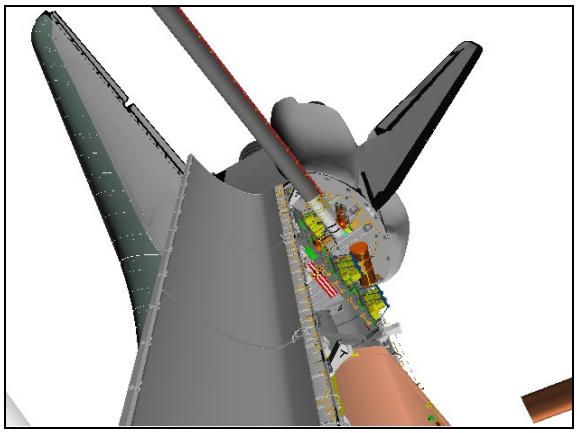

Figure 8.- Handoff Intermediate Position (22: Base Elbow: -135, -40).

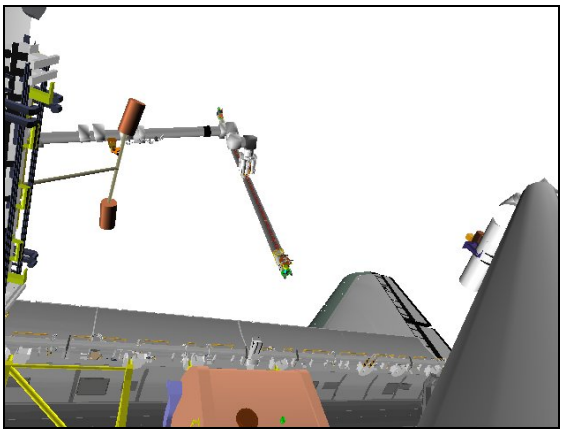

Figure 9.- Handoff Intermediate Position (92: SRMS Elbow: -35, -10).

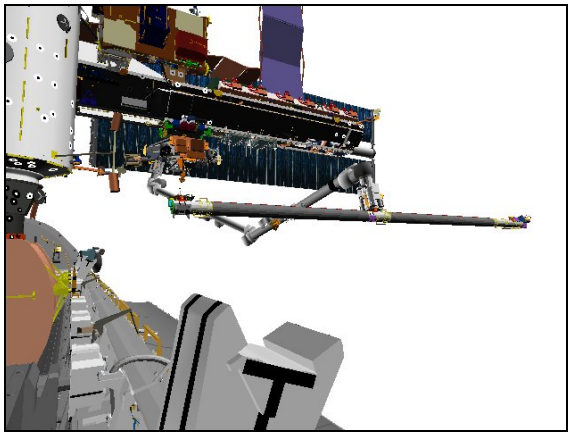

Figure 10.- Handoff Intermediate Position
(V10: Camera C: +30, +5).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

Locked						
SR	SY	SP	EP	WP	WY	WR
-27.7	+42.5	-74.2	-49.3	-86.3	-143.0	-78.9
X	Y	Z	Pitch	Yaw	Roll	
+100	-690	-367	+90.0	-70.0	+45.0	
FOR	Loaded – OBSS Mid MPM, SR Held					
Disp	W3>Berth OBSS Mid NSP					

4. MANEUVERING TO HANDOFF POSITION
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +5)	24: Tip Elbow (-30, +50)	92: SRMS Elbow (-35, -10)	91: Camera C (+30, +5) Camera A (-10, +20)

MSS: SSRMS: SSRMS

Verify SR – Locked

SSRMS FOR OCAS

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

X	Y	Z	Pitch	Yaw	Roll
+208	-210	-367	+90	-70	+45

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	+100	-690	-367	+90.0	-70.0	+45.0
TGT	**+208**	**-210**	-367	+90.0	-70.0	+45.0
ERR	-108	-480	0	0.0	0.0	0.0

****
* If FOR or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest FOR per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify FOR and errors are correct on FOR Position overlay.
****

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

DCP AUTO SEQ → PROC

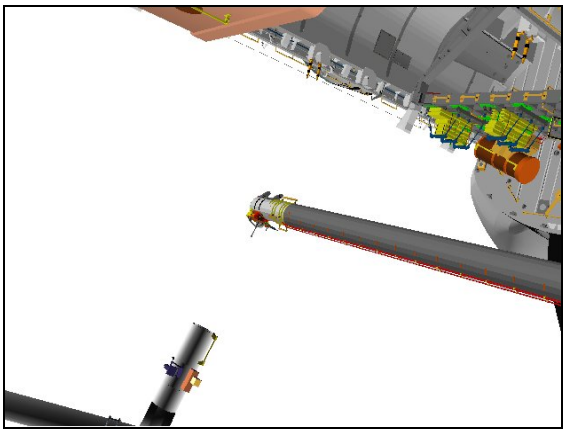

Figure 11.- OBSS Handoff Position
(24: Tip Elbow: -30, +30).

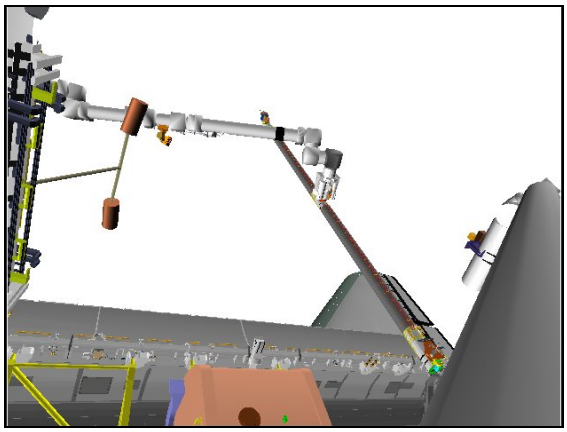

Figure 12.- OBSS Handoff Position
(92: SRMS Elbow: -35, -10).

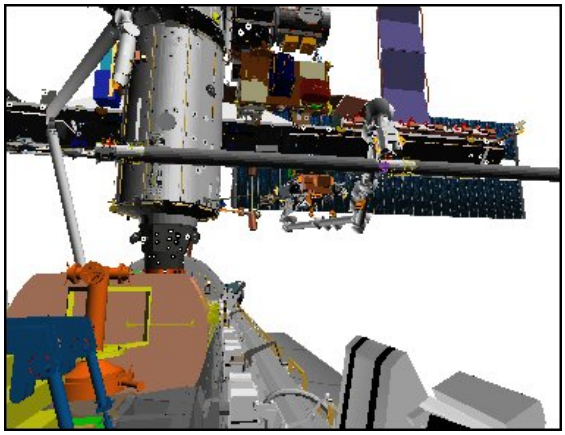

Figure 13.- OBSS Handoff Position
(V10: Camera C: +10, +10).

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
-27.7	+67.6	-100.9	-39.9	-86.0	-122.9	-101.7
X	Y	Z	Pitch	Yaw	Roll	
+208	-210	-367	+90.0	-70.0	+45.0	
FOR	Loaded – OBSS Mid MPM, SR Held					
Disp	W3>Berth OBSS Mid NSP					

DCP BRAKES SSRMS → ON (Verify ON)

5. VERIFICATION OF DESAT REQUEST

PCS MSS: SSRMS: Thrusters: Thruster Controls for MSS Ops

Verify 'Desat Request:' – Inh

6. SRMS GRAPPLE
Give SRMS operator GO for OBSS Grapple.

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5.406 OBSS UNGRAPPLE AT HANDOFF

(RBT FS/12A.1/FIN 1) Page 1 of 4 pages

1. SETUP

Configure Cameras and overlays for ungrapple.

Monitor 1	Monitor 2	Monitor 3	V10
24: Tip Elbow (+5, +5)	25: Tip LEE	92: SRMS Elbow (-25, +5)	Camera C (+25, +15)

NOTE

The LEE Camera must be fully zoomed out to correspond to the target overlay.

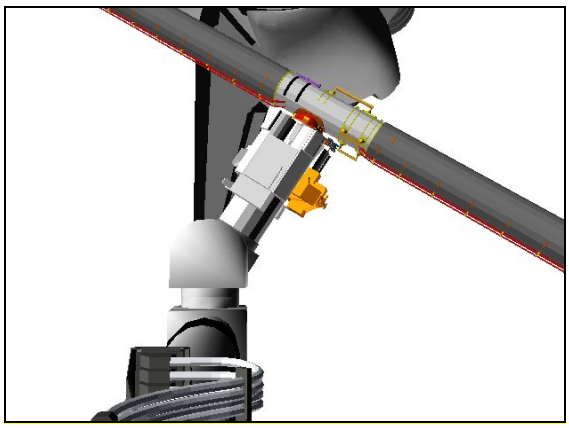

Figure 1.- OBSS Handoff Position (24: Tip Elbow: +5, +5).

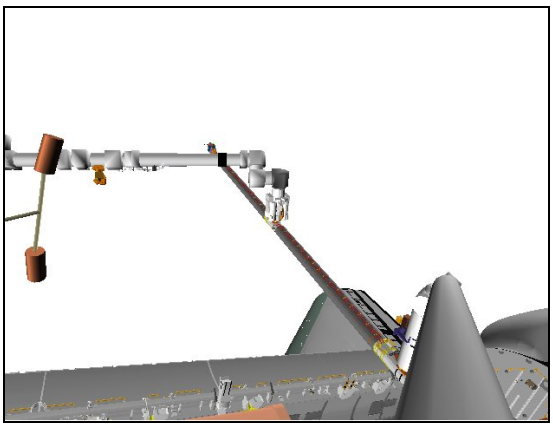

Figure 2.- OBSS Handoff Position (92: SRMS Elbow: -25, +5).

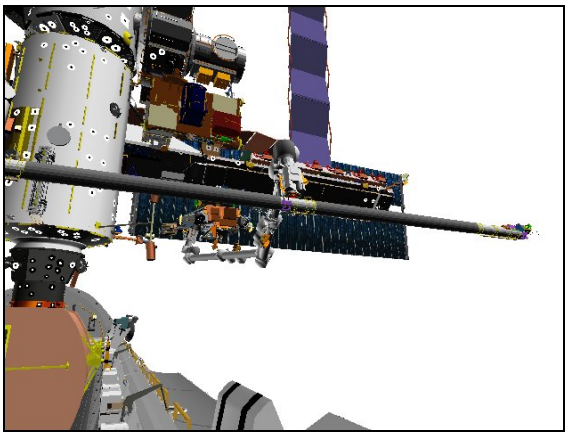

Figure 3.- OBSS Handoff Position (V10: Camera C: +25, +15).

PCS MSS: SSRMS: SSRMS

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

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

RHC RATE → VERNIER (Verify Vernier on PCS)

PCS MSS: SSRMS: Rate: SSRMS Rate

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

2. OBSS UNGRAPPLE (CARRIAGE PUSHOFF)
On SRMS operator GO for OBSS Ungrapple

DCP BRAKES SSRMS → OFF (Verify OFF)

2.1 SSRMS Limp

PCS MSS: SSRMS: Limp: SSRMS Limp

cmd All Limp (Verify Limp – blue)

MSS: SSRMS: SSRMS

Verify all joints – Limped

2.2 Auto Release
MSS: SSRMS: Tip LEE: SSRMS Tip LEE

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

Verify 'Confirm or Terminate' prompt.

CAUTION

Due to end-to-end system latency, the RHC Trigger is hot up to 3 seconds prior to receiving a Trigger Hot icon status on the PCS.

NOTE

Once the trigger is hot, only safing or trigger commands should be sent to the Robotics equipment. If a configuration change is required, including routing MSS Cameras, safe the system to exit LEE operations (SCR 23262, 14662).

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Release

RHC TRIGGER → press (momentarily)

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

Verify Unloaded Parameters – √

2.3 SSRMS Backoff

MSS: SSRMS: Limp: SSRMS Limp

cmd None Limp (Verify Standby – blue)

MSS: SSRMS: SSRMS

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

THC/ RHC — Maneuver to Grapple Fixture Backoff position (-X THC Command) (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-27.7	+56.7	-101.2	-47.4	-68.5	-131.1	-89.6
X	Y	Z	Pitch	Yaw	Roll	
+138	-159	-576	-74.1	-19.3	-84.6	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

DCP — BRAKES SSRMS → ON (Verify ON)

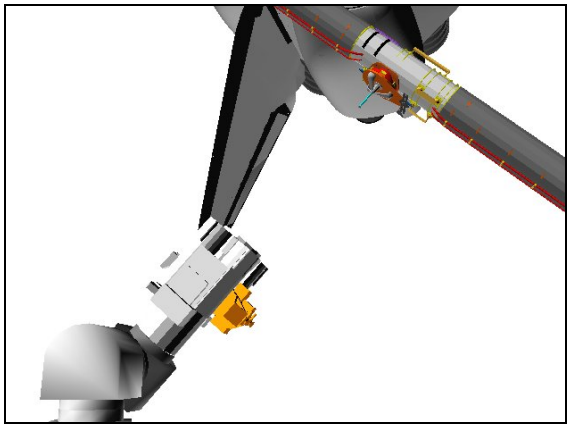

Figure 4.- OBSS Handoff Backoff (24: Tip Elbow: +15, +15).

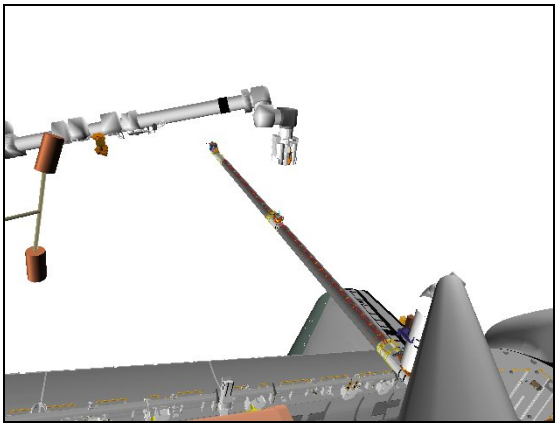

Figure 5.- OBSS Handoff Backoff (92: SRMS Elbow: -25, +5).

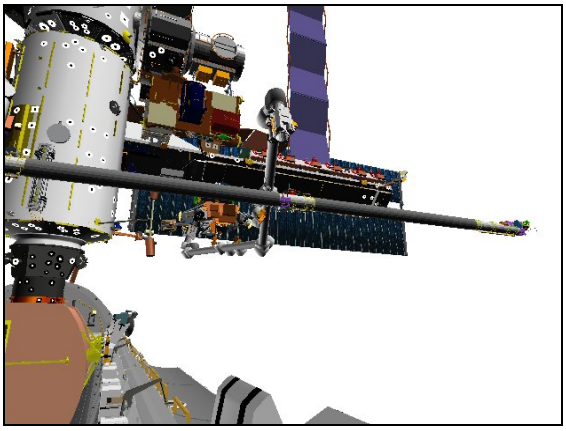

Figure 6.- OBSS Handoff Backoff
(V10: Camera C: +25, +15).

5.407 MANEUVER TO SURVEY SUPPORT VIEWING POSITION

(RBT FS/12A.1/FIN 1) Page 1 of 10 pages

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +5)	22: Base Elbow (-165, -15) 09: P1 Lower Outboard (+90, 0)	13: LAB Stbd Zenith (-160, +75)	SRMS Elbow (-40, +5) Camera C (+35, +15)

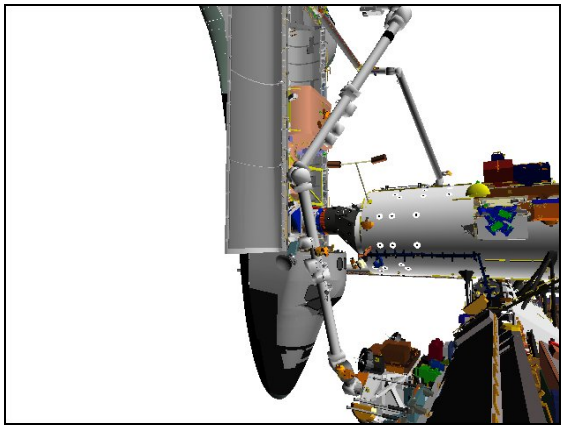

Figure 1.- OBSS Handoff Backoff (03: S1 Lower Outboard: +60, +5).

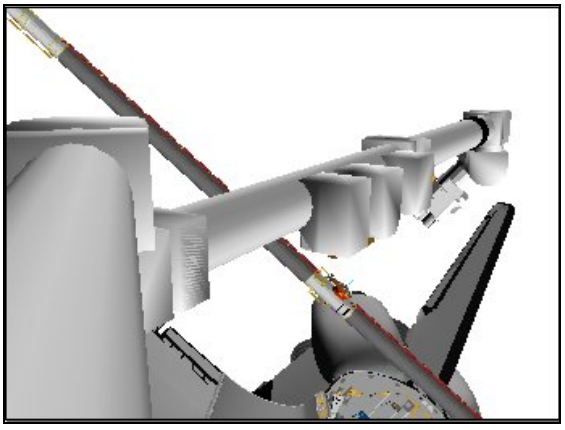

Figure 2.- OBSS Handoff Backoff (22: Base Elbow: -165, -15).

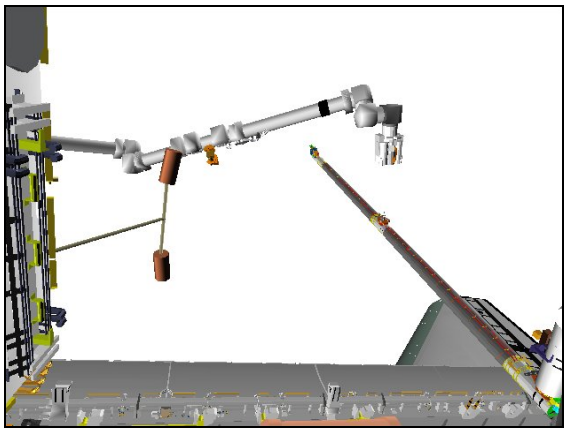

Figure 3.- OBSS Handoff Backoff (V10: SRMS Elbow: -40, +5).

RHC RATE → COARSE (Verify Coarse on PCS)

DCP BRAKES SSRMS → OFF (Verify OFF)

MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

2. JOINT OCAS 1
MSS: SSRMS: SSRMS

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Joint OCAS 1 position.

SR	SY	SP	EP	WP	WY	WR
-50.0	+56.7	-101.2	-61.3	-68.5	-131.1	-89.6

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)	-27.7	+56.7	-101.2	-47.4	-68.5	-131.1	-89.6
TGT	**-50.0**	+56.7	-101.2	**-61.3**	-68.5	-131.1	-89.6
ERR	+22.3	0.0	0.0	+13.9	0.0	0.0	0.0

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

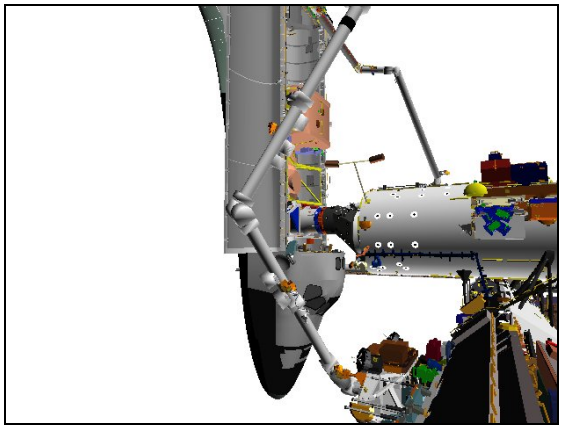

Figure 4.- Joint OCAS 1 End
(03: S1 Lower Outboard: +60, +5).

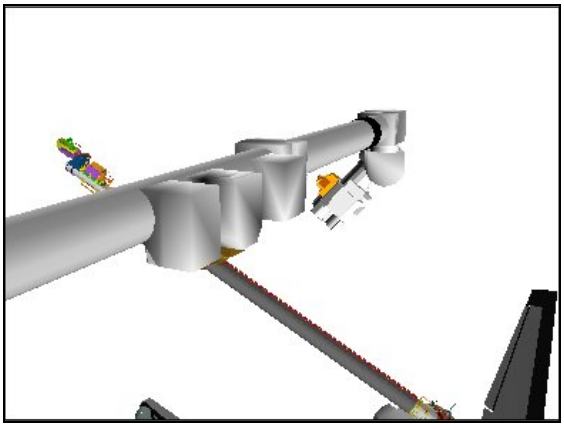

Figure 5.- Joint OCAS 1 End
(22: Base Elbow:-145, -15).

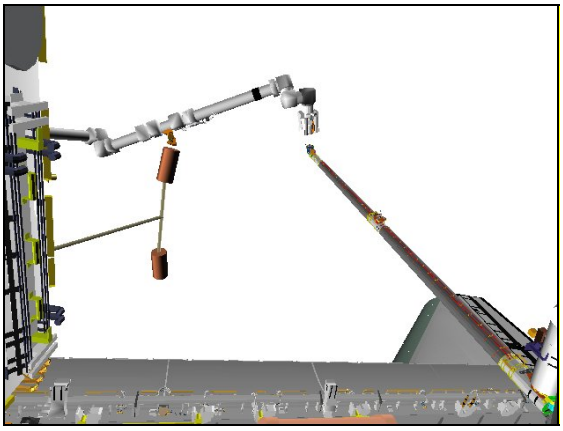

Figure 6.- Joint OCAS 1 End
(V10: SRMS Elbow: -40, +5).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at Joint OCAS 1 End position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-50.0	+56.7	-101.2	-61.3	-68.5	-131.1	-89.6
X	Y	Z	Pitch	Yaw	Roll	
+18	-530	-688	-70.1	-27.7	-92.4	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

3. JOINT OCAS 2

SSRMS Joint OCAS

Input ‘Joint Angles’ ‘Destination’ for Joint OCAS 2 position.

SR	SY	SP	EP	WP	WY	WR
-50.0	+61.1	+46.3	-61.3	-121.8	-39.1	-245.0

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)	-50.0	+56.7	-101.2	-61.3	-68.5	-131.1	-89.6
TGT	-50.0	**+61.1**	**+46.3**	-61.3	**-121.8**	**-39.1**	**-245.0**
ERR	0.0	-4.4	-147.5	0.0	+53.3	-92.0	+155.4

****
* If joint angles or errors are incorrect

PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

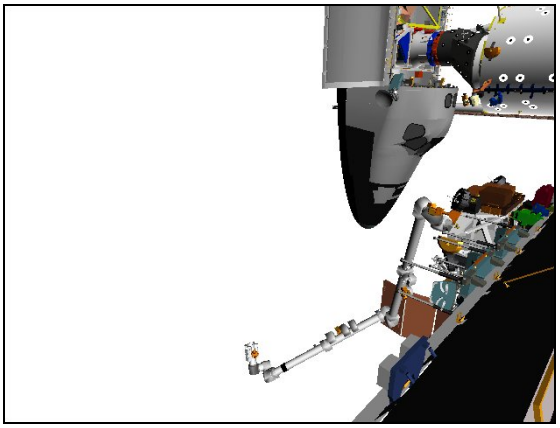

Figure 7.- Joint OCAS 2 End
(03: S1 Lower Outboard: +45, -20).

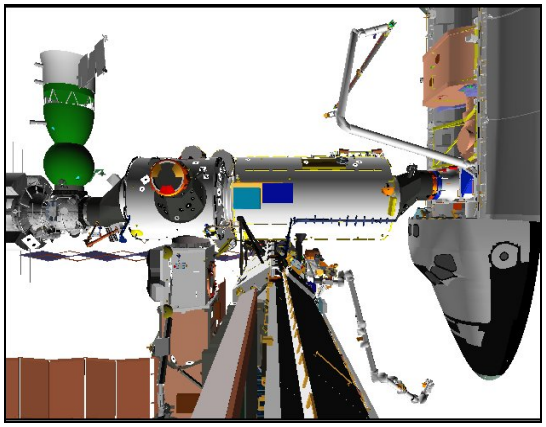

Figure 8.- Joint OCAS 2 End
(09: P1 Lower Outboard:+90, 0).

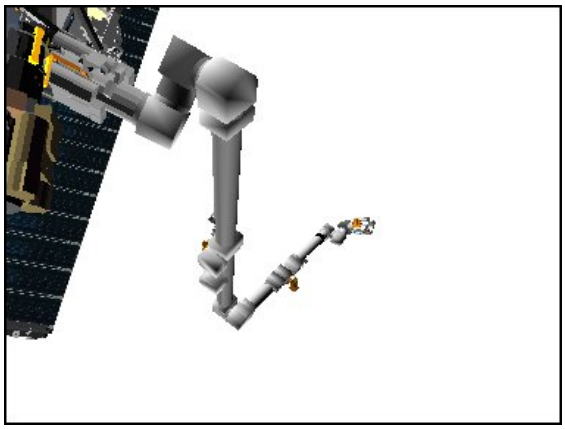

Figure 9.- Joint OCAS 2 End
(13: LAB Stbd Zenith: -160, +40).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at Joint OCAS 2 End position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-50.0	+61.1	+46.3	-61.3	-121.8	-39.1	-245.0
X	Y	Z	Pitch	Yaw	Roll	
-2162	-735	+118	-21.3	+2.2	+12.9	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

Give SRMS Operator GO to maneuver for Focused Inspection.

4. SINGLE JOINT TO SURVEY SUPPORT VIEWING POSITION

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → SHOULDER ROLL (Verify SR – Selected on PCS)

THC Perform "+" Single Joint maneuver to SR: +41.6 (THC up).

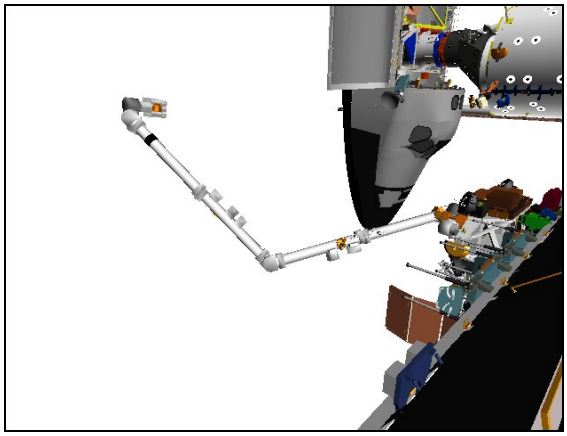

Figure 10.- Survey Support Viewing Position
(03: S1 Lower Outboard: +45, -20).

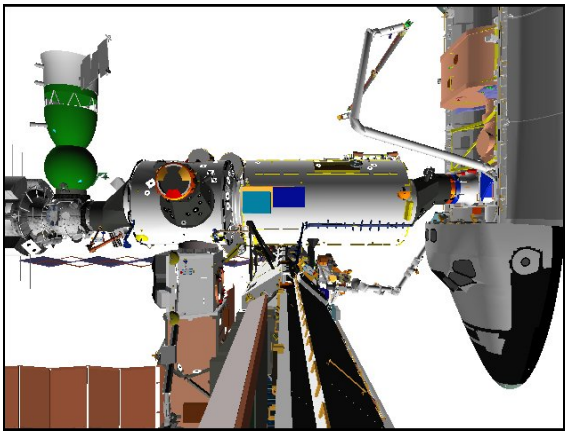

Figure 11.- Survey Support Viewing Position
(09: P1 Lower Outboard: +90, 0).

Figure 12.- Survey Support Viewing Position
(V10: Camera C: +35, +15).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at Survey Support Viewing position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+41.6	+61.1	+46.3	-61.3	-121.8	-39.1	-245.0
X	Y	Z	Pitch	Yaw	Roll	
-920	-1066	+178	-108.8	+65.9	+109.4	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

DCP BRAKES SSRMS → ON (Verify ON)

5. SURVEY SUPPORT VIEWING

NOTE
To view specific areas below the orbiter, the Tip Elbow Camera may be configured as follows: (a) Nose area of orbiter: P: -105, T: +40 (b) Mid area of orbiter: P: -75, T: +20 (c) Aft area of orbiter: P: -55, T: 0

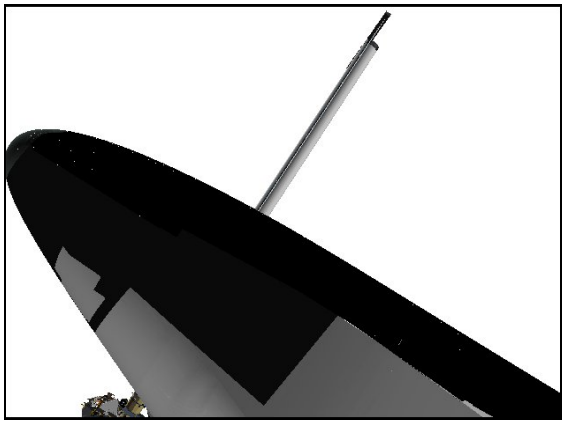

Figure 13.- Nose Area of Orbiter
(24: Tip Elbow: -105, +40).

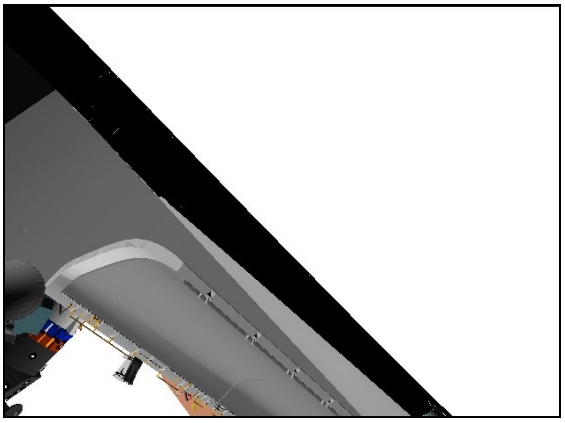

Figure 14.- Mid Area of Orbiter
(24: Tip Elbow: -75, +20).

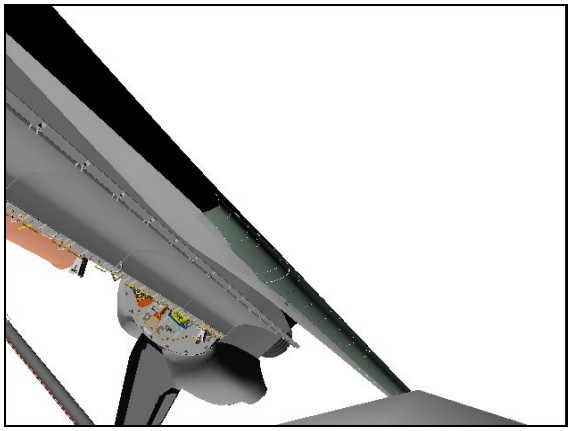

Figure 15.- Aft Area of Orbiter
(24: Tip Elbow: -55, 0).

5.1 Viewing Areas of Orbiter with Tip LEE Camera (Optional)
To view areas of the orbiter using the Tip LEE Camera, the Wrist Cluster can be reconfigured in Single Joint mode, as follows:

5.1.1 If viewing fwd area of orbiter

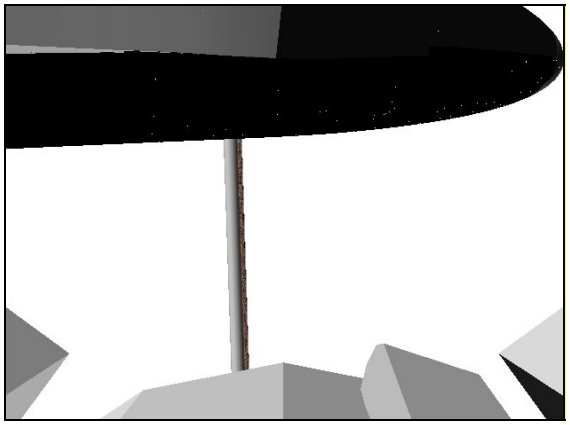

Figure 16.- Survey Support - Fwd Orbiter (25: Tip LEE).

DCP BRAKES SSRMS → OFF (Verify OFF)

PCS MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

5.1.2 If viewing mid area of orbiter

Perform Single Joint maneuver to Mid Orbiter viewing position (within 1 deg).

	SR	SY	SP	EP	WP	WY	WR
Initial Viewing Posn	+41.6	+61.1	+46.3	-61.3	-121.8	-39.1	-245.0
1: WP +					-89.5		
2: WY +						-25.0	
Mid Orbiter	+41.6	+61.1	+46.3	-61.3	-89.5	-25.0	-245.0
	X	Y	Z	Pitch	Yaw	Roll	
	+865	-1113	+184	-45.7	+56.1	+35.2	
	FOR	Unloaded – LEE Tip, SR Held					
	Disp	W3>Berthed OBSS MidMPM NSP					

DCP BRAKES SSRMS → ON (Verify ON)

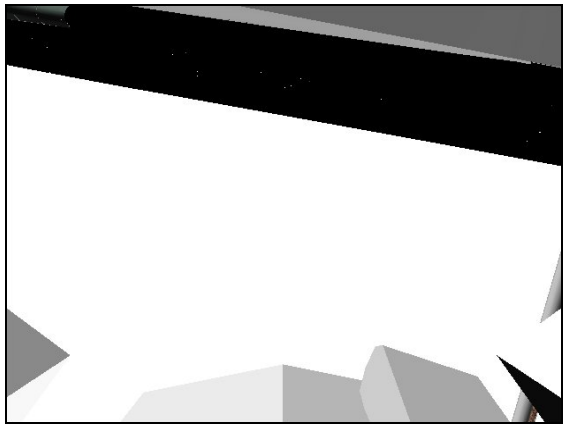

Figure 17.- Survey Support - Mid Orbiter (25: Tip LEE).

5.1.3 If viewing aft area of orbiter

THC Perform Single Joint maneuver to Aft Orbiter viewing position (within 1 deg).

	SR	SY	SP	EP	WP	WY	WR
Initial Viewing Posn	+41.6	+61.1	+46.3	-61.3	-121.8	-39.1	-245.0
1: WP +					-63.0		
2: WY +						-2.0	
Aft Orbiter	+41.6	+61.1	+46.3	-61.3	-63.0	-2.0	-245.0
	X	Y	Z	Pitch	Yaw	Roll	
	-828	-1182	+161	-17.2	+28.3	+8.9	
	FOR	Unloaded – LEE Tip, SR Held					
	Disp	W3>Berthed OBSS MidMPM NSP					

DCP BRAKES SSRMS → ON (Verify ON)

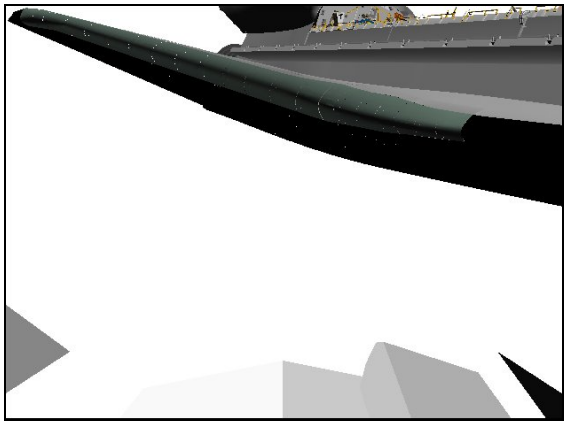

Figure 18.- Survey Support - Aft Orbiter (25: Tip LEE).

5.2 Returning to Survey Support Viewing Position

If required, once viewing support is complete, return to the initial Survey Support Viewing Position using Single Joint Mode.

DCP BRAKES SSRMS → OFF (Verify OFF)

PCS MSS: SSRMS: [SSRMS]

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

If WP not -121.8

DCP JOINT SELECT → WP (Verify WP – Selected on PCS)

THC Perform Single Joint maneuver to WP: -121.8

If WY not -39.1

DCP JOINT SELECT → WY (Verify WY – Selected on PCS)

THC Perform Single Joint maneuver to WY: -39.1

PCS MSS: SSRMS: [SSRMS]

Verify SSRMS at Survey Support Viewing position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+41.6	+61.1	+46.3	-61.3	-121.8	-39.1	-245.0
X	Y	Z	Pitch	Yaw	Roll	
-920	-1066	+178	-108.8	+65.9	+109.4	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

6. CLEANUP

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)

5.408 OBSS UNGRAPPLE AT HANDOFF TO SSRMS STOW

(RBT FS/12A.1/FIN 1) Page 1 of 5 pages

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +5)	22: Base Elbow (-165, -15) 09: P1 Lower Outboard (+90, 0)	13: LAB Stbd Zenith (-160, +75)	SRMS Elbow (-40, +5) Camera C (+35, +15)

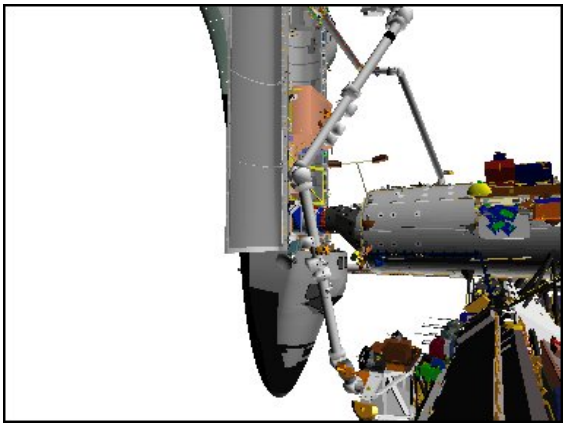

Figure 1.- OBSS Handoff Backoff (03: S1 Lower Outboard: +60, +5).

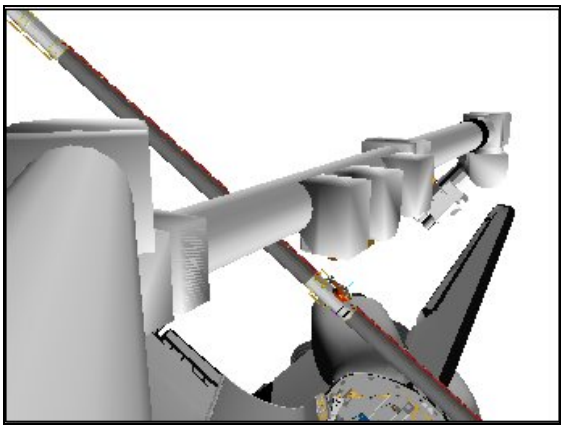

Figure 2.- OBSS Handoff Backoff (22: Base Elbow: -165, -15).

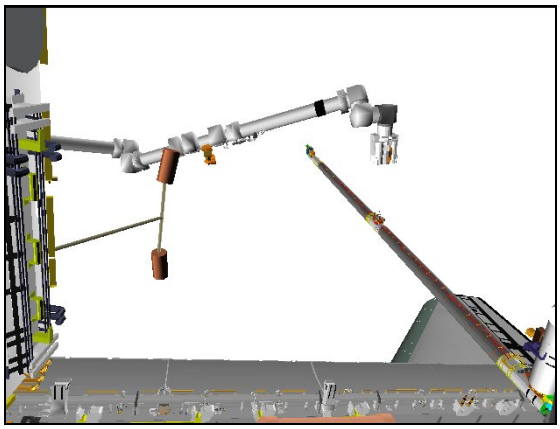

Figure 3.- OBSS Handoff Backoff (V10: SRMS Elbow: -40, +5).

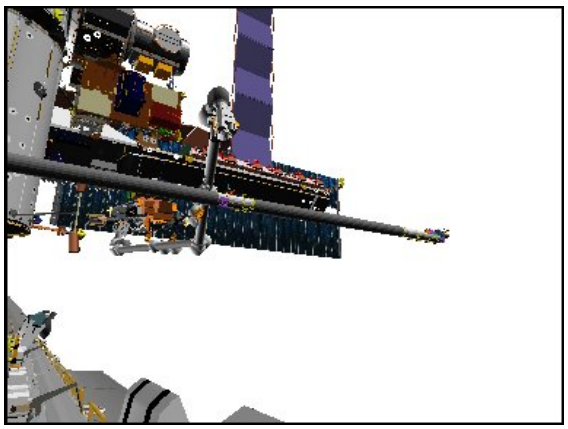

Figure 4.- OBSS Handoff Backoff (V10: Camera C: +35, +15).

RHC RATE → COARSE (Verify Coarse on PCS)

DCP BRAKES SSRMS → OFF (Verify OFF)

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

2. SSRMS CLEARANCE MANEUVER

NOTE
Monitor clearance to MBS Mast Camera with the Lab Camera.
Clearance at Clearance position is approximately 58 cm (1.9 ft).

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for OBSS Clearance position.

SR	SY	SP	EP	WP	WY	WR
-60.0	+56.7	-101.2	-65.0	-68.5	-131.1	-89.6

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)	-27.7	+56.7	-101.2	-47.4	-68.5	-131.1	-89.6
TGT	**-60.0**	**+56.7**	**-101.2**	**-65.0**	**-68.5**	**-131.1**	**-89.6**
ERR	+32.3	0.0	0.0	+17.6	0.0	0.0	0.0

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

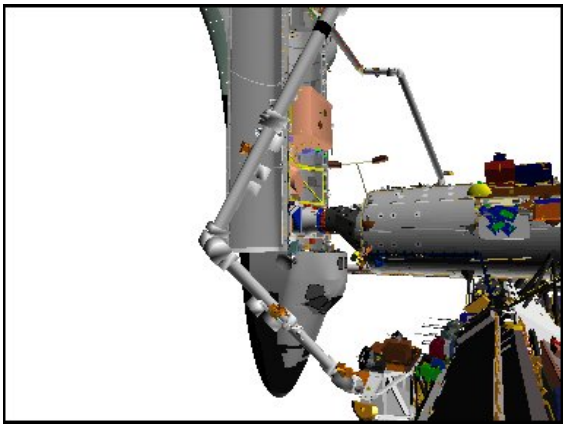

Figure 5.- OBSS Clearance
(03: S1 Lower Outboard: +60, +5).

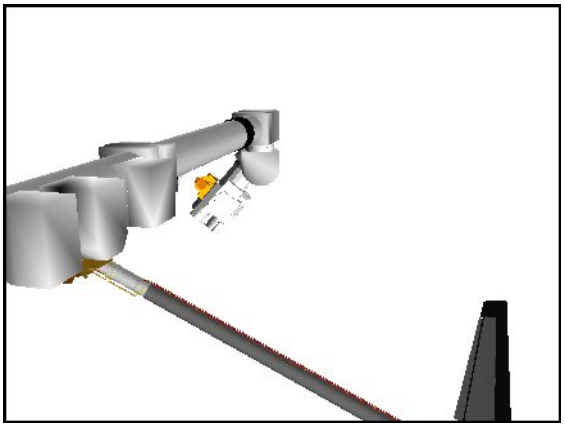

Figure 6.- OBSS Clearance
(22: Base Elbow: -130, -15).

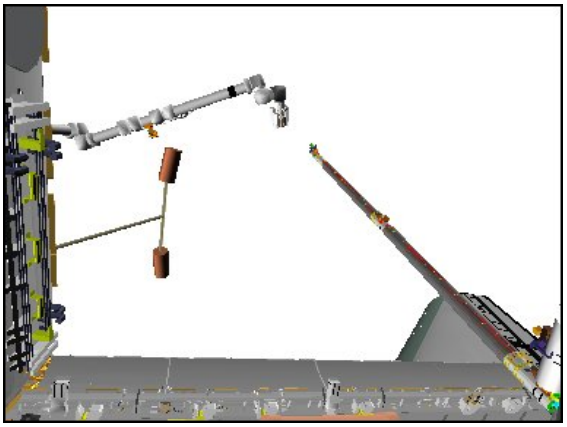

Figure 7.- OBSS Clearance
(V10: SRMS Elbow: -40, +5).

Figure 8.- OBSS Clearance
(V10: Camera C: +35, +15).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

SR	SY	SP	EP	WP	WY	WR
-60.0	+56.7	-101.2	-65.0	-68.5	-131.1	-89.6
X	Y	Z	Pitch	Yaw	Roll	
-67	-705	-728	-71.3	-32.0	-98.7	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

3. SSRMS STOW

NOTE

1. Monitor clearance to MBS Mast Camera with the Lab Camera. Closest clearance during the maneuver is approximately 51 cm (1.7 ft).
2. Expect singularity warning for EP between -15 and +15 deg.
3. Expect singularity warning for WY between +80 and +100 deg.

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for SSRMS Stow position.

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4

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)	-60.0	+56.7	-101.2	-65.0	-68.5	-131.1	-89.6
TGT	**-180.0**	**+96.0**	**-183.0**	**+146.7**	**-131.1**	**+175.4**	**+125.4**
ERR	+120.0	-39.3	+81.8	-211.7	+62.6	-306.5	-215.0

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

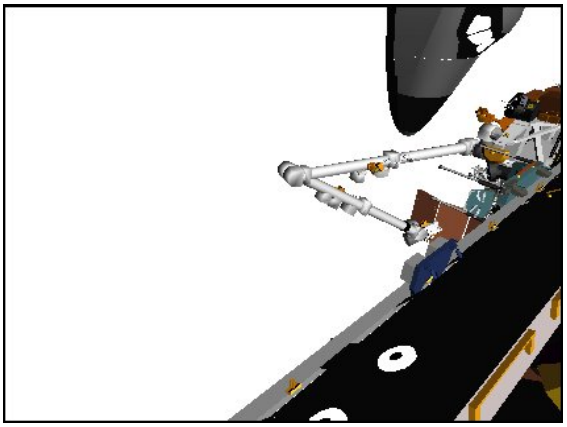

Figure 9.- SSRMS Stow
(03: S1 Lower Outboard: +40, -35).

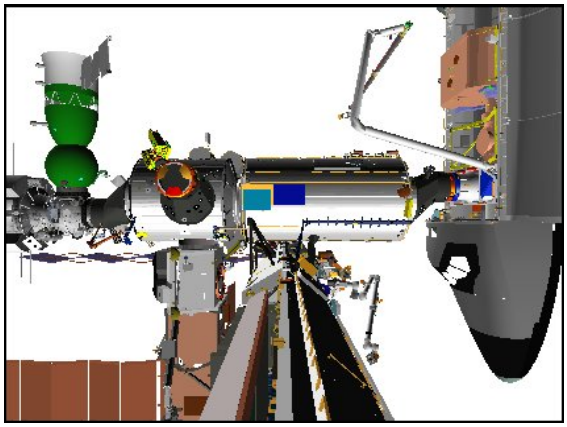

Figure 10.- SSRMS Stow
(09: P1 Lower Outboard: +90, 0).

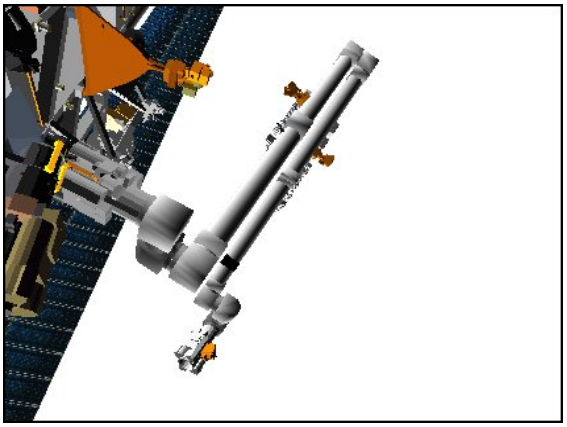

Figure 11.- SSRMS Stow
(13: LAB Stbd Zenith: -160, +55).

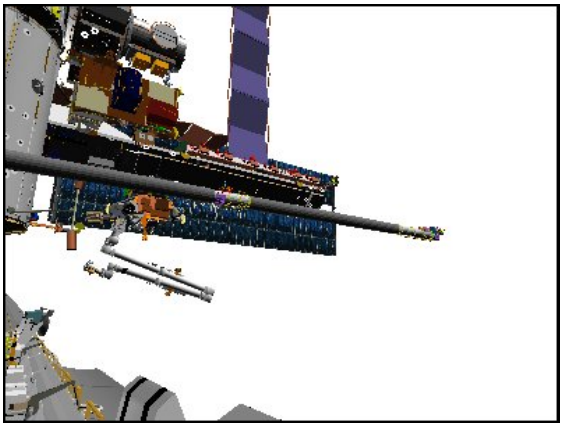

Figure 12.- SSRMS Stow
(V10: Camera C: +35, +15).

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

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
X	Y	Z	Pitch	Yaw	Roll	
-1826	-180	-415	+9.1	+75.0	-157.4	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

Give SRMS Operator GO to maneuver to Undock position.

4. SAFING

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)

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5.409 SURVEY SUPPORT VIEWING TO P6 RETRACT VIEWING

(RBT FS/12A.1/FIN) Page 1 of 7 pages

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+40, -30) 37: MBS Mast (-170, +60)	09: P1 Lower Outboard (+90, 0)	13: LAB Stbd Zenith (-160, +65)	Camera C (+35, +15) SRMS Elbow (+120, -50)

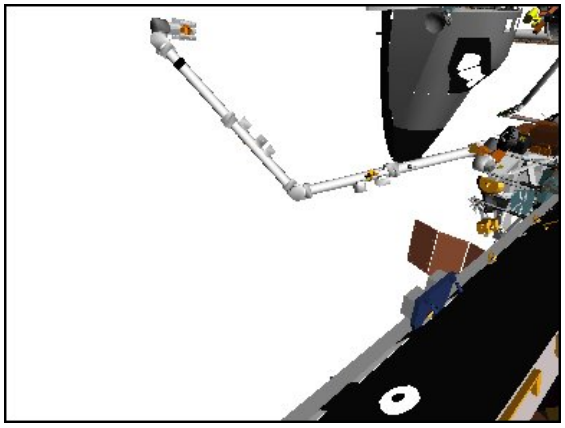

Figure 1.- Survey Support Viewing (03: S1 Lower Outboard: +40, -30).

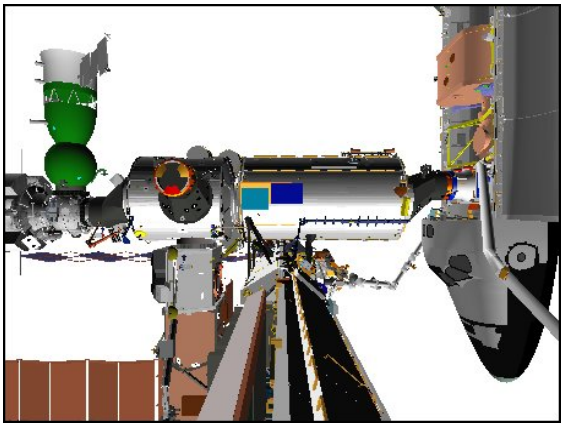

Figure 2.- Survey Support Viewing (09: P1 Lower Outboard: +90, 0).

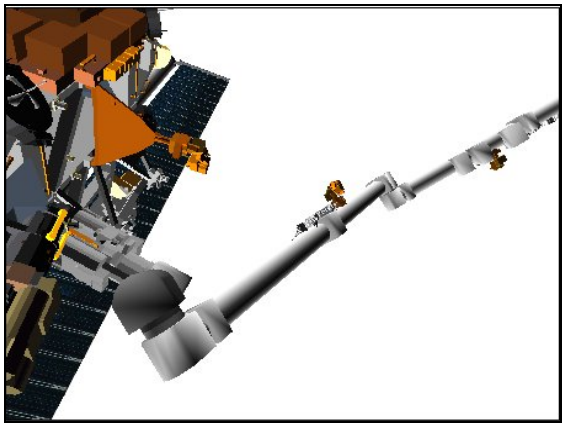

Figure 3.- Survey Support Viewing (13: LAB Stbd Zenith: -160, +65).

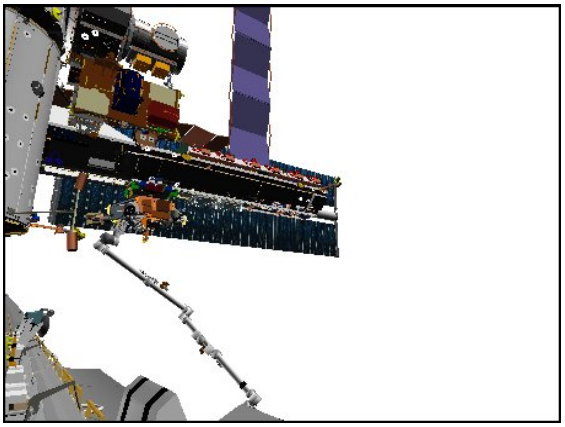

Figure 4.- Survey Support Viewing (V10: Camera C: +35, +15).

Verify SRMS at 4B SAW Retract with OBSS Viewing Position.

PCS MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

√Coarse

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

2. MANEUVERING TO INTERMEDIATE POSITION

SSRMS Joint OCAS

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

SR	SY	SP	EP	WP	WY	WR
-194.4	+85.2	-137.0	-30.0	-154.8	+184.9	-61.5

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)	+41.6	+61.1	+46.3	-61.3	-121.8	-39.1	-245.0
TGT	**-194.4**	**+85.2**	**-137.0**	**-30.0**	**-154.8**	**+184.9**	**-61.5**
ERR	+236.0	-24.1	+183.3	-31.3	+33.0	-224.0	-183.5

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

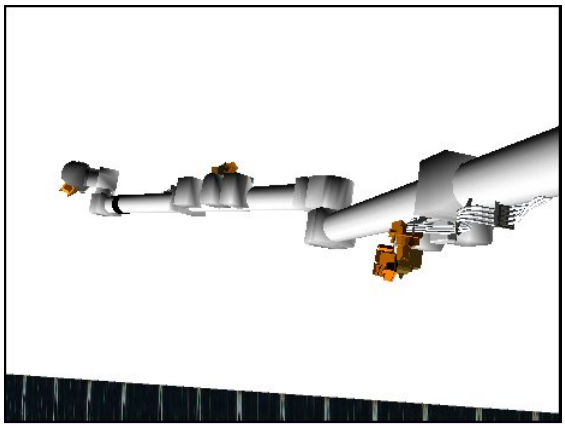

Figure 5.- Intermediate
(37: MBS Mast: -110, +5).

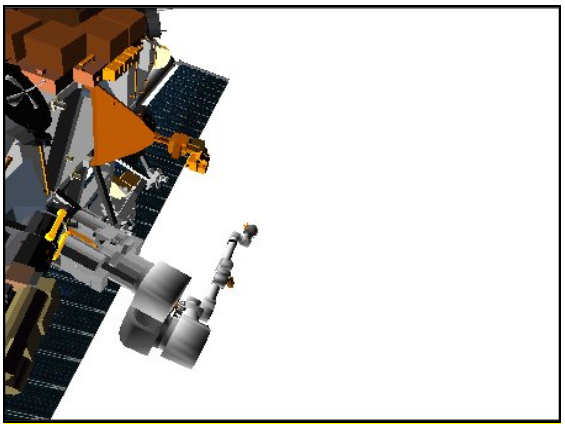

Figure 6.- Intermediate
(13: LAB Stbd Zenith: -160, +65).

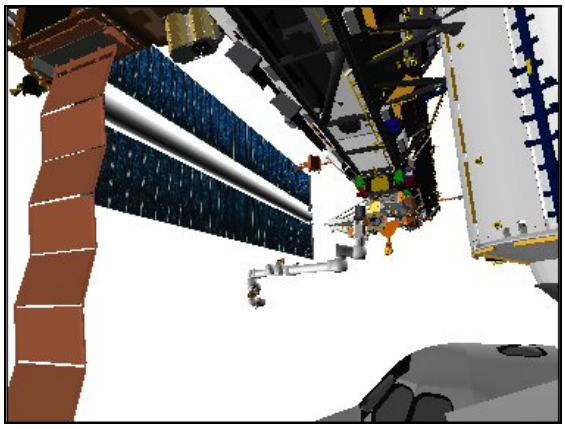

Figure 7.- Intermediate
(V10: SRMS Elbow: +120, -50).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

SR	SY	SP	EP	WP	WY	WR
-194.4	+85.2	-137.0	-30.0	-154.8	+184.9	-61.5
X	Y	Z	Pitch	Yaw	Roll	
-2416	-1309	-696	+171.6	-35.3	-162.4	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

3. CLEARANCE MANEUVER

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
37: MBS Mast (-110, +5)	09: P1 Lower Outboard (+100, -20)	13: LAB Stbd Zenith (-170, +55)	SRMS Elbow (+70, -60)

NOTE

Monitor clearance to Orbiter Nose and P6 Radiator with P1 Outboard Lower or SRMS Elbow Camera. The closest clearance to the P6 Radiator during the maneuver is about 140 cm (4.6 ft). The closest clearance to the Orbiter Nose during the maneuver is about 144 cm (4.7 ft).

PCS MSS: SSRMS: Rate: [SSRMS Rate]

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

RHC RATE → VERNIER (Verify Vernier on PCS)

PCS MSS: SSRMS: [SSRMS]

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → SHOULDER YAW (Verify SY – Selected on PCS)

THC Perform "+" Single Joint maneuver to SY: +250.4 (THC up).

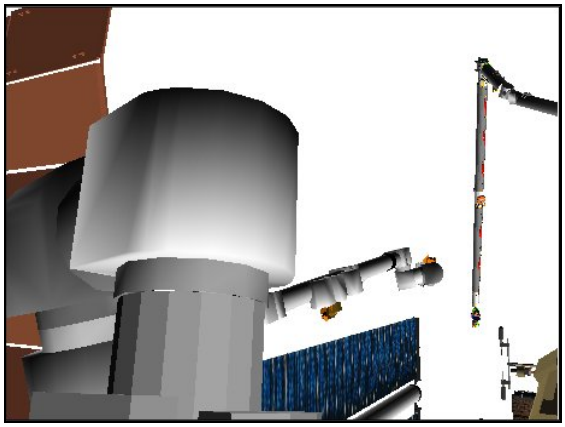

Figure 8.- Clearance
(37: MBS Mast: -30, +5).

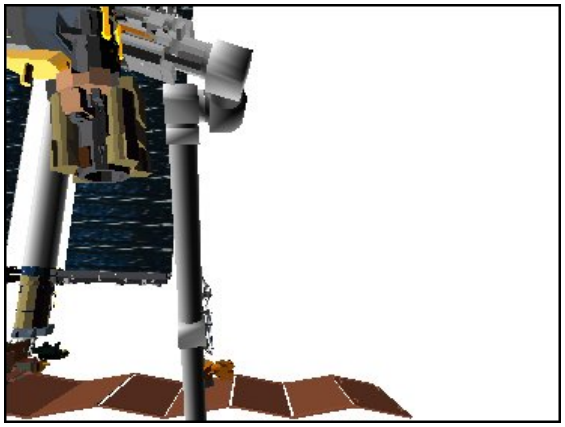

Figure 9.- Clearance
(13: LAB Stbd Zenith: -175, +30).

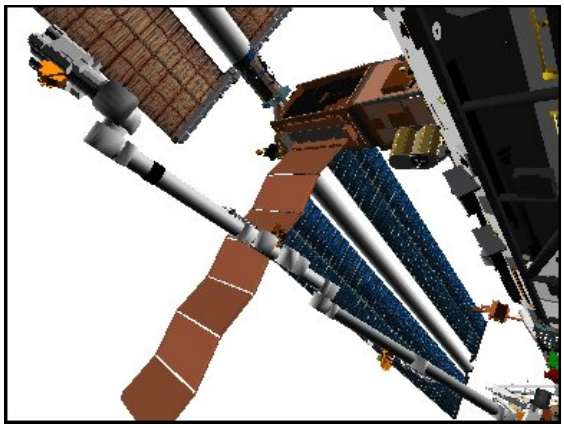

Figure 10.- Clearance
(V10: SRMS Elbow: +85, -35).

4. MANEUVERING TO P6 RETRACT VIEWIING

NOTE
Monitor clearance to SRMS with P1 Outboard Lower or SRMS Elbow Camera. The closest clearance to the SRMS during the end of the maneuver to P6 Retract Viewing Position is approximately 129 cm (4.2 ft). At the final position, the clearanace is approximately 131 cm (4.3 ft).

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for P6 Retract Viewing position.

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-155.0	-61.2	-34.2	+204.3	-84.5

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)	-194.4	+250.4	-137.0	-30.0	-154.8	+184.9	-61.5
TGT	**-194.4**	**+250.4**	**-155.0**	**-61.2**	**-34.2**	**+204.3**	**-84.5**
ERR	0.0	0.0	+18.0	+31.2	-120.6	-19.4	+23.0

****
* If joint angles or errors are incorrect

PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*

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

****

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

DCP AUTO SEQ → PROC

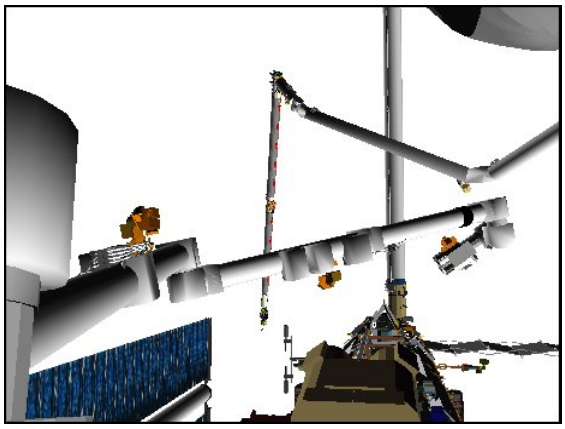

Figure 11.- P6 Retract Viewing
(37: MBS Mast: -10, +5).

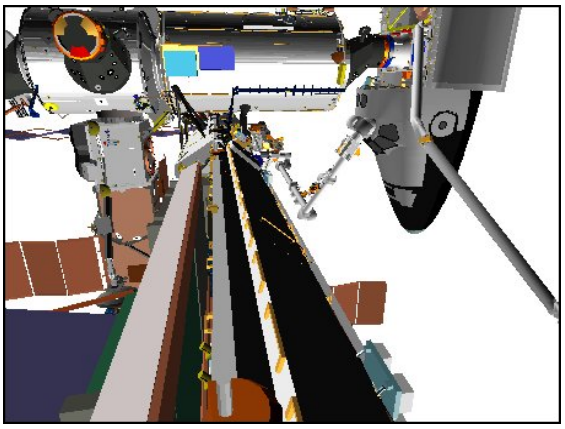

Figure 12.- P6 Retract Viewing
(09: P1 Lower Outboard: +100, -20).

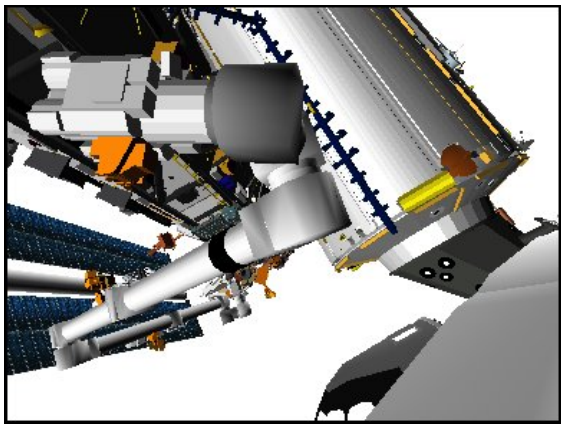

Figure 13.- P6 Retract Viewing
V10: SRMS Elbow: (+150, -40).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at P6 Retract Viewing position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-155.0	-61.2	-34.2	+204.3	-84.5
X	Y	Z	Pitch	Yaw	Roll	
-1089	+978	-145	+146.6	+9.2	-18.8	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

5. CLEANUP

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)

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5.501 MNVR TO OBSS GRAPPLE AT HANDOFF

(RBT FS/12A.1/FIN 1) Page 1 of 7 pages

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+45, -20)	09: P1 Lower Outboard (+90, 0)	13: LAB Stbd Zenith (-150, +50) 22: Base Elbow (170, -10)	Camera C (+35, +15)

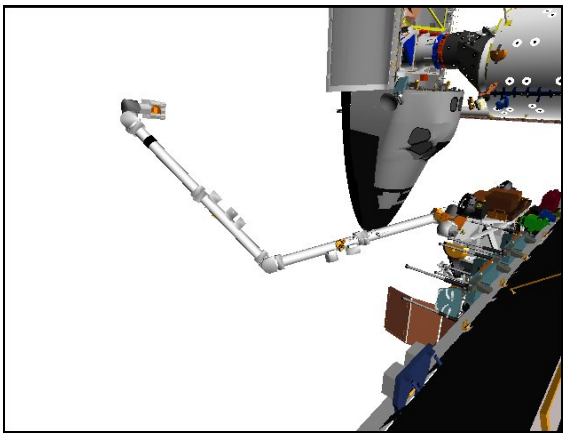

Figure 1.- SSRMS Support Viewing (03: S1 Lower Outboard: +45, -20).

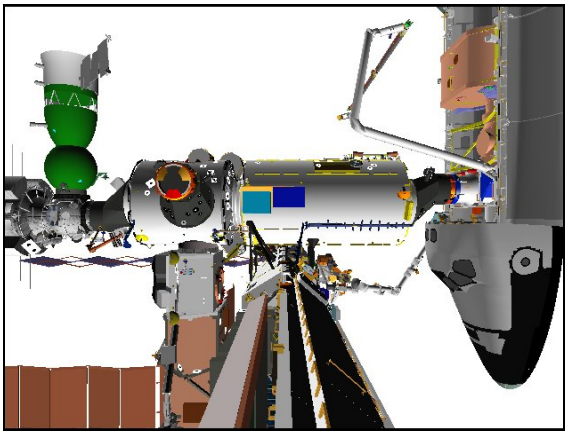

Figure 2.- SSRMS Support Viewing (09: P1 Lower Outboard: +90, 0).

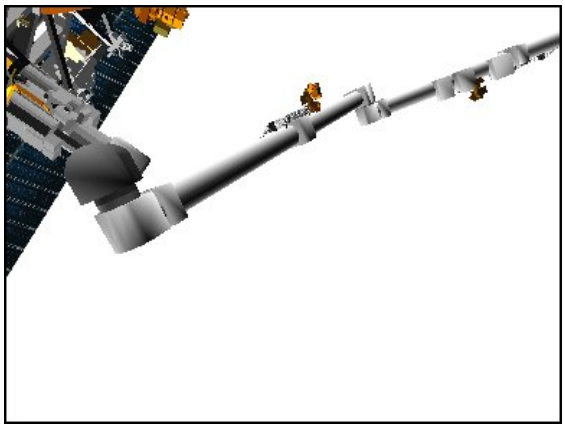

Figure 3.- SSRMS Support Viewing (13: LAB Stbd Zenith: -150, +50).

Figure 4.- SSRMS Support Viewing (V10: Camera C: +35, +15).

PCS MSS: SSRMS: SSRMS

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

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

Verify Display – W3>Berth OBSS Mid NSP

Verify Command – SSRMS>Internal

Verify SRMS is at the OBSS Handoff position.

Verify SSRMS at Survey Support Viewing position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
+41.6	+61.1	+46.3	-61.3	-121.8	-39.1	-245.0
X	Y	Z	Pitch	Yaw	Roll	
-920	-1066	+178	-108.8	+65.9	+109.4	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

2. SINGLE JOINT MANEUVER CLEAR

PCS MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → COARSE (Verify Coarse on PCS)

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → SHOULDER ROLL (Verify SR – Selected on PCS)

THC Perform "-" Single Joint maneuver to SR: -50.0 (THC down).

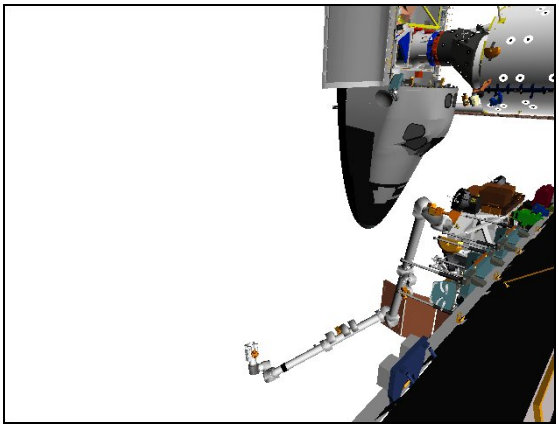

Figure 5.- Clear
(03: S1 Lower Outboard: +45, -20).

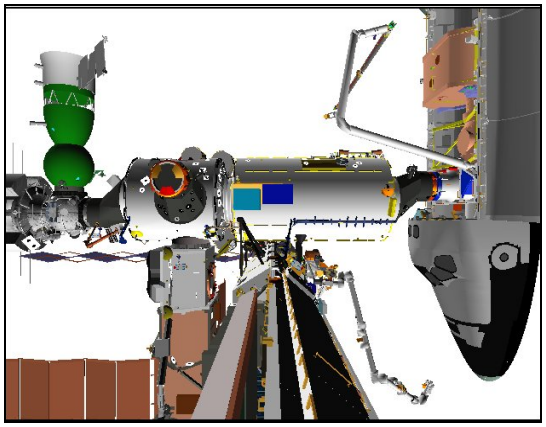

Figure 6.- Clear
(09: P1 Lower Outboard: +90, 0).

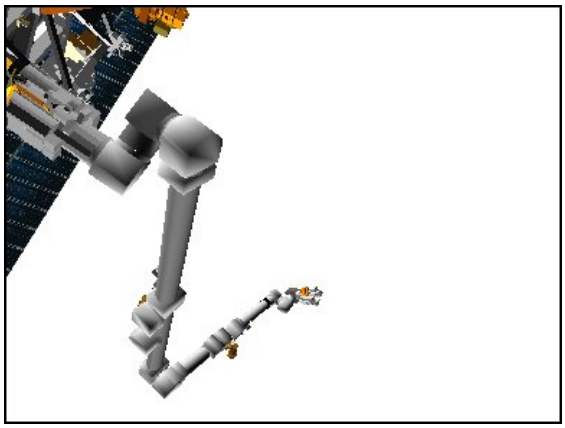

Figure 7.- Clear
(13: LAB Stbd Zenith: -150, +50).

Figure 8.- Clear
(V10: Camera C: +35, +15).

3. JOINT OCAS TO OBSS PRE-GRAPPLE INTERMEDIATE
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+45, -20)	09: P1 Lower Outboard (+90, 0) 92: SRMS Elbow (-40, +5)	13: LAB Stbd Zenith (-150, +50) 22: Base Elbow (+170, -10)	Camera C (+35, +15)

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Pre-Grapple Intermediate position.

SR	SY	SP	EP	WP	WY	WR
-50.0	+56.7	-101.2	-61.3	-68.5	-131.1	-89.6

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)	-50.0	+61.1	+46.3	-61.3	-121.8	-39.1	-245.0
TGT	**-50.0**	**+56.7**	**-101.2**	**-61.3**	**-68.5**	**-131.1**	**-89.6**
ERR	0.0	+4.4	+147.5	0.0	-53.3	+92.0	-155.4

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

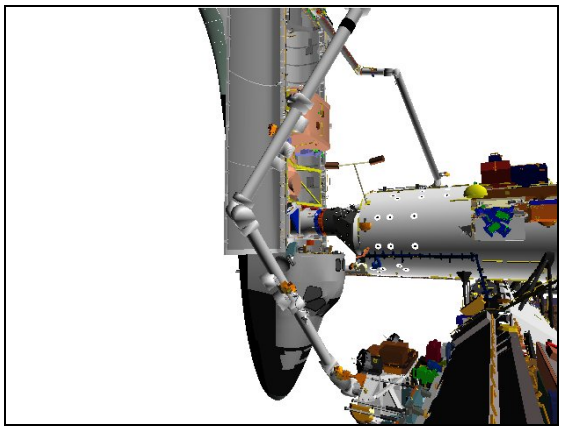

Figure 9.- OBSS Pre-Grapple Intermediate
(03: S1 Lower Outboard: +60, +5).

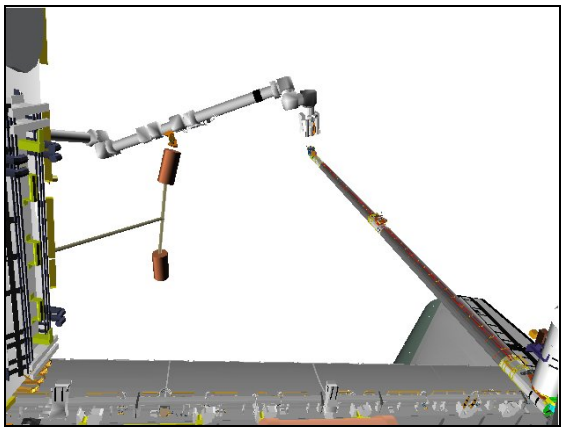

Figure 10.- OBSS Pre-Grapple Intermediate
(92: SRMS Elbow: -40, +5).

Figure 11.- OBSS Pre-Grapple Intermediate
(V10: Camera C: +35, +15).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

SR	SY	SP	EP	WP	WY	WR
-50.0	+56.7	-101.2	-61.3	-68.5	-131.1	-89.6
X	Y	Z	Pitch	Yaw	Roll	
+18	-530	-688	-70.1	-27.7	-92.4	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

4. JOCAS TO OBSS PRE-GRAPPLE AT HANDOFF POSITION

PCS MSS: SSRMS: Rate: SSRMS Rate

Set ‘Scale’ ‘Vernier’ Rate Scale: 1.0 (Verify 1.0)

RHC RATE → VERNIER (Verify Vernier on PCS)

SSRMS Joint OCAS

Input ‘Joint Angles’ ‘Destination’ for Pre-Grapple at Handoff position.

SR	SY	SP	EP	WP	WY	WR
-27.7	+56.7	-101.2	-47.4	-68.5	-131.1	-89.6

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)	-50.0	+56.7	-101.2	-61.3	-68.5	-131.1	-89.6
TGT	**-27.7**	**+56.7**	**-101.2**	**-47.4**	**-68.5**	**-131.1**	**-89.6**
ERR	-22.3	0.0	0.0	-13.9	0.0	0.0	0.0

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

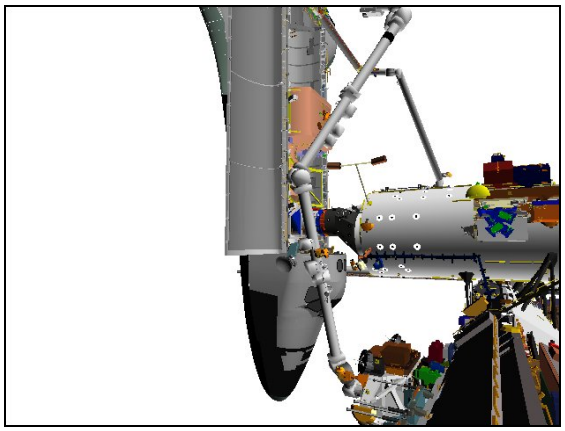

Figure 12.- OBSS Pre-Grapple at Handoff (03: S1 Lower Outboard: +60, +5).

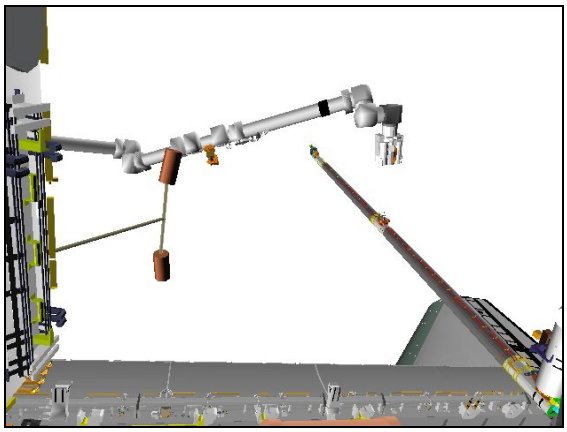

Figure 13.- OBSS Pre-Grapple at Handoff (92: SRMS Elbow: -40, +5).

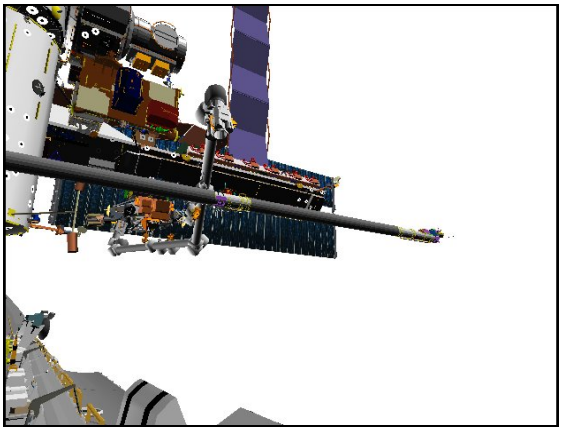

Figure 14.- OBSS Pre-Grapple at Handoff
(V10: Camera C: +35, +15).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

SR	SY	SP	EP	WP	WY	WR
-27.7	+56.7	-101.2	-47.4	-68.5	-131.1	-89.6
X	Y	Z	Pitch	Yaw	Roll	
+138	-158	-577	-74.1	-19.3	-84.6	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

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5.502 OBSS GRAPPLE AT HANDOFF

(RBT FS/12A.1/FIN 1) Page 1 of 4 pages

1. SETUP

Configure Cameras and overlays for grapple.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +10)	25: Tip LEE	92: Camera D (-22, +18) 92: SRMS Elbow (-25, +7)	Camera C (+25, +15)

NOTE

The LEE Camera must be fully zoomed out to correspond to the target overlay.

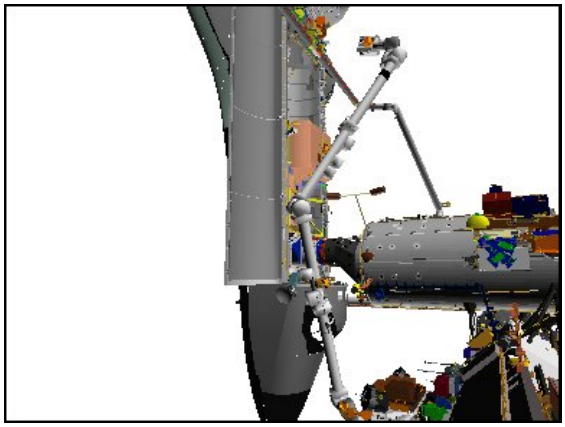

Figure 1.- OBSS Pre-Grapple at Handoff (03: S1 Lower Outboard: +60,+10).

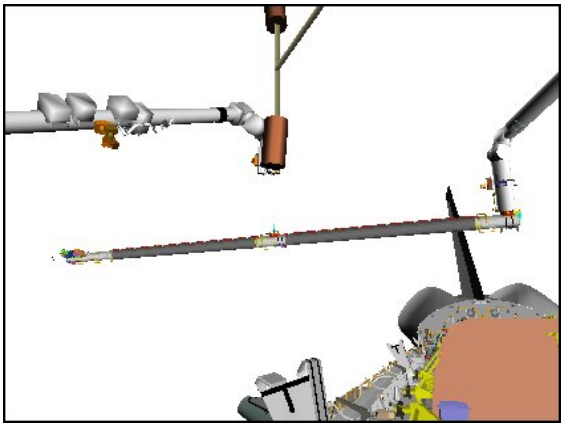

Figure 2.- OBSS Pre-Grapple at Handoff (92: Camera D: -22, +18).

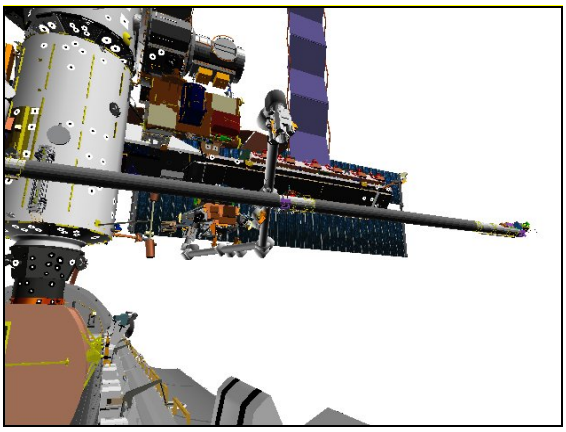

Figure 3.- OBSS Pre-Grapple at Handoff (V10: Camera C: +25, +15).

PCS MSS: SSRMS: Rate: SSRMS Rate

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

√Vernier

2. VERIFICATION OF DESAT REQUEST

MSS: SSRMS: Thrusters: [Thruster Controls for MSS Ops]

Verify 'Desat Request:' – Inh

3. OBSS GRAPPLE SETUP AND CAPTURE

3.1 Setup

MSS: SSRMS: [SSRMS]

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: [Joint Lock]

cmd Shoulder Roll (Verify SR – Locked)

3.2 Slow Capture Commands

MSS: SSRMS: Tip LEE: [SSRMS Tip LEE]

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

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

CAUTION

Due to end-to-end system latency, the RHC Trigger is hot up to 3 seconds prior to receiving a Trigger Hot icon status on the PCS.

NOTE

Once the trigger is hot, only safing or trigger commands should be sent to the Robotics equipment. If a configuration change is required, including routing MSS cameras, safe the system to exit LEE operations (SCR 23262, 14662).

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Capture

3.3 Maneuvering to Within Grapple Envelope

RHC/ THC — Maneuver to within grapple envelope.

3.4 Grapple

RHC — TRIGGER → press (momentarily)

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

3.5 Cleanup

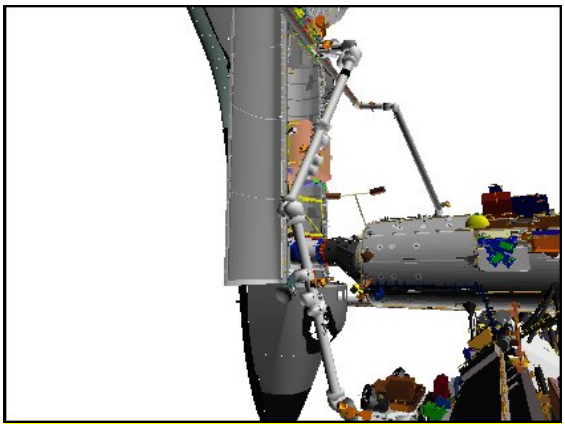

Figure 4.- OBSS Grapple
(03: S1 Lower Outboard: +60, +10).

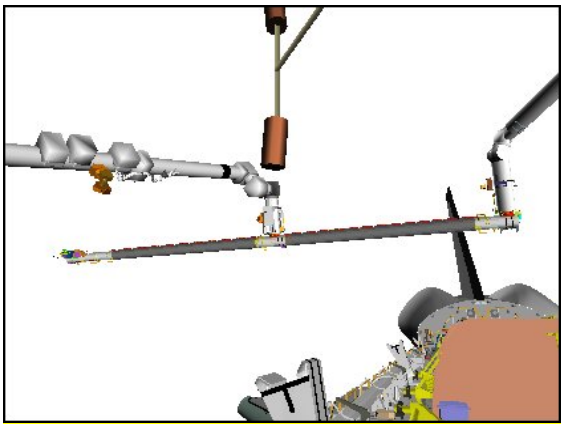

Figure 5.- OBSS Grapple
(92: Camera D: -22, +18).

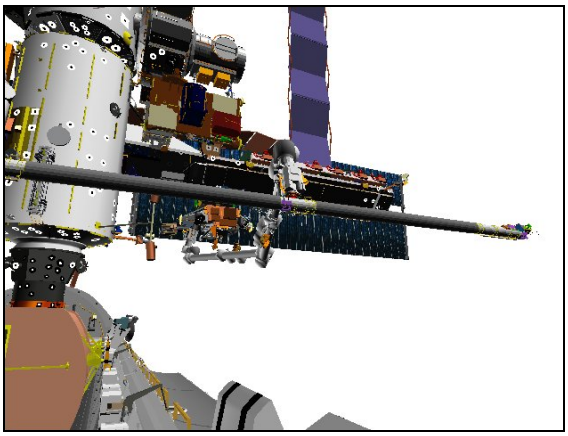

Figure 6.- OBSS Grapple
(V10: Camera C: +25, +15).

DCP BRAKES SSRMS → ON (Verify ON)

PCS MSS: SSRMS: SSRMS

Verify Loaded Parameters – √
Verify 'Loaded Parameters' (two) – OBSS Mid MPM, SR Held

Give shuttle crew GO for OBSS Ungrapple.

Change Command ▶ W3 ▶ Berth OBSS Mid NSP (Verify W3>Berth OBSS Mid NSP)

Review {SSRMS LEE CUE CARD}, all (SODF: RBT GEN: REFERENCE).

5.502 OBSS GRAPPLE AT HANDOFF

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

SR	SY	SP	EP	WP	WY	WR
-27.7	+67.6	-100.9	-39.9	-86.0	-122.9	-101.7
X	Y	Z	Pitch	Yaw	Roll	
+208	-210	-367	+89.9	-70.0	+44.9	
FOR	Loaded – OBSS MidMPM, SR Held					
Disp	W3>Berth OBSS Mid NSP					

5.503 OBSS MANEUVER TO CLEAR UHF

(RBT FS/12A.1/FIN 1) Page 1 of 7 pages

1. SETUP

On SRMS operator GO for OBSS maneuver to Handoff Intermediate position,

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +5)	24: Tip Elbow (-30, +30)	92: SRMS Elbow (-35, -10) Camera A (-10, +20)	Camera C (+10, 10)

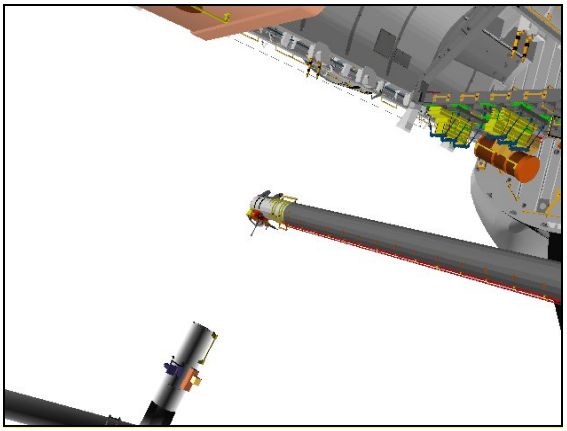

Figure 1.- OBSS Grapple at Handoff (24: Tip Elbow: -30, +30).

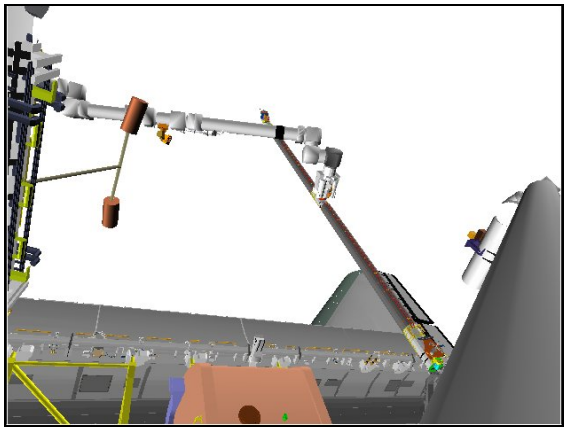

Figure 2.- OBSS Grapple at Handoff (92: SRMS Elbow: -35, -10).

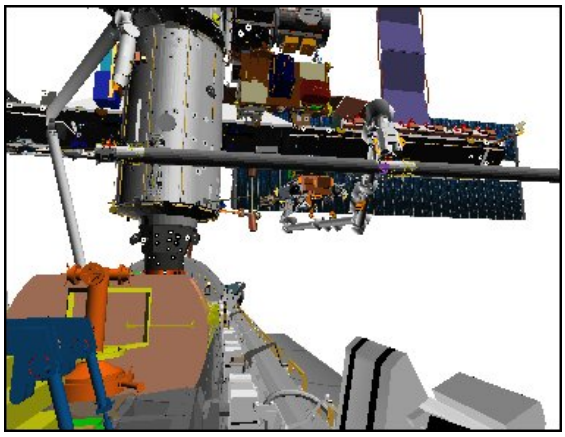

Figure 3.- OBSS Grapple at Handoff (V10: Camera C: +10, +10).

2. MANEUVERING TO HANDOFF INTERMEDIATE POSITION

DCP BRAKES SSRMS → OFF (Verify OFF)

RHC RATE → COARSE (Verify Coarse on PCS)

PCS MSS: SSRMS: SSRMS

Enter Mode – FOR OCAS (Verify blue)

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

cmd Shoulder Roll (Verify SR – Locked)

SSRMS FOR OCAS

Input 'FOR' 'Destination' for OBSS Handoff Intermediate position.

X	Y	Z	Pitch	Yaw	Roll
+100	-690	-367	+90.0	-70.0	+45.0

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	+208	-210	-367	+89.9	-70.0	+44.9
TGT	**+100**	**-690**	**-367**	**+90.0**	**-70.0**	**+45.0**
ERR	+108	+480	0	-0.1	0.0	-0.1

****
* If FOR or errors are incorrect
PCS * | **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* | Input correct Dest FOR per table above.
*
* | **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * | Verify FOR and errors are correct on FOR Position overlay.
****

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

DCP AUTO SEQ → PROC

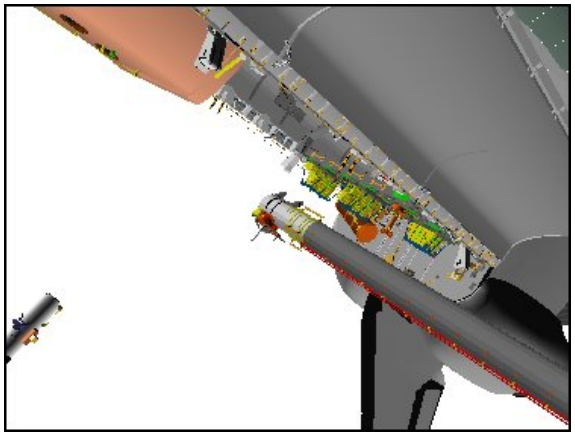

Figure 4.- OBSS Handoff Intermediate
(24: Tip Elbow: -30, +50).

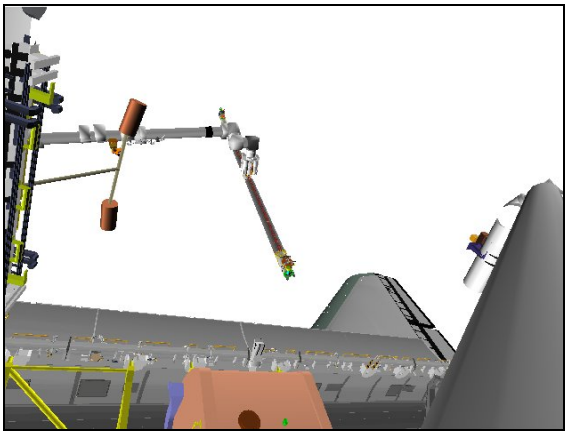

Figure 5.- OBSS Handoff Intermediate
(91: SRMS Elbow: -35, -10).

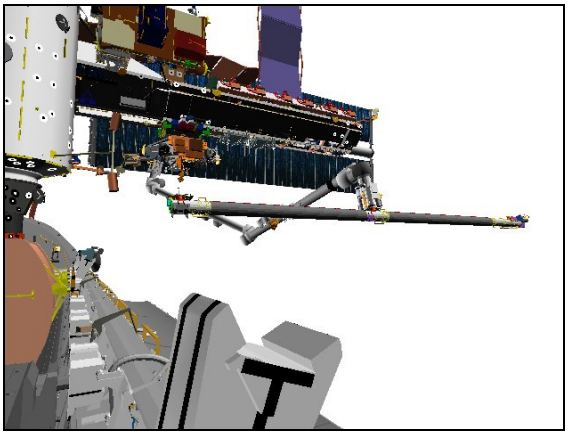

Figure 6.- OBSS Handoff Intermediate
(V10: Camera C: +30, +5).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

Locked						
SR	SY	SP	EP	WP	WY	WR
-27.7	+42.5	-74.2	-49.3	-86.3	-143.0	-78.9
X	Y	Z	Pitch	Yaw	Roll	
+100	-690	-367	+90.0	-70.0	+45.0	
FOR	Loaded – OBSS MidMPM, SR Held					
Disp	W3>Berth OBSS Mid NSP					

3. MANEUVERING TO STARBOARD POSITION

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +5)	13: LAB Stbd Zenith (-20, -5)	92: SRMS Elbow (-35, -10) Camera D (-20, +15)	Camera C (+30, +5)

MSS: SSRMS: SSRMS

Verify SR – Locked

SSRMS FOR OCAS

Input 'FOR' 'Destination' for Starboard position.

X	Y	Z	Pitch	Yaw	Roll
+100	-690	-367	+20.0	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	+100	-690	-367	+90.0	-70.0	+45.0
TGT	**+100**	**-690**	**-367**	**+20.0**	**0.0**	**0.0**
ERR	0	0	0	+70.0	-70.0	+45.0

****
* If FOR or errors are incorrect
PCS * | **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* | Input correct Dest FOR per table above.
*
* | **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * | Verify FOR and errors are correct on FOR Position overlay.
****

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

DCP AUTO SEQ → PROC

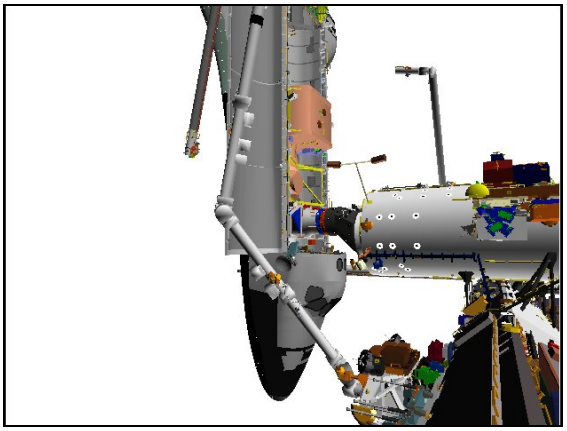

Figure 7.- Starboard Position
(03: S1 Lower Outboard: +60, +5).

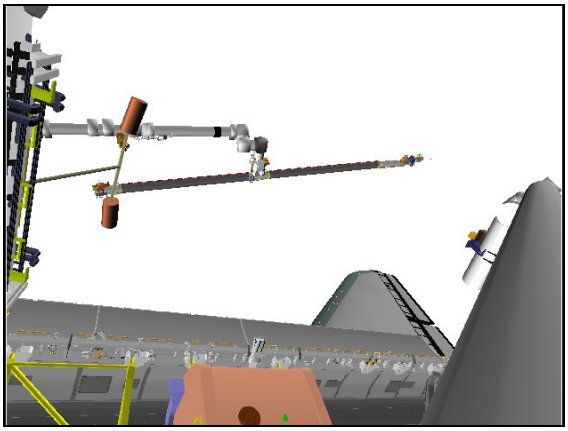

Figure 8.- Starboard Position
(92: SRMS Elbow: -35, -10).

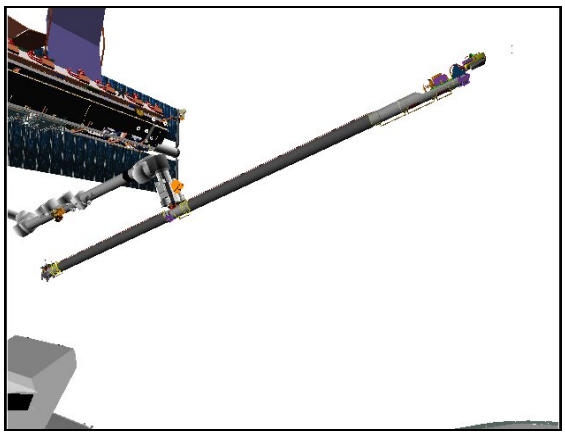

Figure 9.- Starboard Position
(V10: Camera C: +60, +5).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

Locked						
SR	SY	SP	EP	WP	WY	WR
-27.7	+50.2	-77.7	-46.5	-93.3	-147.3	-3.9
X	Y	Z	Pitch	Yaw	Roll	
+100	-690	-367	+20.0	0.0	0.0	
FOR	Loaded – OBSS MidMPM, SR Held					
Disp	W3>Berth OBSS Mid NSP					

4. MANEUVERING TO CLEAR UHF ANTENNA POSITION

MSS: SSRMS: SSRMS

Verify SR – Locked

SSRMS FOR OCAS

Input 'FOR' 'Destination' for Clear UHF Antenna position.

X	Y	Z	Pitch	Yaw	Roll
0	-190	-167	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	+100	-690	-367	+20.0	0.0	0.0
TGT	**0**	**-190**	**-167**	**0.0**	**0.0**	**0.0**
ERR	+100	-500	-200	+20.0	0.0	0.0

****
* If FOR or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest FOR per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify FOR and errors are correct on FOR Position overlay.
****

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

DCP AUTO SEQ → PROC

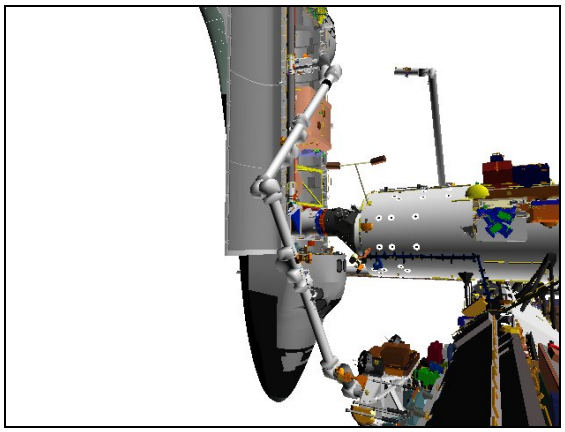

Figure 10.- Clear UHF Antenna
(03: S1 Lower Outboard: +60, +5).

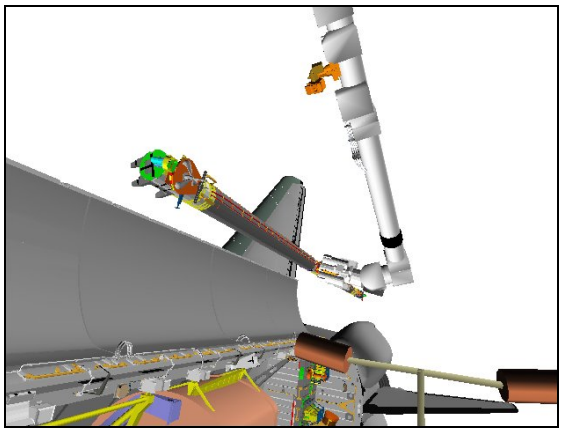

Figure 11.- Clear UHF Antenna
(13: LAB Stbd Zenith: -20, -5).

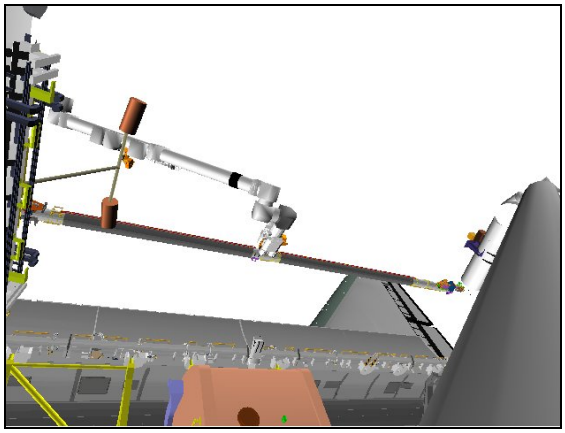

Figure 12.- Clear UHF Antenna
(92: SRMS Elbow: -35, -10).

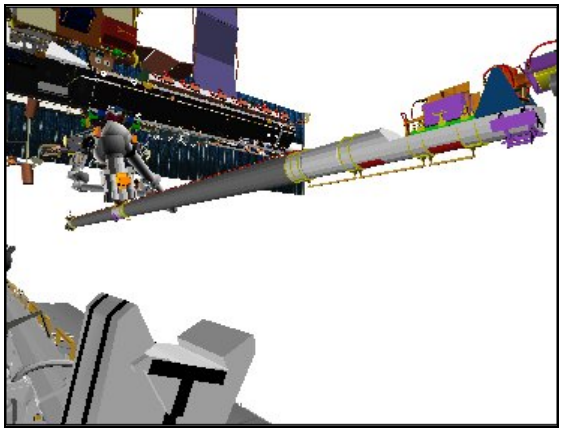

Figure 13.- Clear UHF Antenna
(V10: Camera C: +40, +5).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at Clear UHF Antenna position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-27.7	+83.5	-95.2	-60.8	-56.1	-118.5	-3.0
X	Y	Z	Pitch	Yaw	Roll	
0	-190	-167	0.0	0.0	0.0	
FOR	Loaded – OBSS MidMPM, SR Held					
Disp	W3>Berth OBSS Mid NSP					

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5.504 OBSS BERTH

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1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +5)	13: LAB Stbd Zenith (-20, -5) 24: Tip Elbow (-90, +35)	92: SRMS Elbow (-35, -10) Camera D (-20, +15)	Camera C (+40, +5)

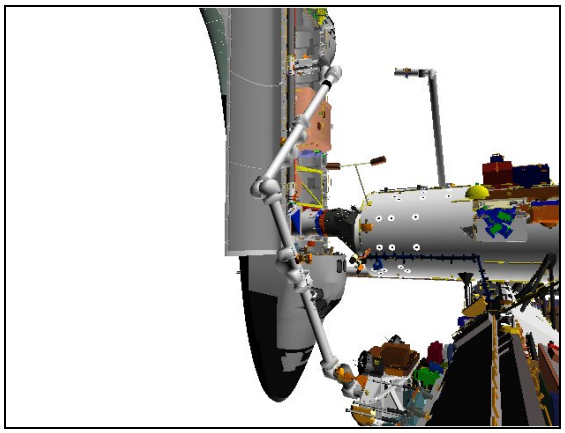

Figure 1.- Clear UHF Antenna (03: S1 Lower Outboard: +60, +5).

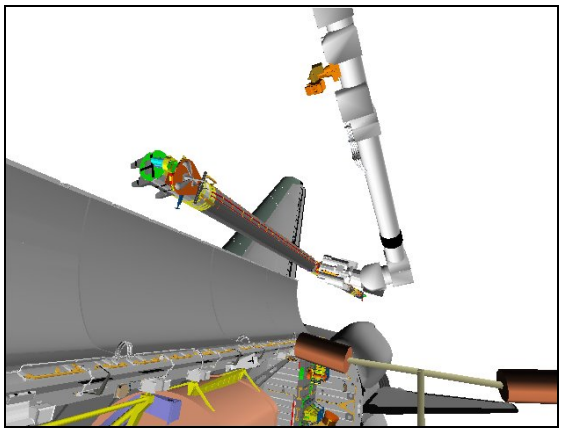

Figure 2.- Clear UHF Antenna (13: LAB Stbd Zenith: -20, -5).

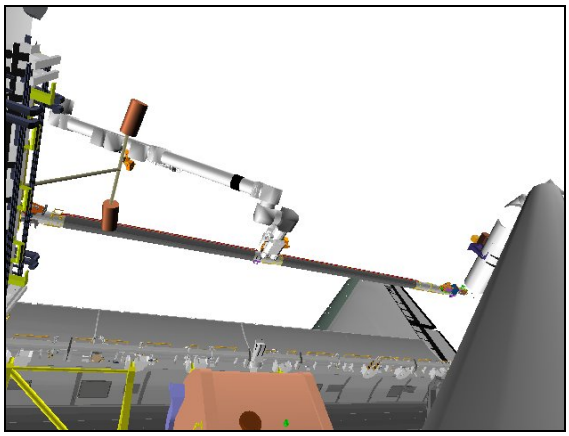

Figure 3.- Clear UHF Antenna (91: SRMS Elbow: -35, -10).

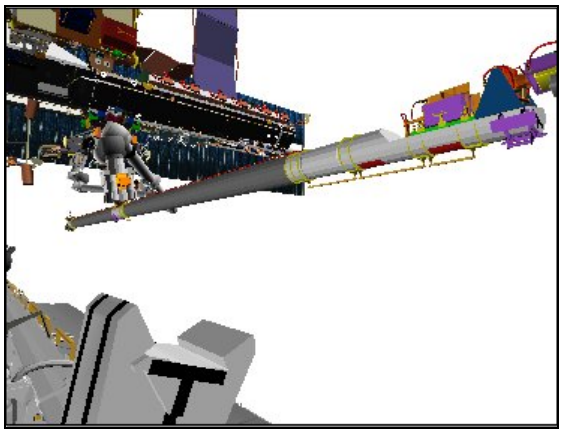

Figure 4.- Clear UHF Antenna (V10: Camera C: +40, +5).

RHC RATE → VERNIER (Verify Vernier on PCS)

PCS MSS: SSRMS: Rate: SSRMS Rate

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

2. MANEUVERING TO LOW HOVER POSITION

NOTE
Monitor clearance to UHF Antenna using SRMS Elbow Camera. Clearance at Low Hover is approximately 92 cm (3.0 ft).

MSS: SSRMS: SSRMS

Verify SR – Locked

SSRMS FOR OCAS

Input 'FOR' 'Destination' for OBSS Low Hover position.

X	Y	Z	Pitch	Yaw	Roll
0	0	-100	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	-190	-167	0.0	0.0	0.0
TGT	**0**	**0**	**-100**	**0.0**	**0.0**	**0.0**
ERR	0	-190	-67	0.0	0.0	0.0

****
* If FOR or errors are incorrect
PCS * | **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* | Input correct Dest FOR per table above.
*
* | **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * | Verify FOR and errors are correct on FOR Position overlay.
****

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

DCP AUTO SEQ → PROC

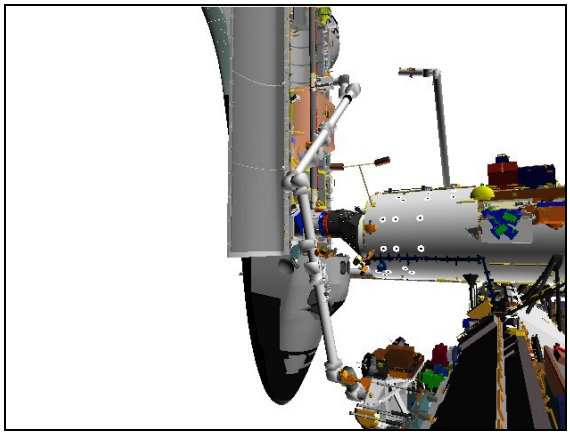

Figure 5.- OBSS Low Hover
(03: S1 Lower Outboard: +60, +5).

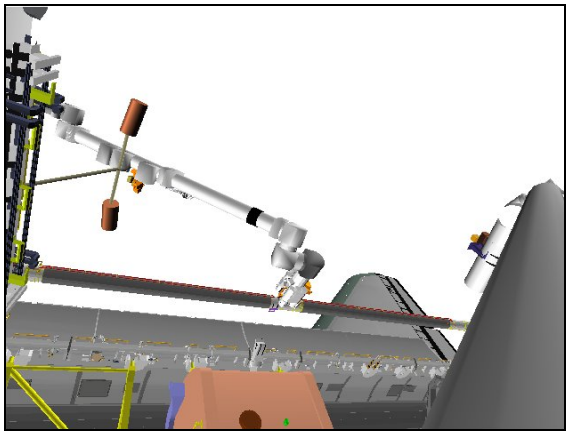

Figure 6.- OBSS Low Hover
(92: SRMS Elbow: -35, -10).

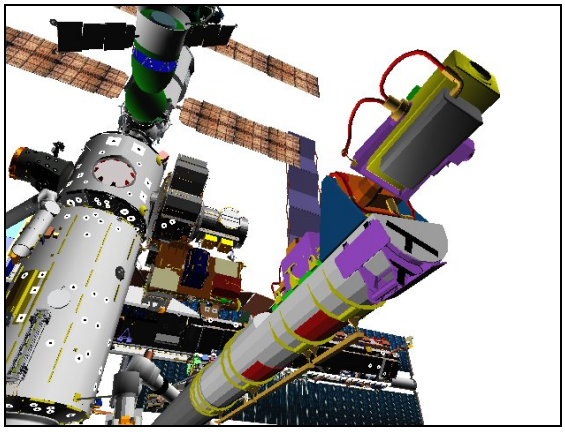

Figure 7.- OBSS Low Hover
(V10: Camera C: +25, +40).

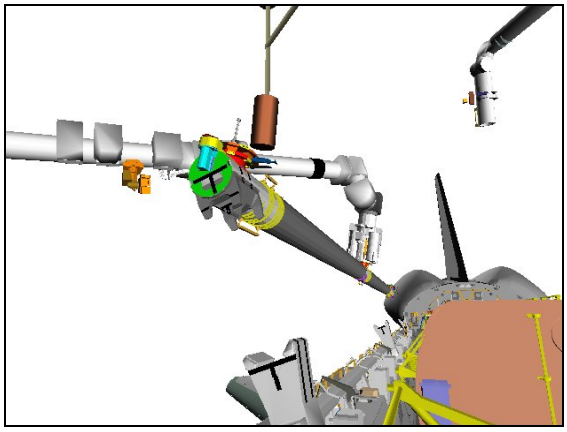

Figure 8.- OBSS Low Hover
(92: Camera D: -20, +15).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

Locked						
SR	SY	SP	EP	WP	WY	WR
-27.7	+87.3	-107.8	-53.3	-55.3	-115.4	-7.8
X	Y	Z	Pitch	Yaw	Roll	
0	0	-100	0.0	0.0	0.0	
FOR	Loaded – OBSS MidMPM, SR Held					
Disp	W3>Berth OBSS Mid NSP					

3. VERIFICATION OF DESAT REQUEST

MSS: SSRMS: Thrusters: Thruster Controls for MSS Ops

Verify 'Desat Request:' – Inh

4. BERTHING OBSS

Configure Cameras and overlays for berthing.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +5)	24: Tip Elbow (-90, +35)	92: Mux D/C (D: -5, 0) (C: 3, 0)	SRMS Elbow (-35, -10)

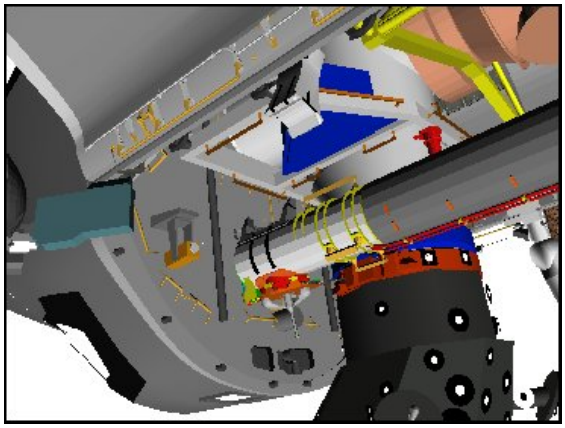

Figure 9.- Low Hover
(24: Tip Elbow: -90, +35).

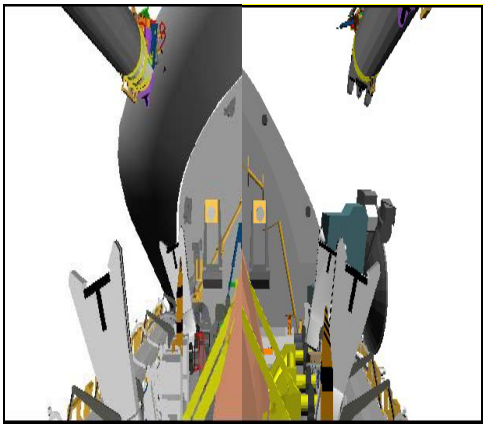

Figure 10.- Low Hover
(92: Mux D/C; FL = 42mm).

Verify shuttle crew standing by for STBD RMS R-F-L callouts during berth.

MSS: SSRMS: Rate: SSRMS Rate

Set 'Scale' 'Vernier' Rate Scale: 0.4 (Verify 0.4)

MSS: SSRMS: SSRMS

Verify Command – W3>Berth OBSS Mid NSP

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: Joint Lock

cmd Shoulder Roll (Verify SR – Locked)

THC/ RHC — Maneuver OBSS to Berthed position (until shuttle crew callout that three of three STBD RMS R-F-L tb - gray, expected at Z = 0).

Expected OBSS Berthed position.

Locked						
SR	SY	SP	EP	WP	WY	WR
-27.7	+93.3	-110.4	-49.1	-66.0	-110.8	-17.7
X	Y	Z	Pitch	Yaw	Roll	
0	0	0	0.0	0.0	0.0	
FOR	Loaded – OBSS MidMPM, SR Held					
Disp	W3>Berth OBSS Mid NSP					

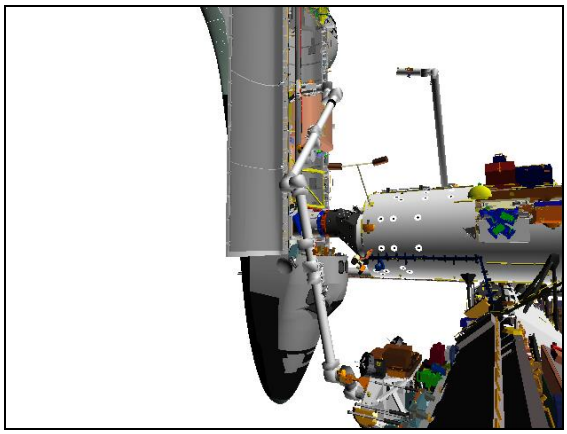

Figure 11.- OBSS Berth
(03: S1 Lower Outboard: +60, +5).

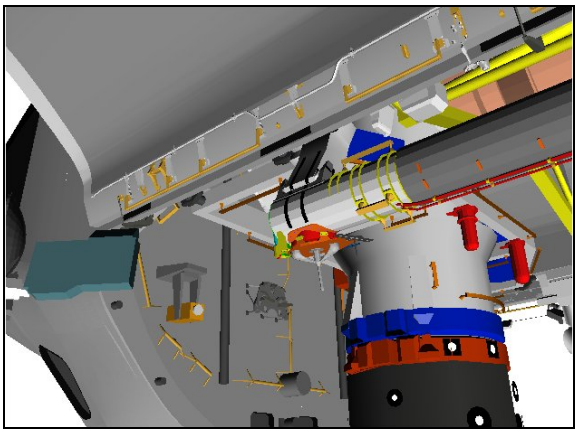

Figure 12.- OBSS Berth
(24: Tip Elbow: -90, +35).

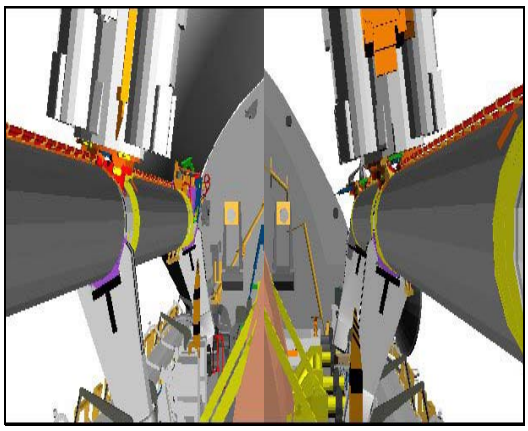

Figure 13.- OBSS Berth
(92: Mux D/C; FL = 42mm).

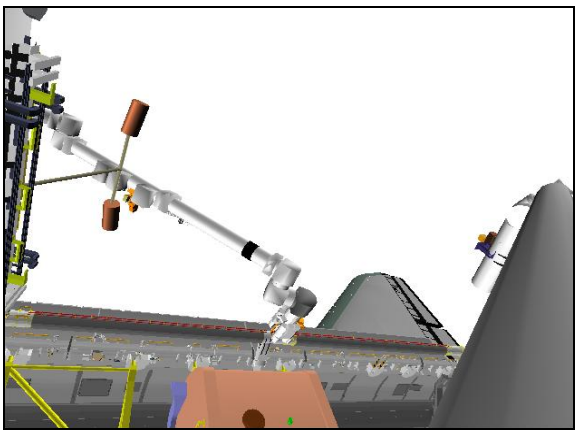

Figure 14.- OBSS Berth
(V10: SRMS Elbow: -35, -10).

PCS — MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Enter Mode – Standby (Verify blue)

5. MRL LATCHING SEQUENCE

5.1 Limp Wrist Joints

MSS: SSRMS: Limp: SSRMS Limp

sel WP, WY, WR

cmd Execute

MSS: SSRMS: SSRMS

Verify Limp – blue

Verify WP, WY, WR – Limped

5.2 Latching MRLs to TC

Give SRMS operator GO to latch STBD MRLs to TC.

5.3 Carriage Derigidization

On SRMS Operator GO to Limp all SSRMS Joints and Derigidize,

MSS: SSRMS: Limp: SSRMS Limp

cmd All Limp (Verify Limp – blue)

MSS: SSRMS: SSRMS

Verify all joints – Limped

MSS: SSRMS: Tip LEE: SSRMS Tip LEE

cmd 'Carriage' Derigidize ▶ Slow (Verify Speed – Slow)

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

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Deridigize

RHC TRIGGER → press (momentarily) (SCR 19064)

PCS Verify 'Carriage' Derigidize – blue (90 s max)

Give SRMS operator GO to complete latching of STBD MRLs.

6. CLEANUP

NOTE
Carriage rigidization is performed in this step to reseat the SSRMS LEE over the OBSS GF prior to initiating a nominal push-off release operation.

On SRMS operator GO for OBSS Ungrapple,

MSS: SSRMS: Tip LEE: 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 (90 s max)
Verify 'Carriage' Retract – blue

DCP BRAKES SSRMS → ON (Verify ON)

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5.505 BERTHED OBSS UNGRAPPLE

(RBT FS/12A.1/FIN 1) Page 1 of 4 pages

1. SETUP

Configure Cameras and overlays for ungrapple.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +5)	25: Tip LEE	22: Base Elbow (-150, -10) 92: Camera D (-6, +7)	Camera C (+5, +10)

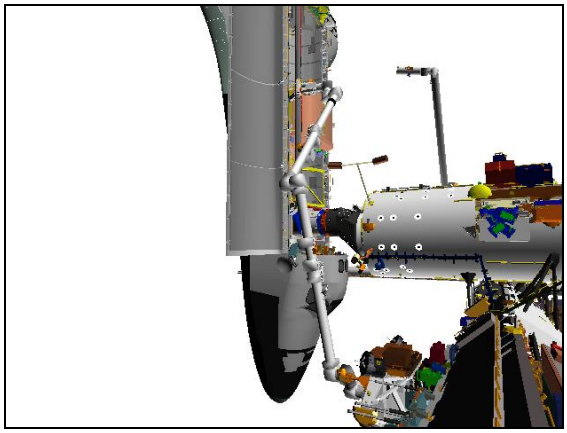

Figure 1.- OBSS Berth
(03: S1 Lower Outboard: +60, +5).

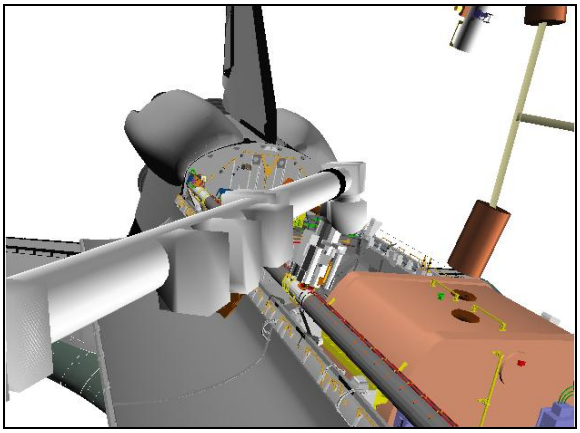

Figure 2.- OBSS Berth
(22: Base Elbow: -150, -10).

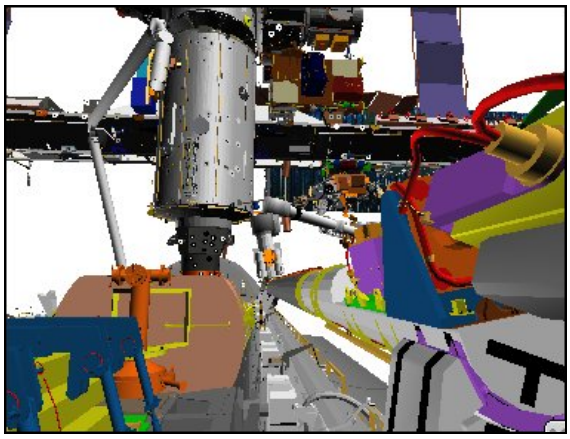

Figure 3.- OBSS Berth
(V10: Camera C: +5, +10).

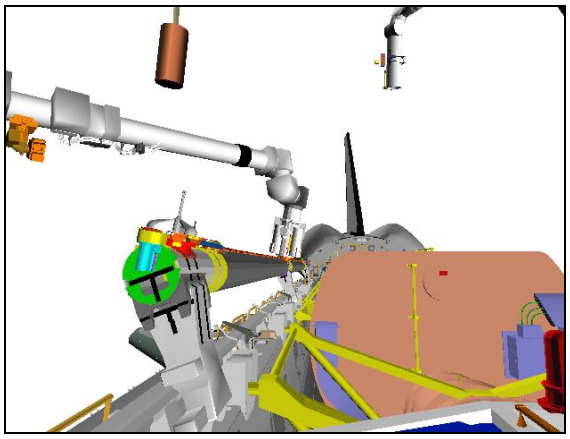

Figure 4.- OBSS Berth
(92: Camera D: -6, +7).

PCS MSS: SSRMS: SSRMS

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

Change Display ▶ W3 ▶ Berth OBSS FRGF NSP (Verify W3>Berth OBSS FRGF NSP)

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

MSS: SSRMS: Rate: SSRMS Rate

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

MSS: SSRMS: SSRMS

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

SR	SY	SP	EP	WP	WY	WR
-27.7	+93.3	-110.4	-49.1	-66.0	-110.8	-17.7
X	Y	Z	Pitch	Yaw	Roll	
+45	+12	+23	+90.0	0.0	-30.0	
FOR	Loaded – OBSS Mid MPM, SR Held					
Disp	W3>Berth OBSS FRGF NSP					

2. UNGRAPPLING OBSS (PUSHOFF)

DCP BRAKES SSRMS → OFF (Verify OFF)

2.1 SSRMS Limp

PCS MSS: SSRMS: Limp: SSRMS Limp

cmd All Limp (Verify Limp – blue)

MSS: SSRMS: SSRMS

Verify all joints – Limped

2.2 Auto Release

MSS: SSRMS: Tip LEE: SSRMS Tip LEE

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

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

CAUTION

Due to end-to-end system latency, the RHC Trigger is hot up to 3 seconds prior to receiving a Trigger Hot icon status on the PCS.

NOTE

Once the trigger is hot, only safing or trigger commands should be sent to the Robotics equipment. If a configuration change is required, including routing MSS Cameras, safe the system to exit LEE operations (SCR 23262, 14662).

cmd Confirm (Verify RHC Trigger Hot icon)

Verify LEE Mode – Auto Release

RHC TRIGGER → press (momentarily)

PCS

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

Verify Unloaded Parameters – √

2.3 SSRMS Backoff

NOTE
Monitor clearance to UHF Antenna with the Base Elbow Camera. Clearance at Backoff is approximately 116 cm (3.8 ft).

MSS: SSRMS: Limp: [SSRMS Limp]

cmd None Limp (Verify Standby – blue)

MSS: SSRMS: [SSRMS]

Enter Mode – Manual (Verify blue)

MSS: SSRMS: SSRMS Manual: Joint Lock: [Joint Lock]

cmd Shoulder Roll (Verify SR – Locked)

THC/ RHC

Maneuver SSRMS to Grapple Fixture Backoff position (within 5 cm/1 deg).

Locked						
SR	SY	SP	EP	WP	WY	WR
-27.7	+85.2	-112.4	-50.4	-51.1	-117.1	-5.0
X	Y	Z	Pitch	Yaw	Roll	
-150	0	0	0.0	0.0	0.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS FRGF NSP					

PCS

MSS: SSRMS: [SSRMS]

Enter Mode – Standby (Verify blue)

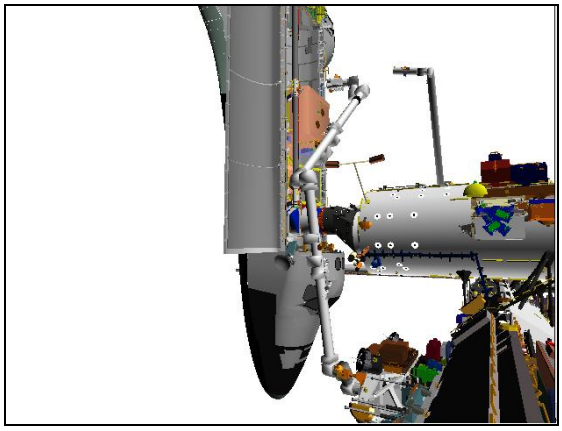

Figure 5.- Grapple Fixture Backoff
(03: S1 Lower Outboard: +60, +5).

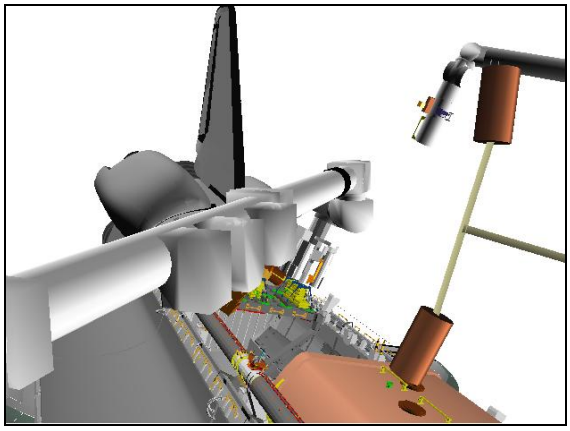

Figure 6.- Grapple Fixture Backoff
(22: Base Elbow: -150, -10).

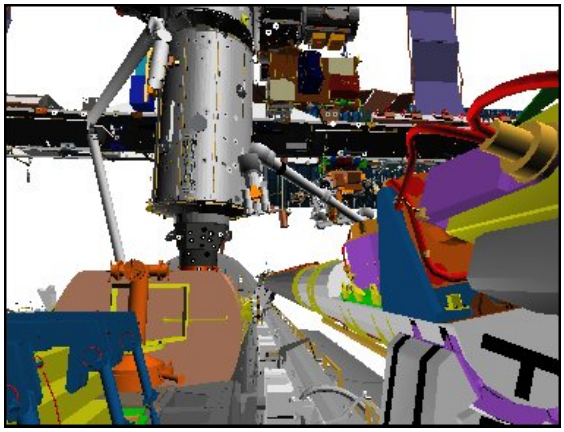

Figure 7.- Grapple Fixture Backoff
(V10: Camera C: +5, +10).

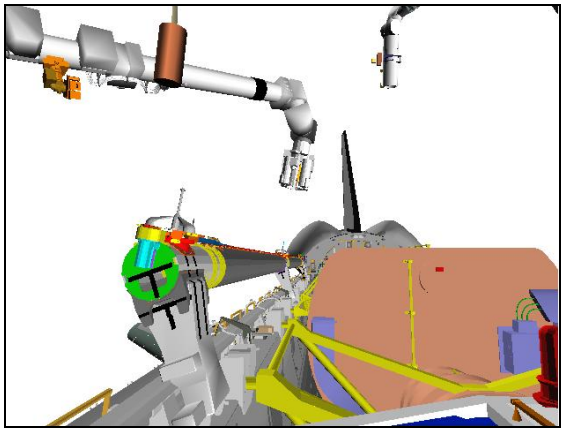

Figure 8.- Grapple Fixture Backoff
(92: Camera D: -6, +7).

5.506 MNVR FROM GF BACKOFF TO SSRMS STOW

(RBT/12A.1/FIN 1) Page 1 of 4 pages

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +20)	13: LAB Stbd Zenith (-150, +80)	22: Base Elbow (-150, -10)	SRMS Elbow (-35, -10)

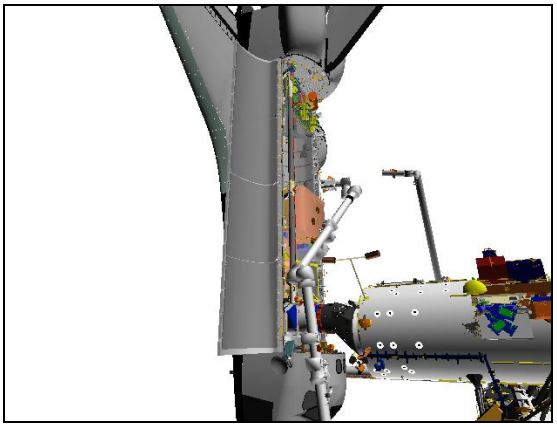

Figure 1.- Grapple Fixture Backoff (03: S1 Lower Outboard: +60, +20).

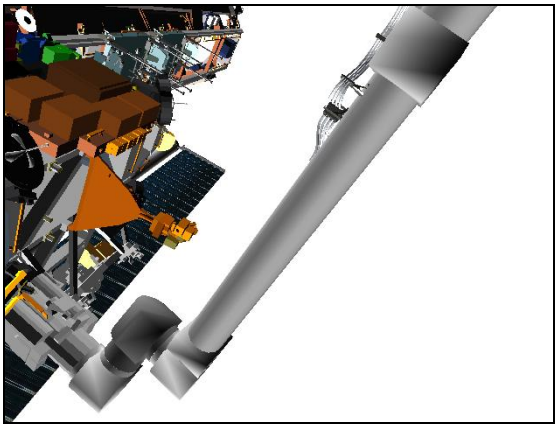

Figure 2.- Grapple Fixture Backoff (13: LAB Stbd Zenith: -150, +80).

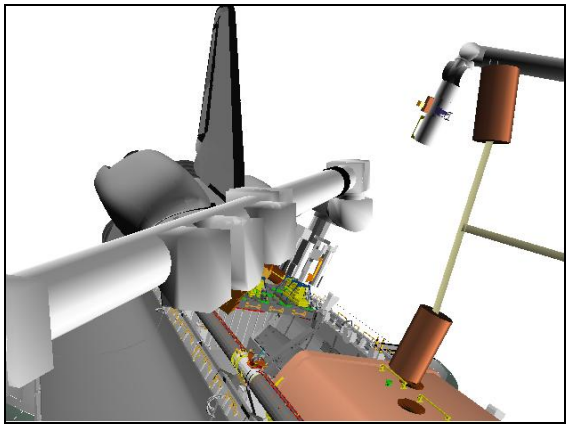

Figure 3.- Grapple Fixture Backoff (22: Base Elbow: -150, -10).

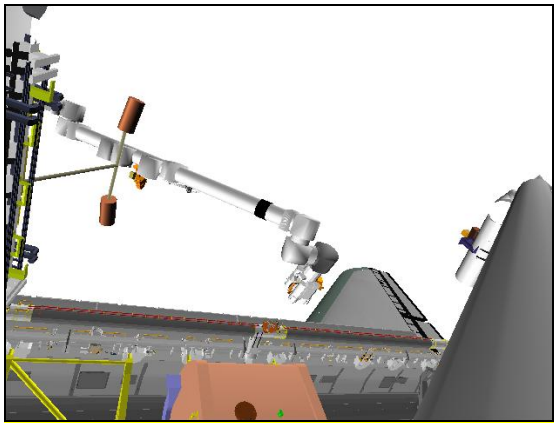

Figure 4.- Grapple Fixture Backoff (V10: SRMS Elbow: -35, -10).

PCS MSS: SSRMS: Rate: SSRMS Rate

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

MSS: SSRMS: SSRMS

√Vernier

Enter Mode – Joint OCAS (Verify blue)

2. MANEUVERING TO SSRMS STOW

NOTE

1. Monitor clearance to UHF Antenna with the SRMS Elbow Camera. Clearance at GF Backoff is approximately 117 cm (3.8 ft).
2. Expect singularity warning for WY between -100 and -80 deg.
3. Expect singularity warning for EP between -15 and +15 deg.
4. Expect singularity warning for WY between +80 and +100 deg.

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for SSRMS Stow position.

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4

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)	-27.7	+85.3	-112.4	-50.4	-51.2	-117.1	-5.0
TGT	**-180.0**	**+96.0**	**-183.0**	**+146.7**	**-131.1**	**+175.4**	**+125.4**
ERR	+152.3	-10.7	+70.6	-197.1	+79.9	-292.5	-130.4

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

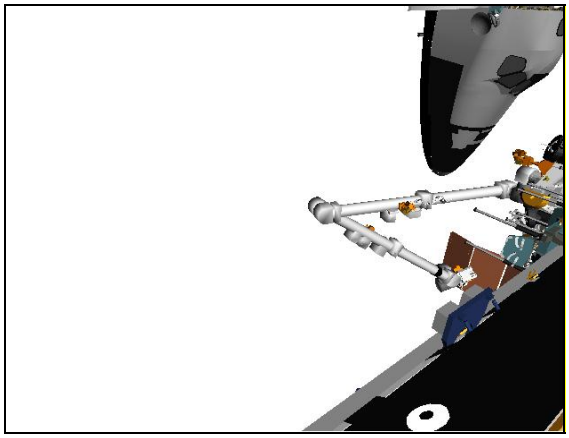

Figure 5.- SSRMS Stow
(03: S1 Lower Outboard: +35, -30).

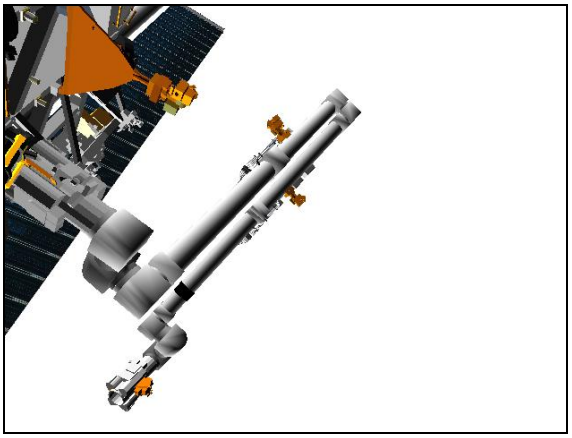

Figure 6.- SSRMS Stow
(13: LAB Stbd Zenith: -150, +60).

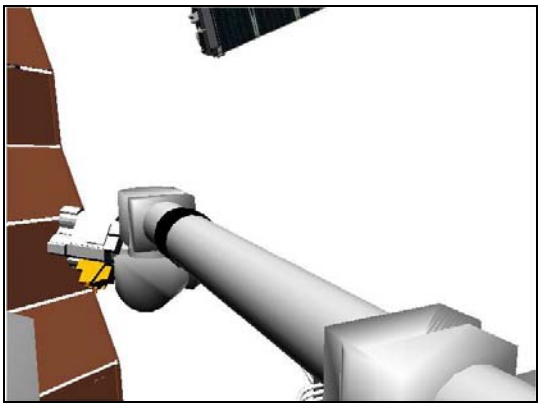

Figure 7.- SSRMS Stow
(22: Base Elbow: +60, -10).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

SR	SY	SP	EP	WP	WY	WR
-180.0	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
X	Y	Z	Pitch	Yaw	Roll	
-225	-351	+1849	+153.7	+54.7	+144.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS FRGF NSP					

3. CLEANUP

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)

5.507 MNVR FROM GF BACKOFF TO P6 RETRACT VIEWING

1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+60, +20)	13: LAB Stbd Zenith (-150, 80)	22: Base Elbow (-150, -10)	SRMS Elbow (-35, -10)

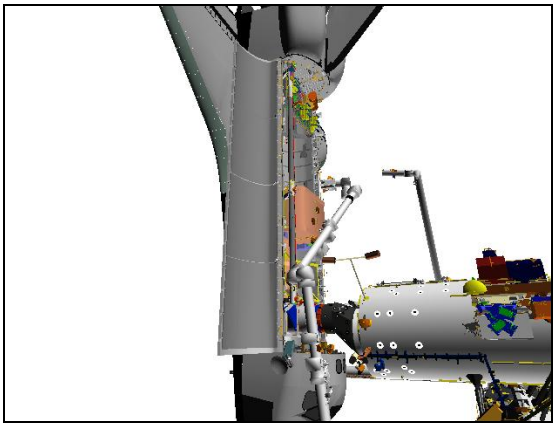

Figure 1.- Grapple Fixture Backoff (03: S1 Lower Outboard: +60, +20).

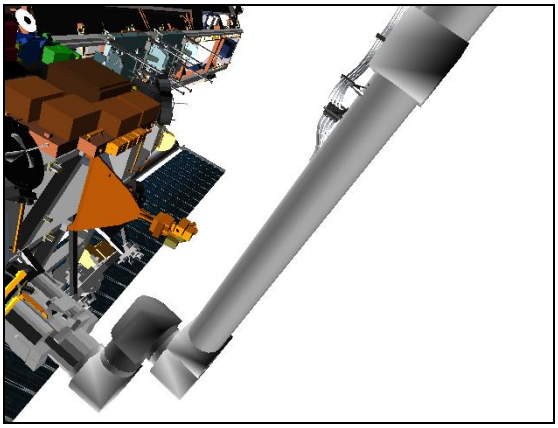

Figure 2.- Grapple Fixture Backoff (13: LAB Stbd Zenith: -150, +80).

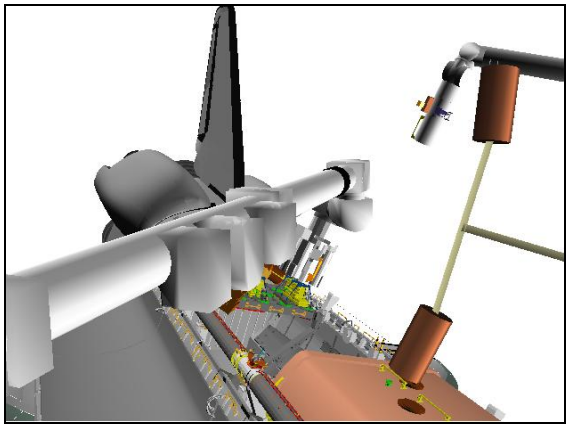

Figure 3.- Grapple Fixture Backoff (22: Base Elbow: -150, -10).

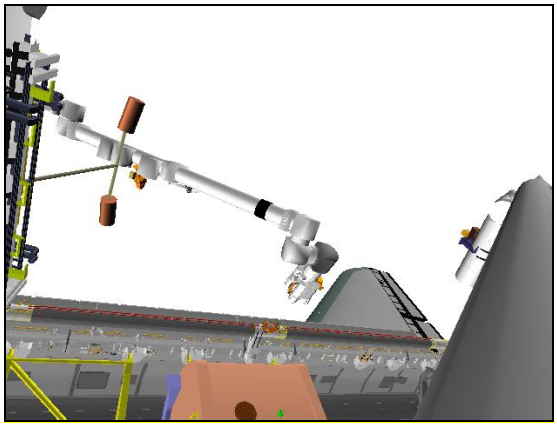

Figure 4.- Grapple Fixture Backoff (V10: SRMS Elbow: -35, -10).

PCS MSS: SSRMS: Rate: SSRMS Rate

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

MSS: SSRMS: SSRMS

√Vernier

Enter Mode – Joint OCAS (Verify blue)

2. MANEUVERING TO INTERMEDIATE

NOTE

1. Monitor clearance to UHF Antenna with the SRMS Elbow Camera. Clearance at GF Backoff is approximately 117 cm (3.8 ft).
2. Expect singularity warning for WY between -100 and -80 deg.
3. Expect singularity warning for WY between +80 and +100 deg.

SSRMS Joint OCAS

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

SR	SY	SP	EP	WP	WY	WR
-194.4	+85.2	-137.0	-30.0	-154.8	+184.9	-61.5

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)	-27.7	+85.2	-112.4	-50.4	-51.1	-117.1	-5.0
TGT	**-194.4**	**+85.2**	**-137.0**	**-30.0**	**-154.8**	**+184.9**	**-61.5**
ERR	+166.7	0.0	+24.6	-20.4	+103.7	-302.0	+56.5

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

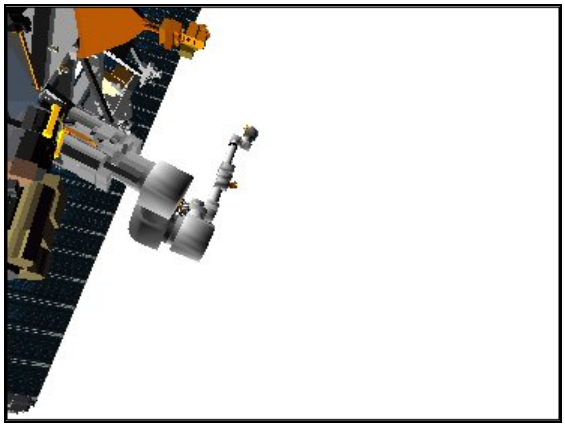

Figure 5.- Intermediate
(13: LAB Stbd Zenith: -160, +50).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

SR	SY	SP	EP	WP	WY	WR
-194.4	+85.2	-137.0	-30.0	-154.8	+184.9	-61.5
X	Y	Z	Pitch	Yaw	Roll	
+96	-1469	+2438	-77.0	-34.1	-125.8	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS FRGF NSP					

3. CLEARANCE MANEUVER
Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
09: P1 Lower Outboard (+100, -20)	13: LAB Stbd Zenith (-160, +50)	37: MBS Mast (-110, 0) 22: Base Elbow (-160, -10)	SRMS Elbow (-145, -5)

MSS: SSRMS: SSRMS

Enter Mode – Single (Verify blue)

WARNING

The active joint must be checked on the PCS before initiating motion. Failure to do so may result in movement of the wrong joint.

DCP JOINT SELECT → SHOULDER YAW (Verify SY – Selected on PCS)

THC Perform "+" Single Joint maneuver to SY: +250.4 (THC up).

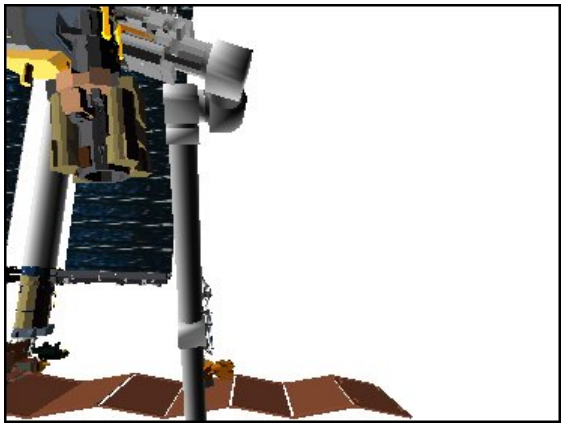

Figure 6.- Clearance
(13: LAB Stbd Zenith: -175, +30).

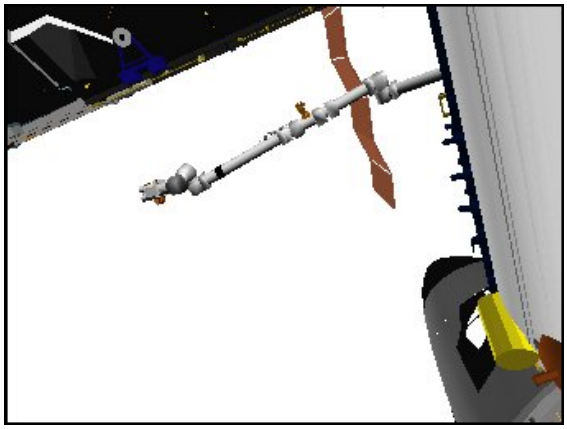

Figure 7.- Clearance
(V10: SRMS Elbow: -145, -5).

4. MANEUVERING TO P6 RETRACT VIEWIING

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for P6 Retract Viewing position.

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-155.0	-61.2	-34.2	+204.3	-84.5

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)	-194.4	+250.4	-137.0	-30.0	-154.8	+184.9	-61.5
TGT	**-194.4**	**+250.4**	**-155.0**	**-61.2**	**-34.2**	**+204.3**	**-84.5**
ERR	0.0	0.0	+18.0	+31.2	-120.6	-19.4	+23.0

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

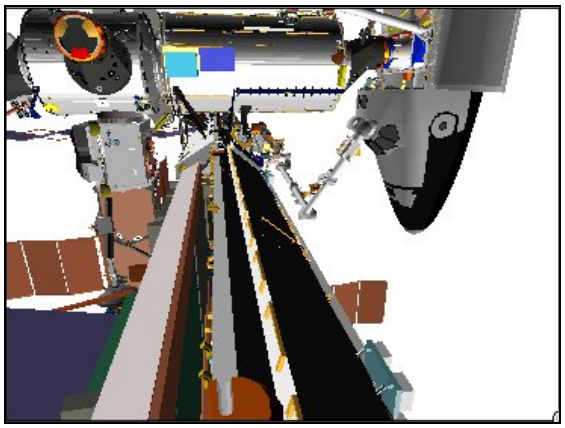

Figure 8.- P6 Retract Viewing
(09: P1 Lower Outboard: +100, -20).

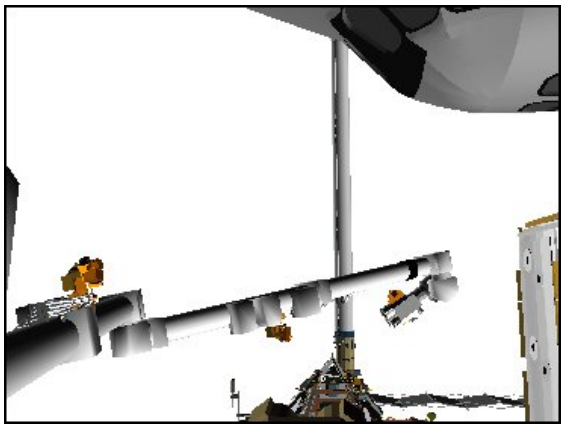

Figure 9.- P6 Retract Viewing
(37: MBS Mast: -5, +10).

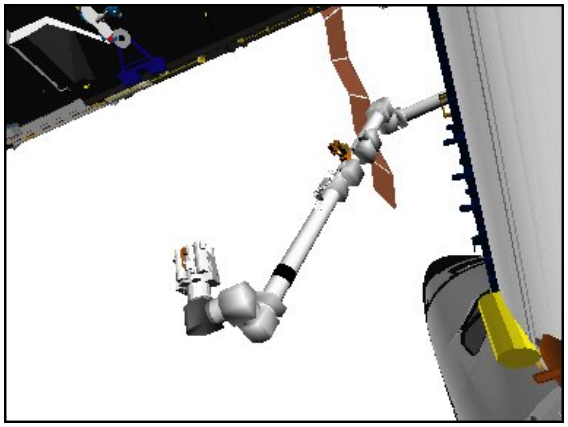

Figure 10.- P6 Retract Viewing
V10: SRMS Elbow: (-145, -5).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

Verify SSRMS at P6 Retract Viewing position (within 5 cm/1 deg).

SR	SY	SP	EP	WP	WY	WR
-194.4	+250.4	-155.0	-61.2	-34.2	+204.3	-84.5
X	Y	Z	Pitch	Yaw	Roll	
-570	+787	+1111	-123.7	-7.6	+6.1	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS FRGF NSP					

Give SRMS Operator GO to maneuver to pre-cradle position.

5. CLEANUP

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)

5.508 SSRMS STOW TO OBSS PRE-GRAPPLE AT HANDOFF

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1. SETUP

Configure Cameras and overlays as required.

Monitor 1	Monitor 2	Monitor 3	V10
03: S1 Lower Outboard (+35, -30)	09: P1 Lower Outboard (+90, 0) 22: Base Elbow (-175, -15)	13: LAB Stbd Zenith (-160, +55)	Camera C (+35, +15) 92: SRMS Elbow (-40, +5)

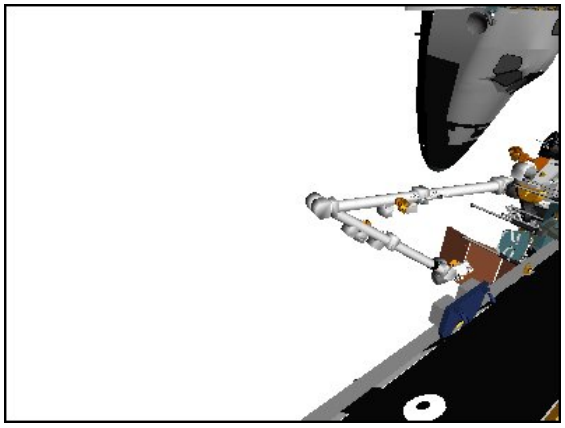

Figure 1.- SSRMS Stow
(03: S1 Lower Outboard: +35, -30).

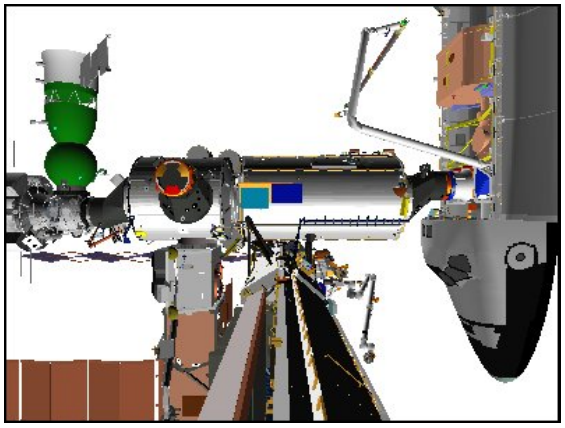

Figure 2.- SSRMS Stow
(09: P1 Lower Outboard: +90, 0).

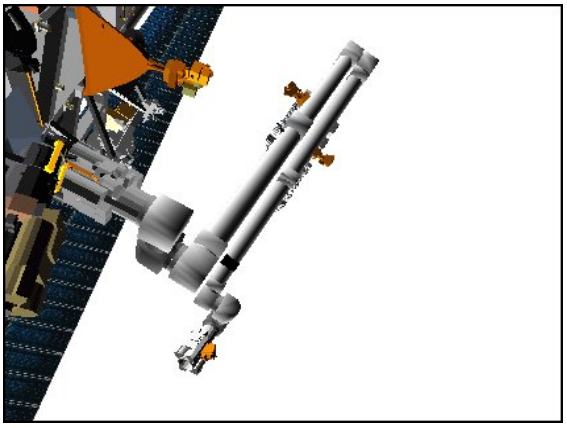

Figure 3.- SSRMS Stow
(13: LAB Stbd Zenith: -160, +55).

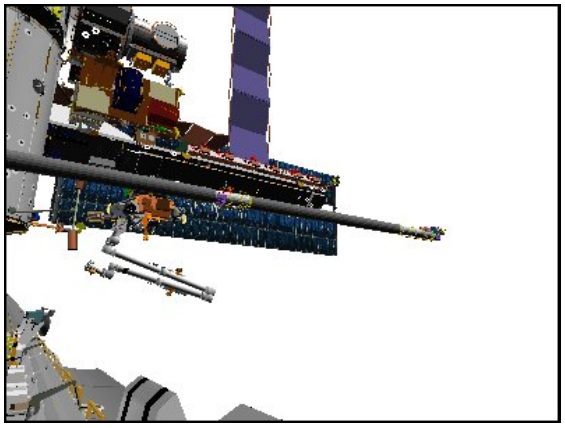

Figure 4.- SSRMS Stow
(V10: Camera C: +35, +15).

PCS MSS: SSRMS: SSRMS

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

Verify Unloaded Parameters – √

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

Change Display ▶ W3 ▶ Berth OBSS Mid NSP (Verify W3>Berth OBSS Mid NSP)

Verify SRMS and OBSS are at the OBSS Handoff position.

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

SR	SY	SP	EP	WP	WY	WR
-180	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
X	Y	Z	Pitch	Yaw	Roll	
-1826	-180	-415	+9.1	+75.0	-157.4	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

PCS MSS: SSRMS: SSRMS Safing: SSRMS Safing

cmd Remove (Verify Not Safed)

DCP BRAKES SSRMS → OFF (Verify OFF)

2. JOINT OCAS TO OBSS PRE-GRAPPLE INTERMEDIATE

NOTE

1. Expect singularity warning for WY between +100 and +80 deg.
2. Expect singularity warning for EP between +15 and -15 deg.
3. Monitor clearance to MBS Mast Camera with the Lab Camera. Closest clearance during the maneuver is approximately 51 cm (1.7 ft).

RHC RATE → COARSE (Verify Coarse on PCS)

PCS MSS: SSRMS: SSRMS

Enter Mode – Joint OCAS (Verify blue)

SSRMS Joint OCAS

Input ‘Joint Angles’ ‘Destination’ for Pre-Grapple Intermediate position.

SR	SY	SP	EP	WP	WY	WR
-60.0	+56.7	-101.2	-61.3	-68.5	-131.1	-89.6

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	+96.0	-183.0	+146.7	-131.1	+175.4	+125.4
TGT	**-60.0**	**+56.7**	**-101.2**	**-61.3**	**-68.5**	**-131.1**	**-89.6**
ERR	-120.0	+39.3	-81.8	+208.0	-62.6	+306.5	+215.0

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

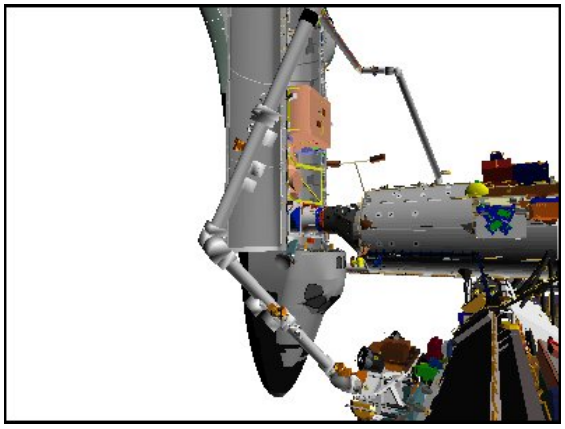

Figure 5.- OBSS Pre-Grapple Intermediate (03: S1 Lower Outboard: +60, +5).

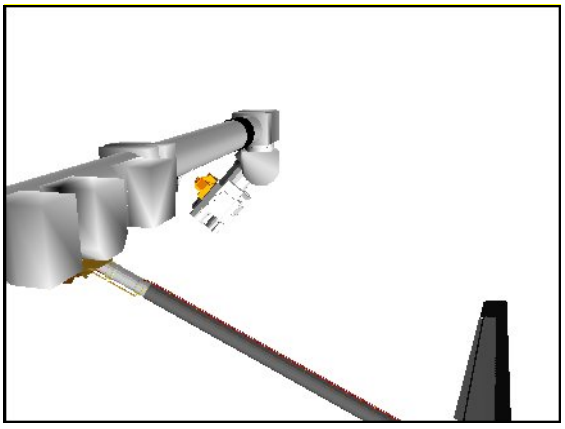

Figure 6.- OBSS Pre-Grapple Intermediate (22: Base Elbow: -130, -15).

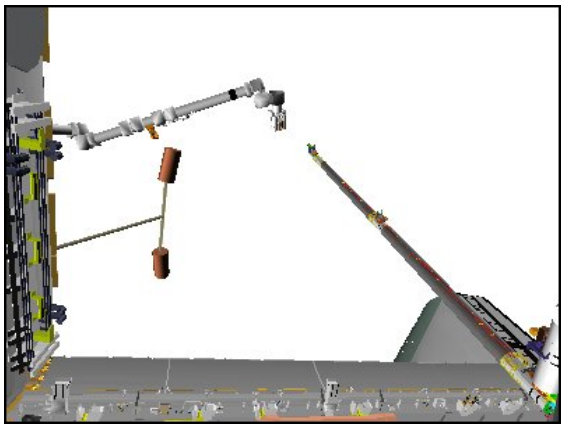

Figure 7.- OBSS Pre-Grapple Intermediate (92: SRMS Elbow: -40, +5).

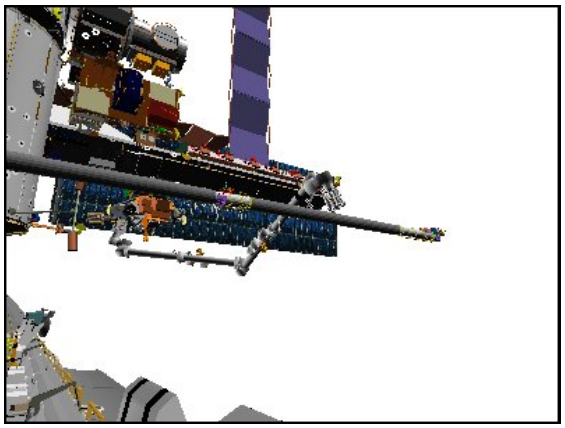

Figure 8.- OBSS Pre-Grapple Intermediate (V10: Camera C: +35, +15).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

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

SR	SY	SP	EP	WP	WY	WR
-60.0	+56.7	-101.2	-61.3	-68.5	-131.1	-89.6
X	Y	Z	Pitch	Yaw	Roll	
-61	-753	-722	-74.1	-31.5	-103.0	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

3. JOCAS TO OBSS PRE-GRAPPLE AT HANDOFF POSN

NOTE
Monitor clearance to MBS Mast Camera with the LAB Camera.
Clearance at start of maneuver is approximately 58 cm (1.9 ft).

RHC RATE → VERNIER (Verify Vernier on PCS)

SSRMS Joint OCAS

Input 'Joint Angles' 'Destination' for Pre-Grapple at Handoff position.

SR	SY	SP	EP	WP	WY	WR
-27.7	+56.7	-101.2	-47.4	-68.5	-131.1	-89.6

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)	-60.0	+56.7	-101.2	-61.3	-68.5	-131.1	-89.6
TGT	**-27.7**	**+56.7**	**-101.2**	**-47.4**	**-68.5**	**-131.1**	**-89.6**
ERR	-32.3	0.0	0.0	-13.9	0.0	0.0	0.0

****
* If joint angles or errors are incorrect
PCS * **cmd** Cancel (Verify Sequence Status – Waiting Destination)
*
* Input correct Dest joint angles per table above.
*
* **cmd** Load (Verify Sequence Status – Confirm or Cancel)
*
MON * Verify joint angles and errors are correct on Joint Angle Position
* overlay.
****

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

DCP AUTO SEQ → PROC

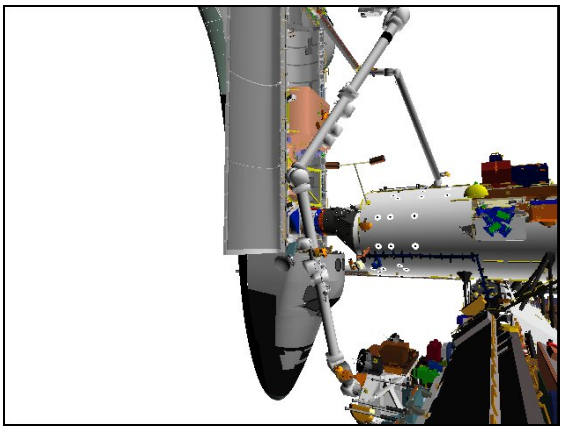

Figure 9.- OBSS Pre-Grapple at Handoff (03: S1 Lower Outboard: +60, +5).

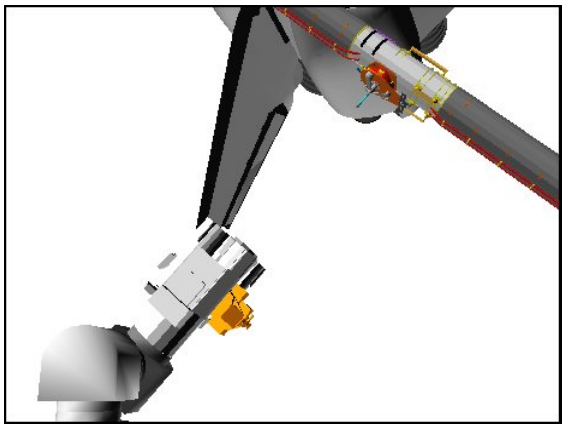

Figure 10.- OBSS Pre-Grapple at Handoff (24: Tip Elbow: +15, +15).

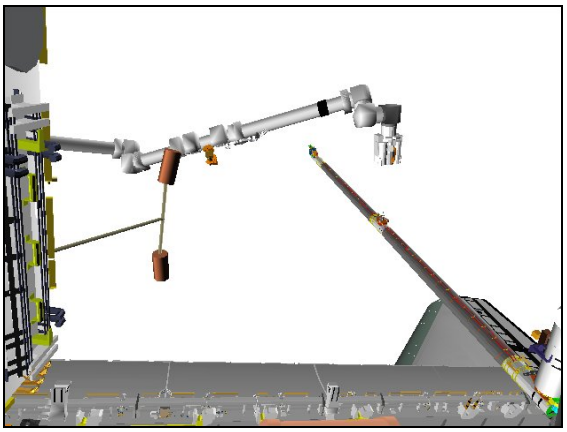

Figure 11.- OBSS Pre-Grapple at Handoff (92: SRMS Elbow: -40, +5).

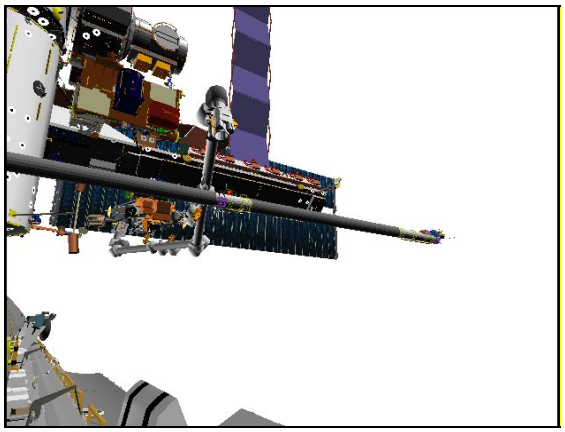

Figure 12.- OBSS Pre-Grapple at Handoff (V10: Camera C: +35, +15).

PCS MSS: SSRMS: SSRMS

Verify Posn Hold – orange

5.508 SSRMS STOW TO OBSS PRE-GRAPPLE AT HANDOFF

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

SR	SY	SP	EP	WP	WY	WR
-27.7	+56.7	-101.2	-47.4	-68.5	-131.1	-89.6
X	Y	Z	Pitch	Yaw	Roll	
+138	-158	-577	-74.1	-19.3	-84.6	
FOR	Unloaded – LEE Tip, SR Held					
Disp	W3>Berth OBSS Mid NSP					

REFERENCE

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6.101 FRAME OF REFERENCE (FOR): P5 MANEUVER

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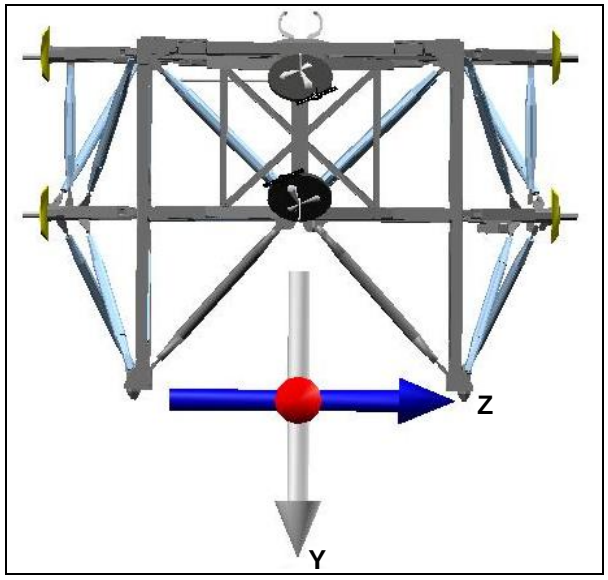
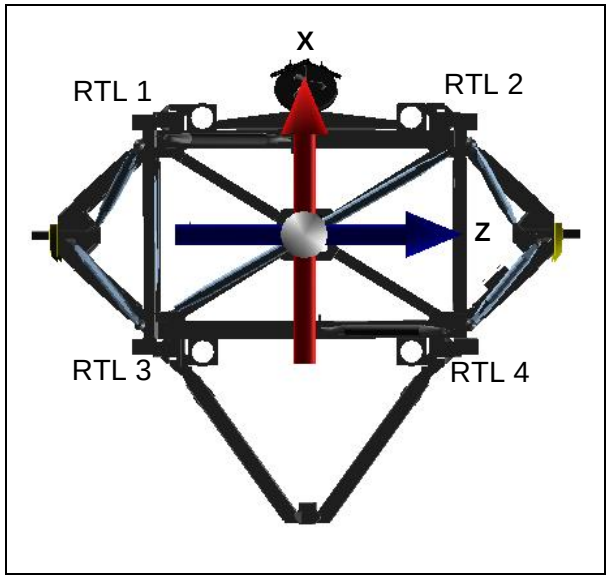
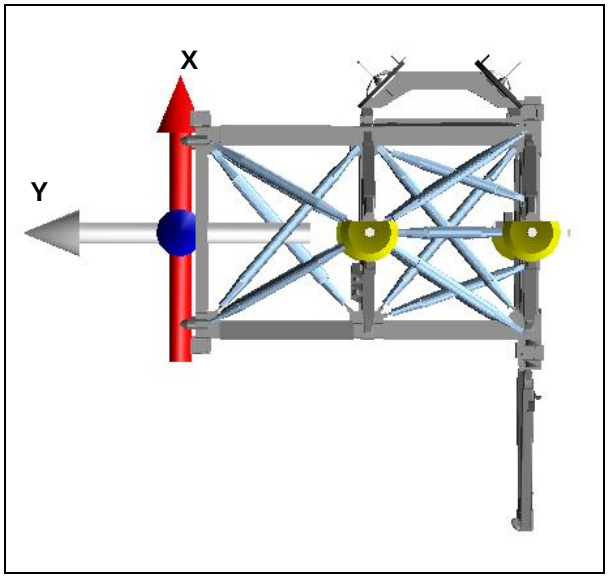


SSRMS SACS Loaded P5 Rate Limits

	Translation		Rotation		Pitch Plane		Joints	
	m/s	cm/s	Rad/s	Deg/s	Rad/s	Deg/s	Rad/s	Deg/s
Coarse	.036	3.6	.005	.286	.0151018	.865	.0302092	1.73
Vernier	.018	1.8	.003	.172	.0151018	.865	.0151046	.865





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6.102 FRAME OF REFERENCE (FOR): P5 INSTALL

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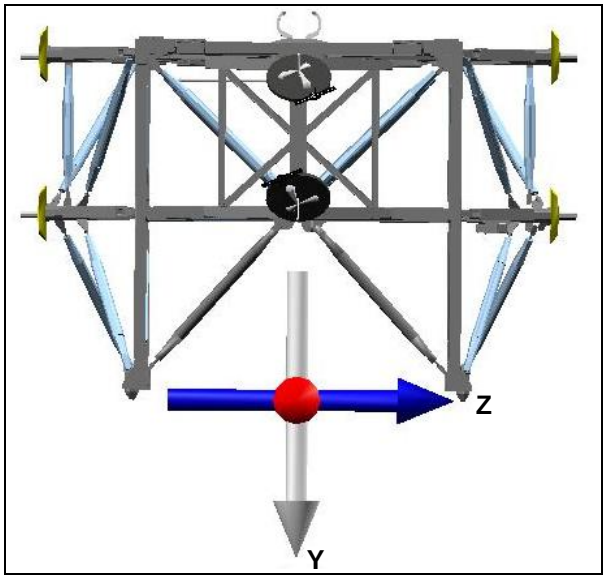
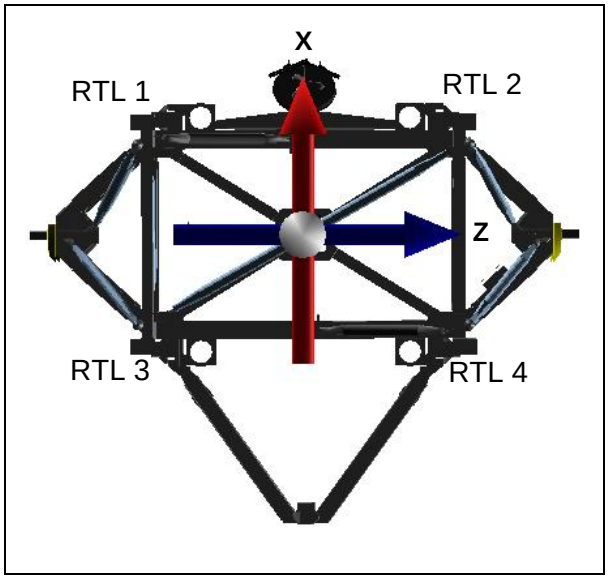
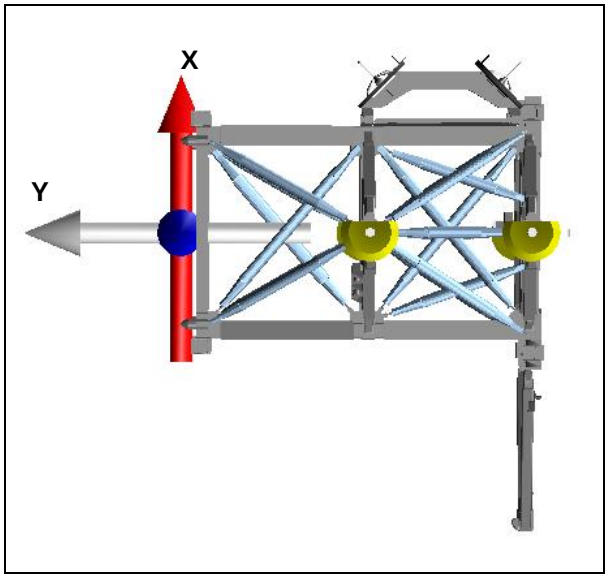


SSRMS SACS Loaded P5 Rate Limits

	Translation		Rotation		Pitch Plane		Joints	
	m/s	cm/s	Rad/s	Deg/s	Rad/s	Deg/s	Rad/s	Deg/s
Coarse	.036	3.6	.005	.286	.0151018	.865	.0302092	1.73
Vernier	.018	1.8	.003	.172	.0151018	.865	.0151046	.865





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6.103 FRAME OF REFERENCE (FOR): EVA CH12PPF6

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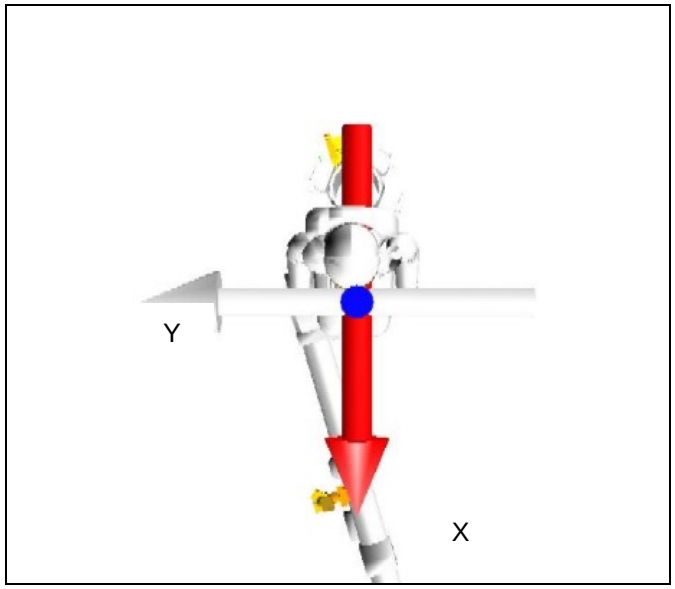
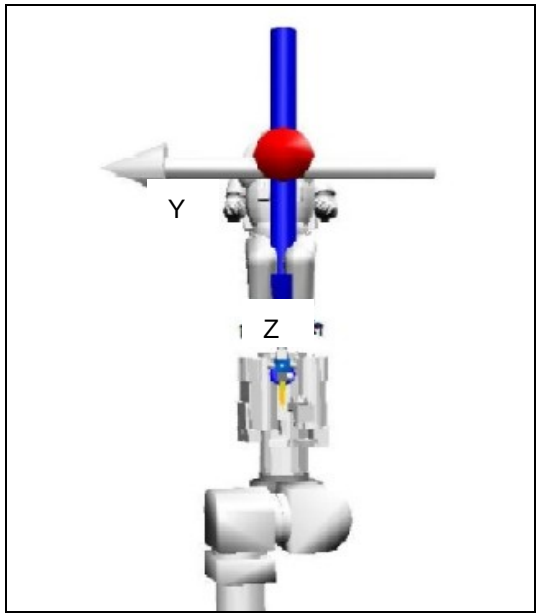
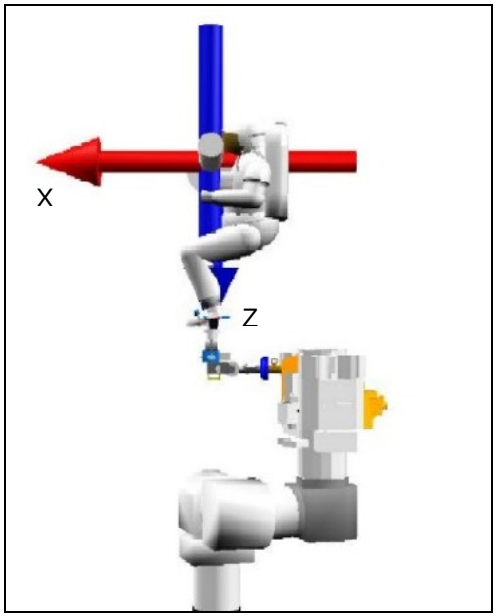


SSRMS SACS Loaded EVA Rate Limits

	Translation		Rotation		Pitch Plane		Joints	
	m/s	cm/s	Rad/s	Deg/s	Rad/s	Deg/s	Rad/s	Deg/s
Coarse	0.11	11	0.020944	1.2	0.01745	0.9998	0.0349066	2.0
Vernier	0.0825	8.25	0.0157	0.8995	0.01745	0.9998	0.0174533	1.0





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6.104 FRAME OF REFERENCE (FOR): OBSS>OBSS MID MPM

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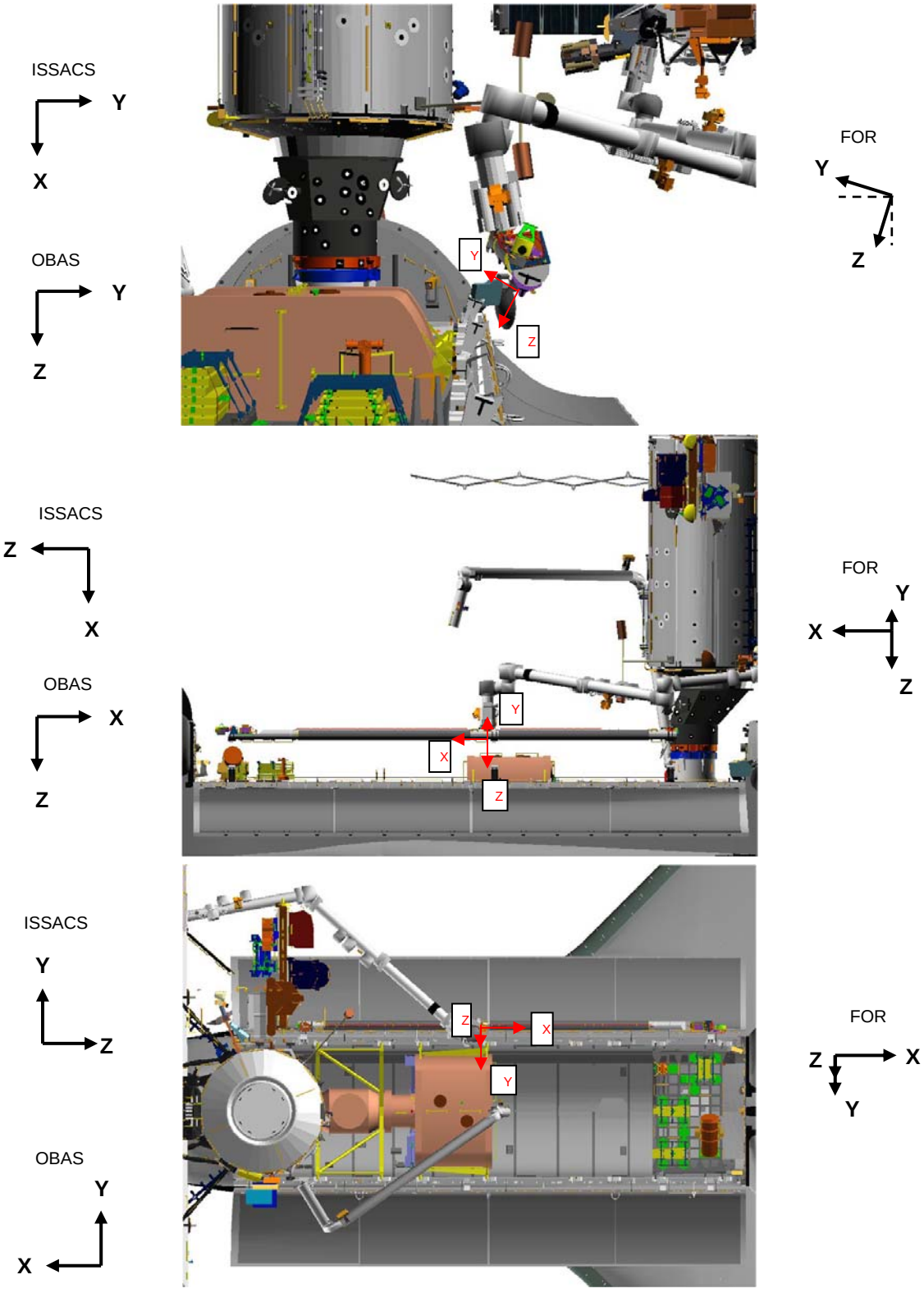

Figure 1.- W3>OBSS Mid MPM Command Frame and FOR.

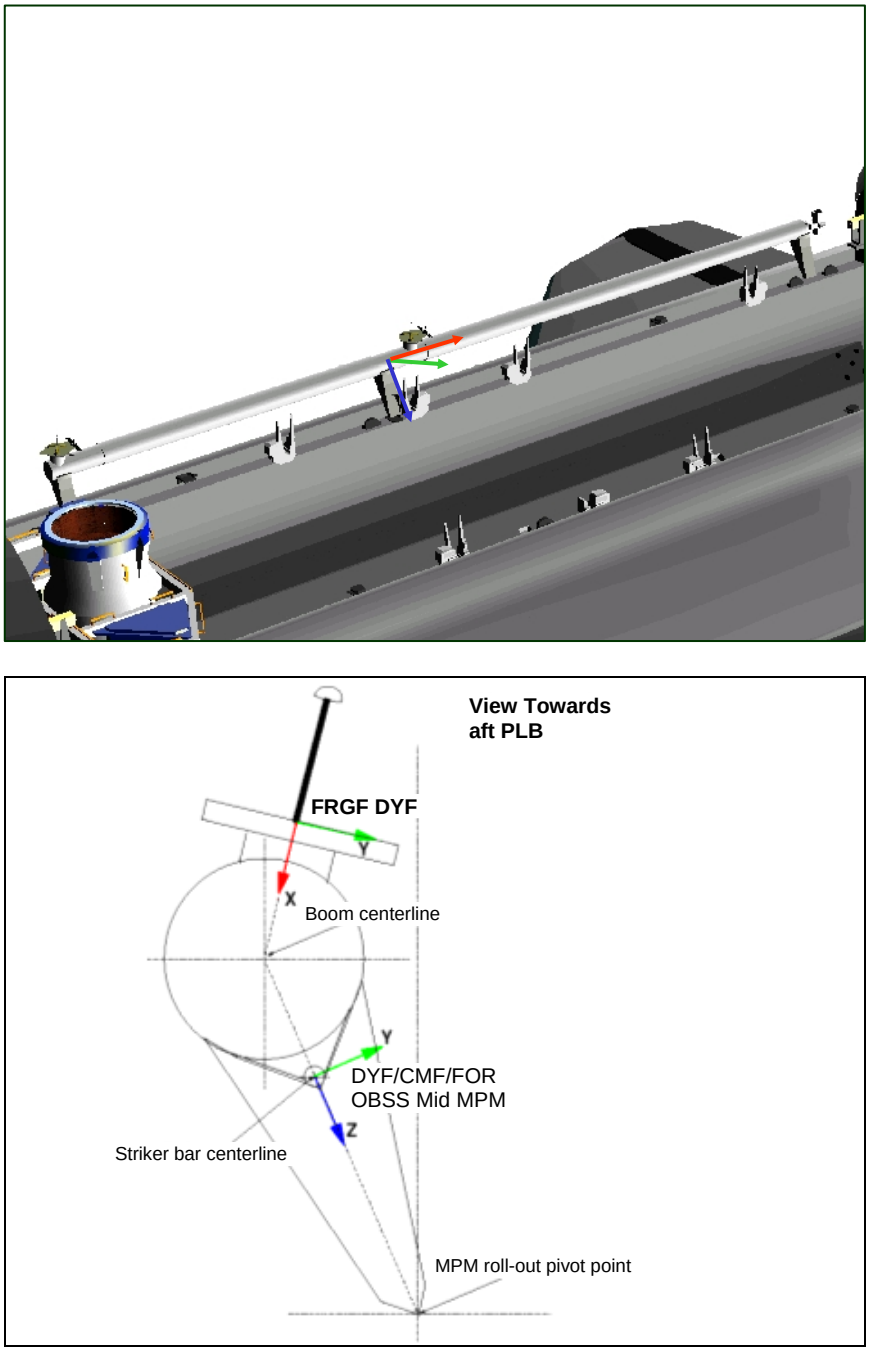

Figure 2.- Berthed OBSS Mid MPM Command Frame and FOR.

6.105 FRAME OF REFERENCE (FOR): OBSS>OBSS FWD MPM

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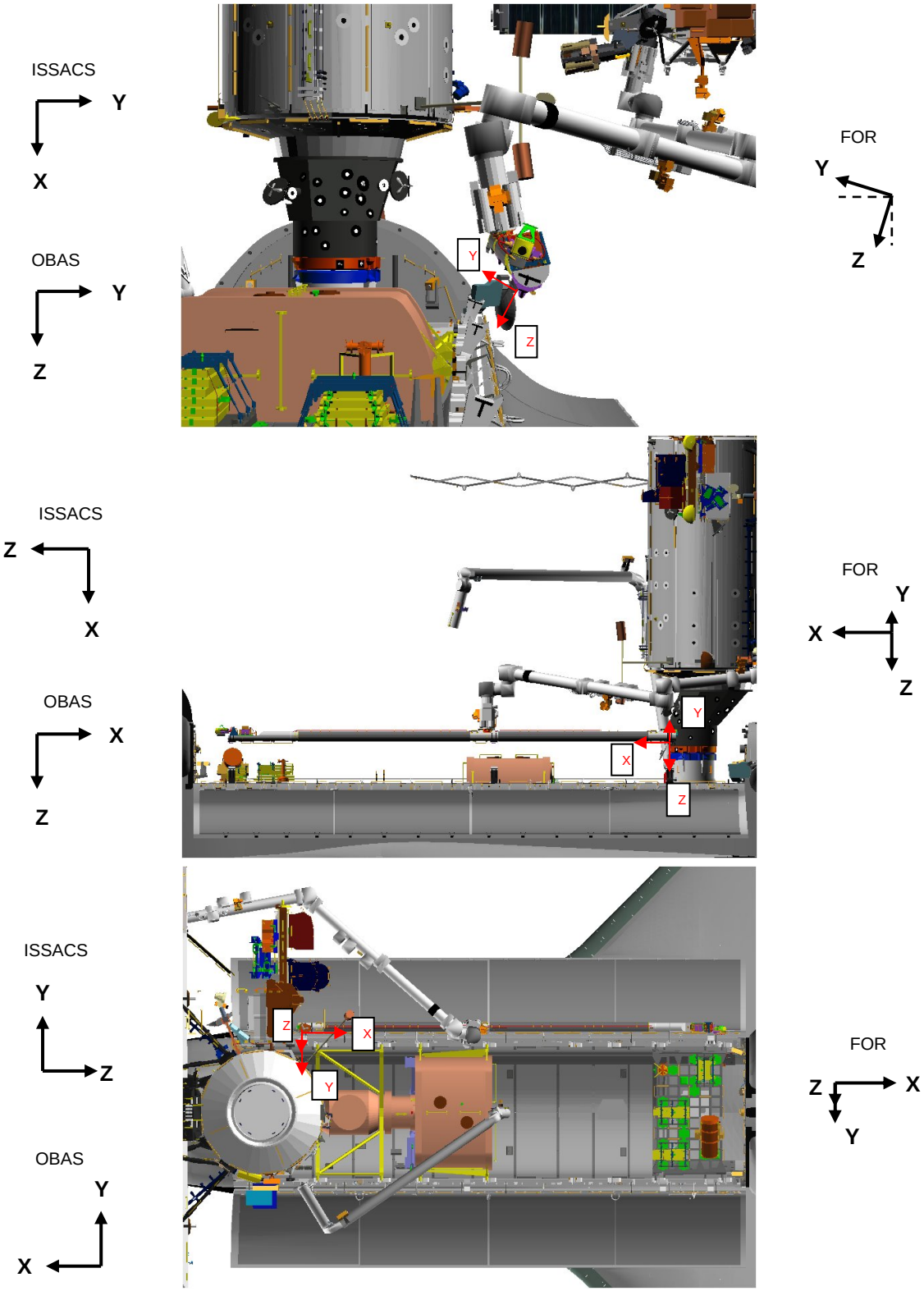


Figure 1.- W3>OBSS Fwd MPM Command Frame and FOR.

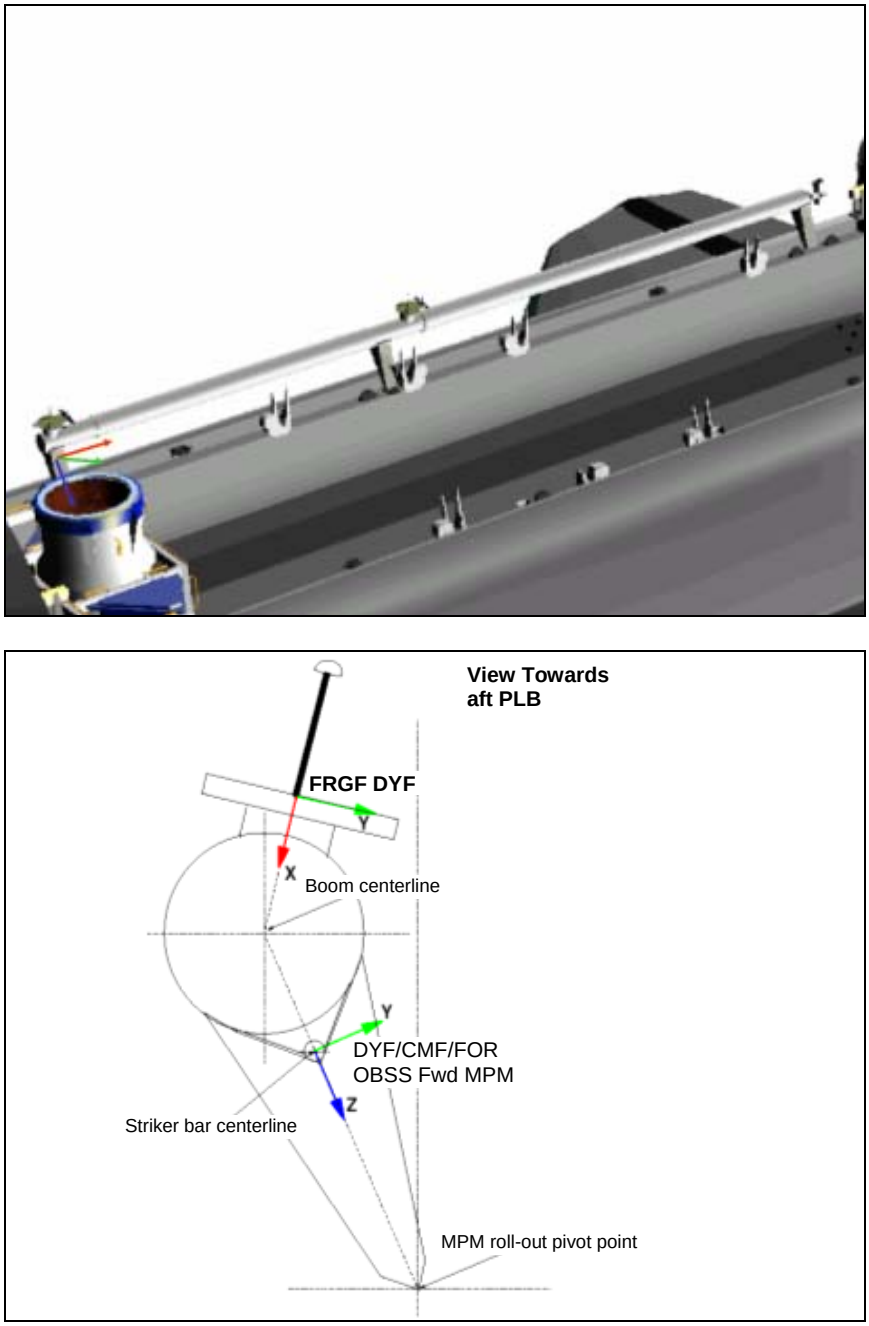
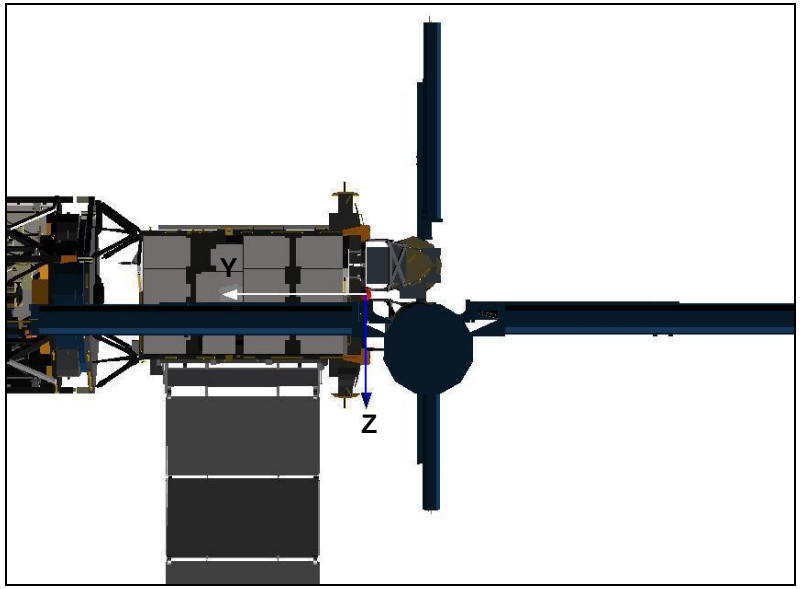
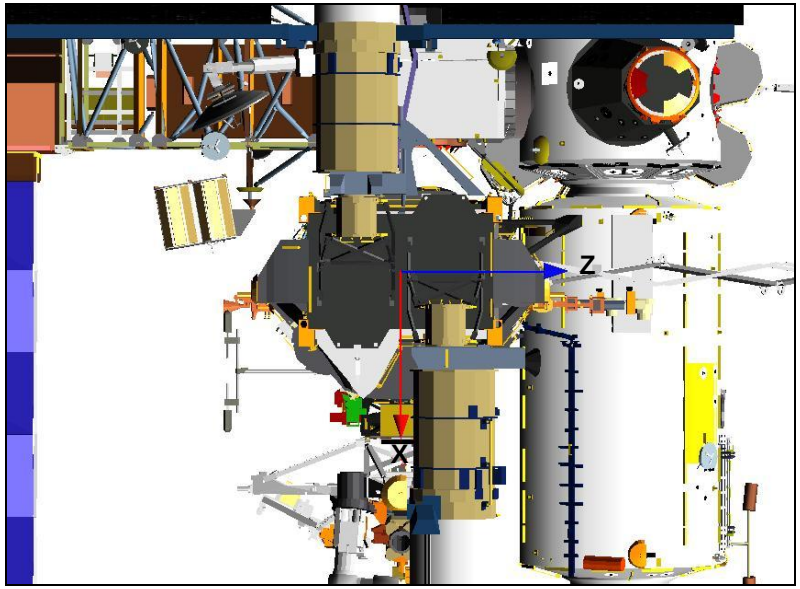


Figure 2.- Berthed OBSS Fwd MPM Command Frame and FOR.

6.106 DISPLAY FRAME: P5 INSTALL
(RBT FS/12A.1/FIN) Page 1 of 1 page





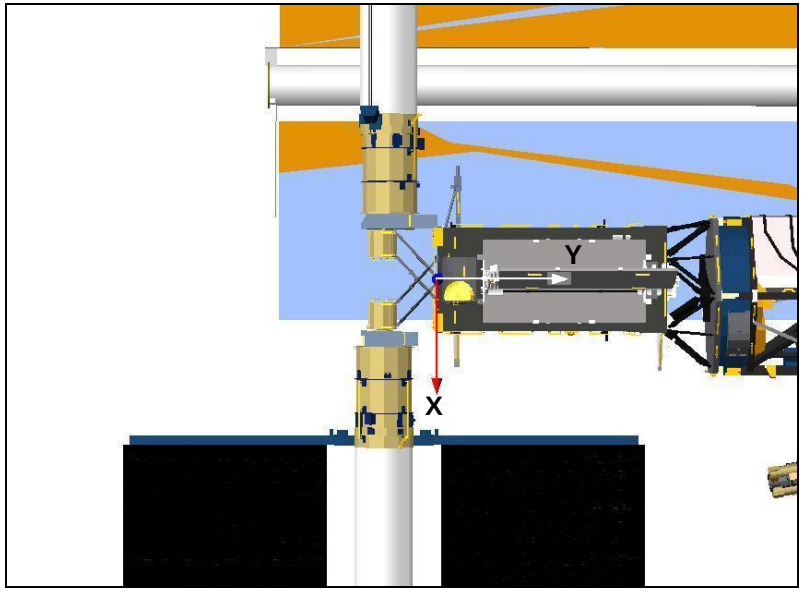


Figure 1.- Display Frame: P5 Install.

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6.107 DISPLAY FRAME: W3>BERTHED OBSS MIDMPM

(RBT FS/12A.1/FIN) Page 1 of 2 pages

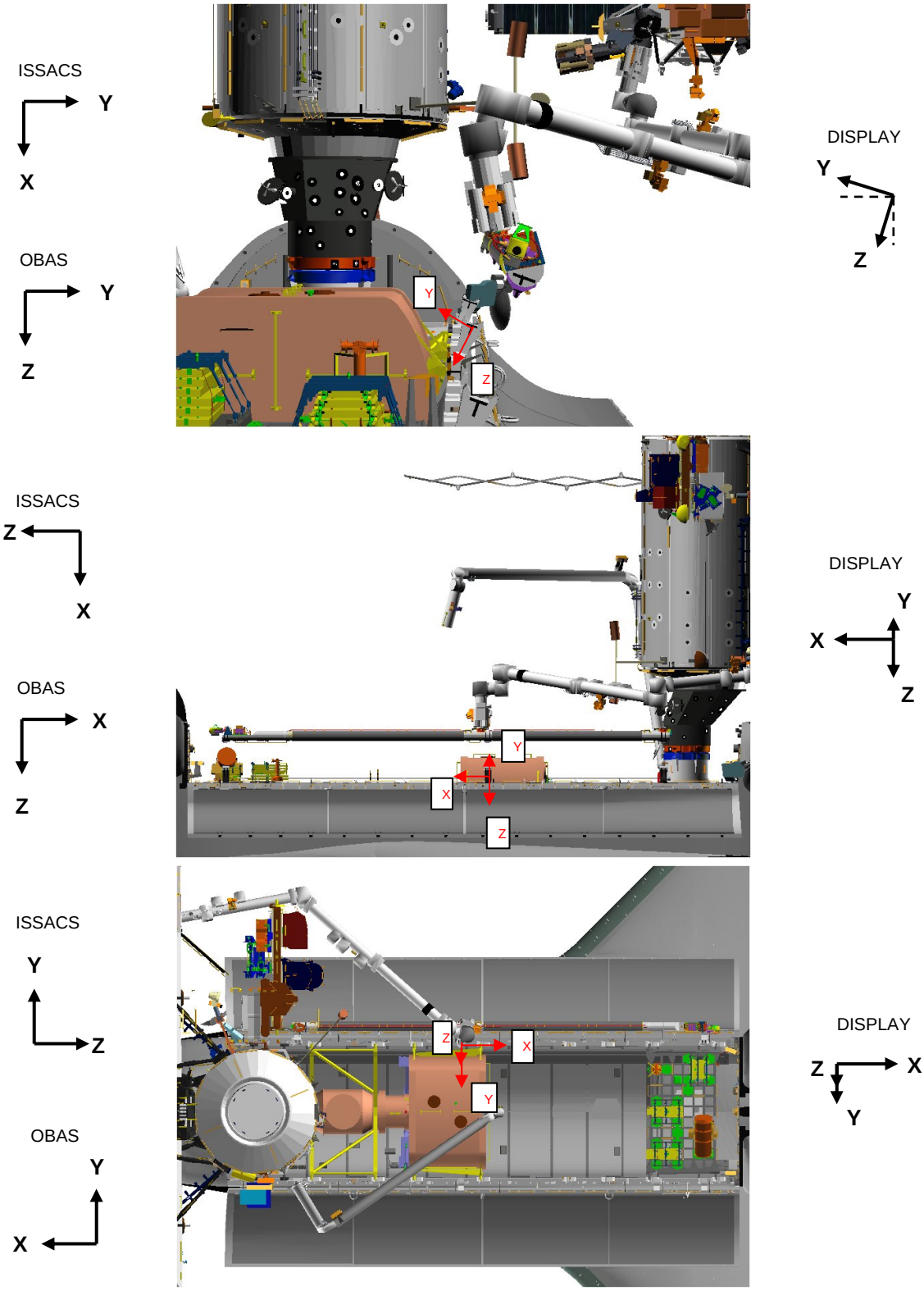
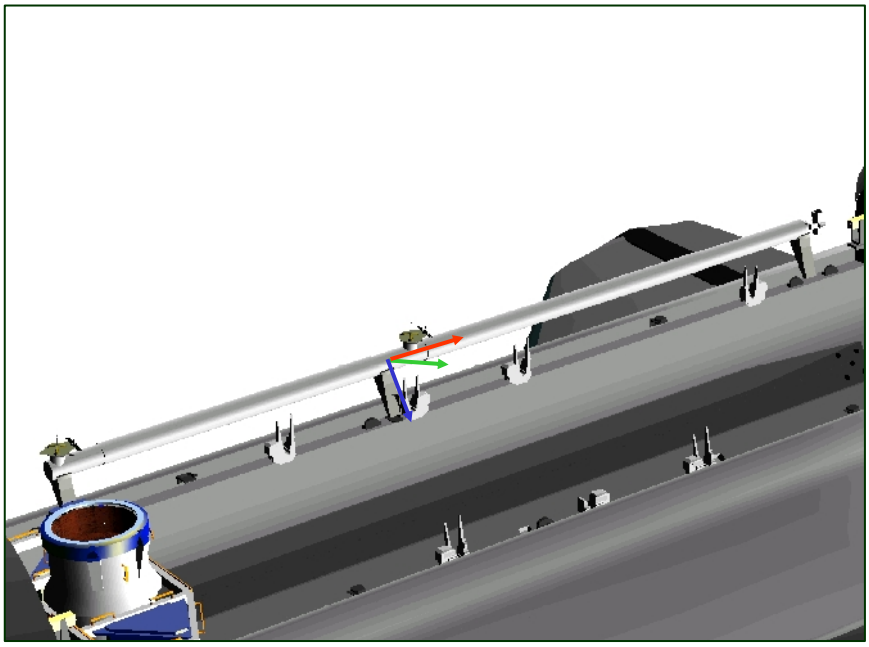


Figure 1.- Berthed OBSS MidMPM Display Frame.



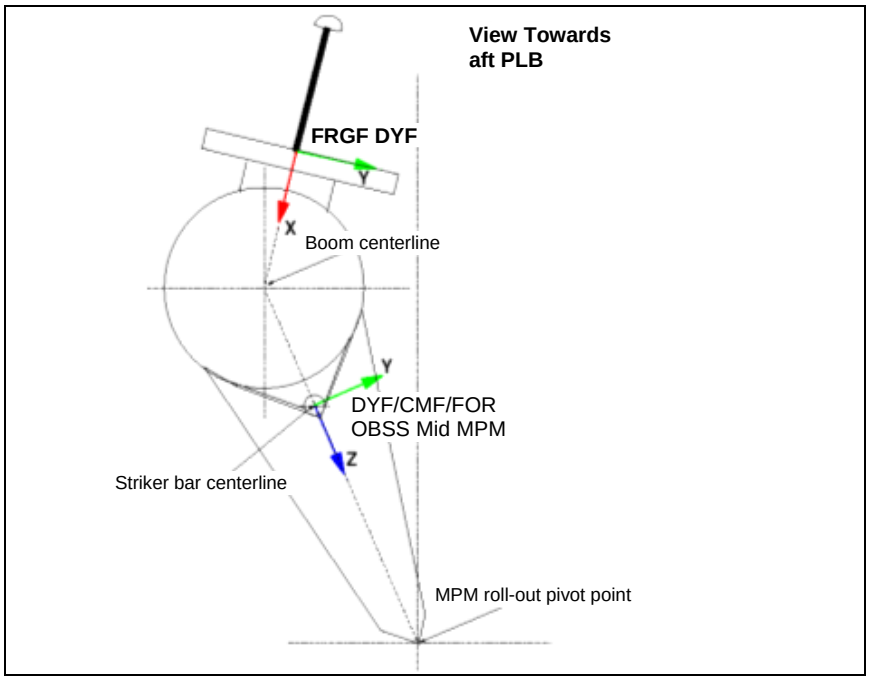


Figure 2.- Berthed OBSS MidMPM Display Frame and FOR.

6.108 DISPLAY FRAME: W3>BERTHED OBSS FWDMPM

(RBT FS/12A.1/FIN) Page 1 of 2 pages

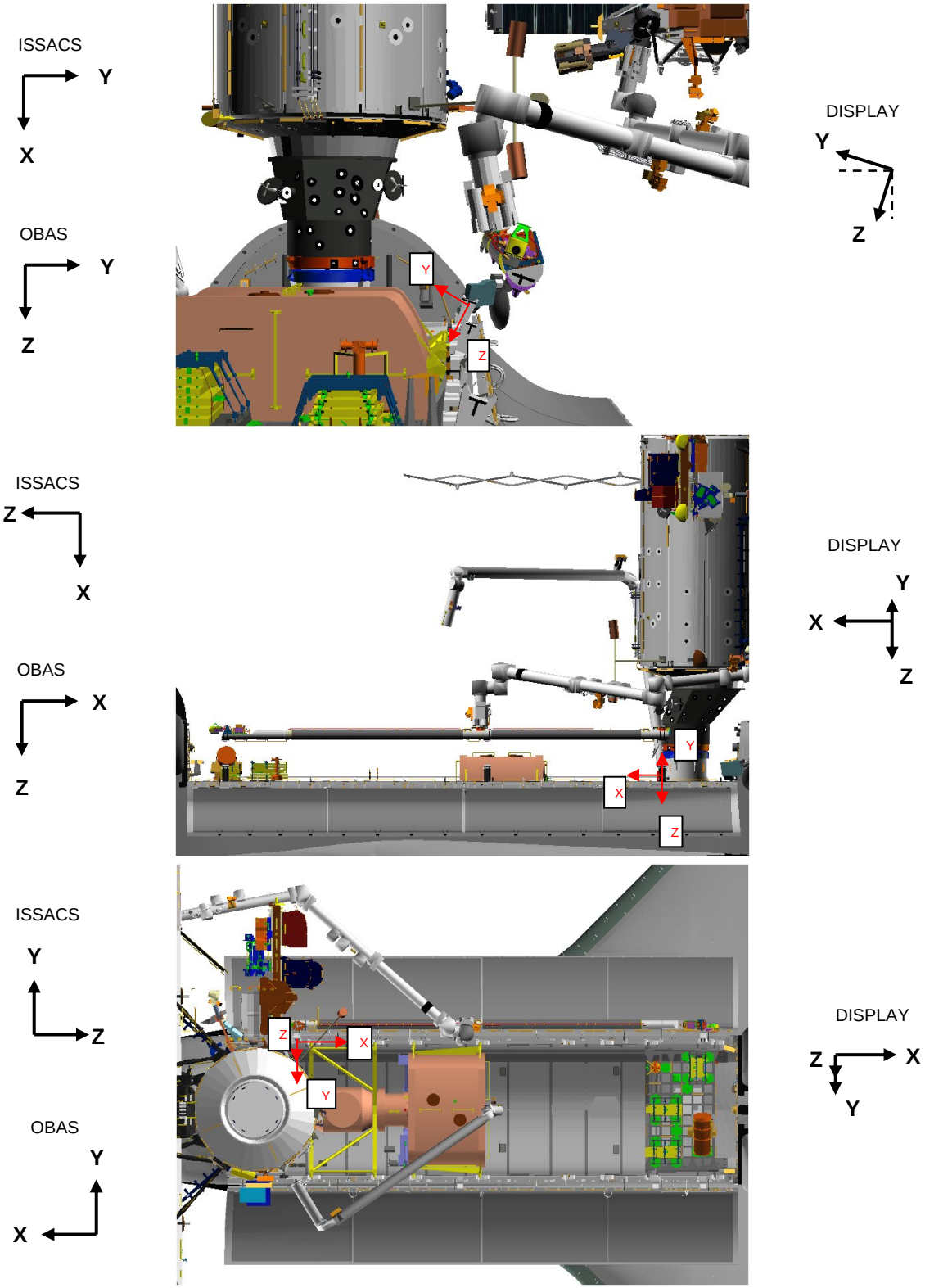


Figure 1.- Berthed OBSS Fwd MPM Display Frame.

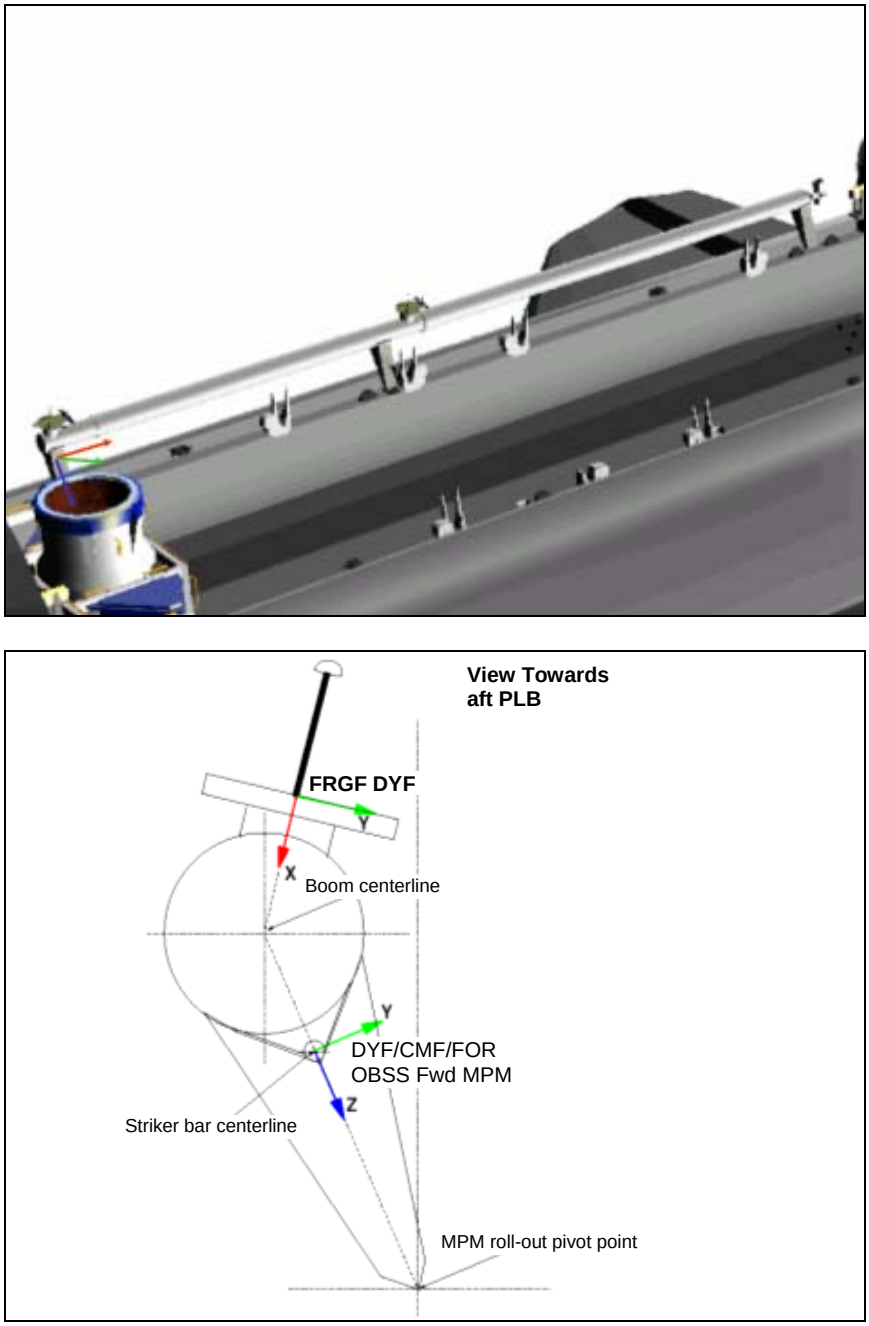


Figure 2.- Berthed OBSS Fwd MPM Display Frame and FOR.

6.109 OBSS BERTHING ALIGNMENT CUES

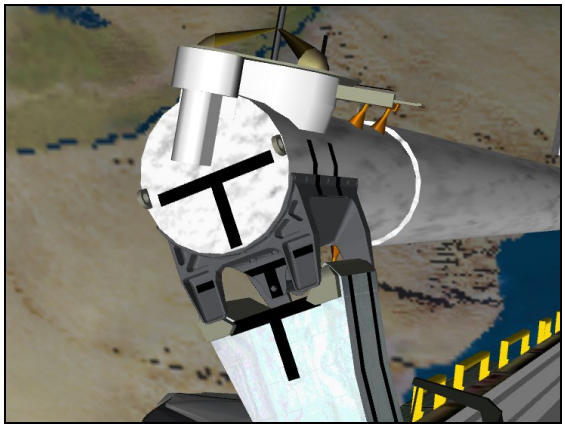


Figure 1.- OBSS 10cm from Latched (Camera D viewing Fwd MPM).

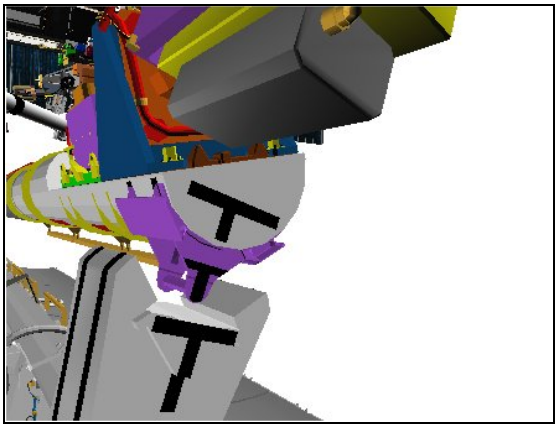


Figure 2.- OBSS 10cm from Latched (Camera C viewing Aft MPM).

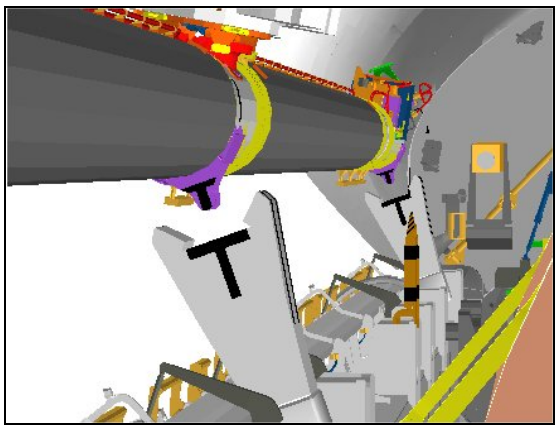


Figure 3.- OBSS 15cm from Latched (Camera D viewing Mid and Aft MPM).

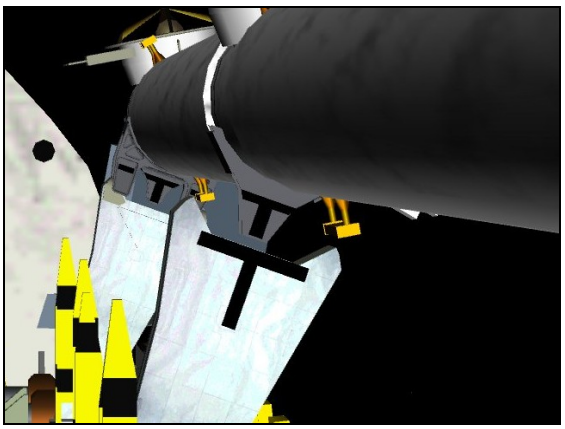


Figure 4.- OBSS 10cm from Latched (Camera C viewing Mid and Fwd MPM).

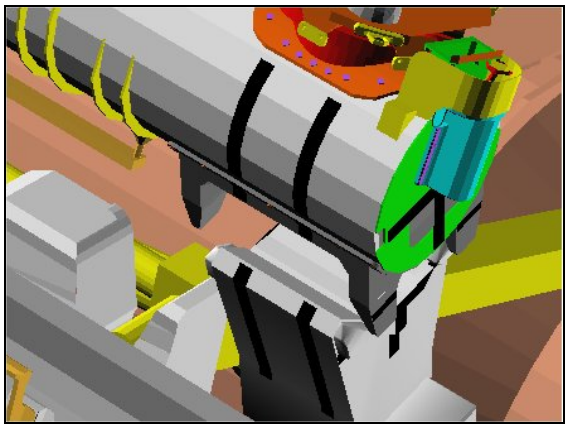


Figure 5.- OBSS 15cm from Latched (SSRMS Base Elbow viewing Fwd MPM).

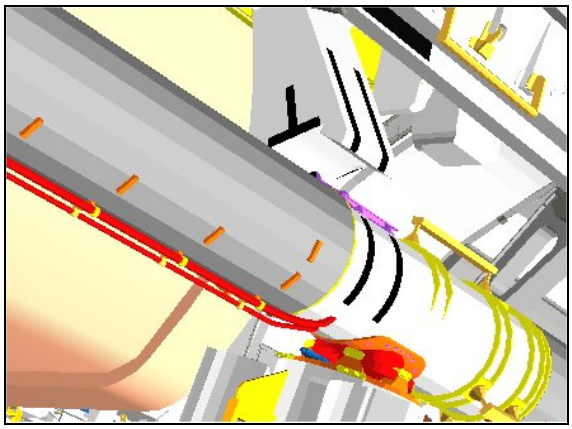


Figure 6.- OBSS 15cm from Latched (SSRMS Tip Elbow viewing Mid MPM).

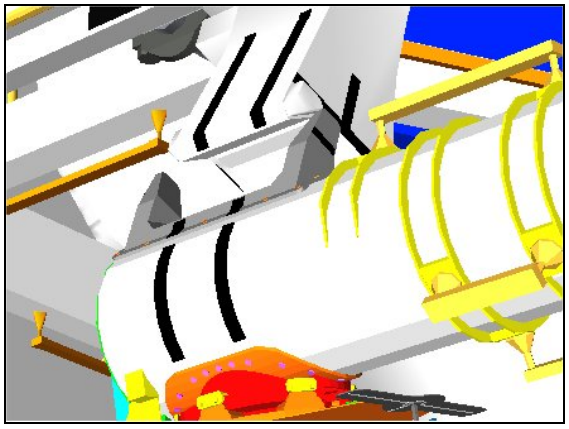


Figure 7.- OBSS 15cm from Latched
(SSRMS Tip Elbow viewing Aft MPM).

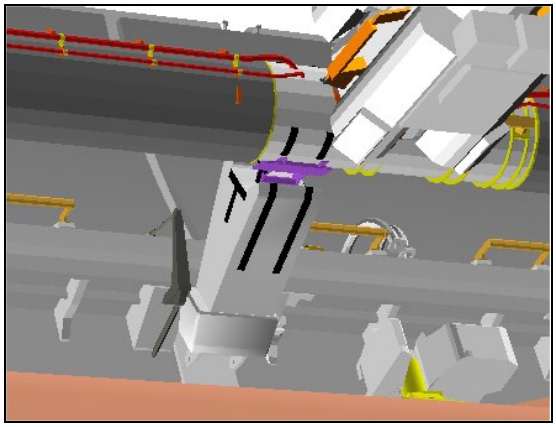


Figure 8.- OBSS 7cm from Latched
(SRMS Elbow viewing Mid MPM).

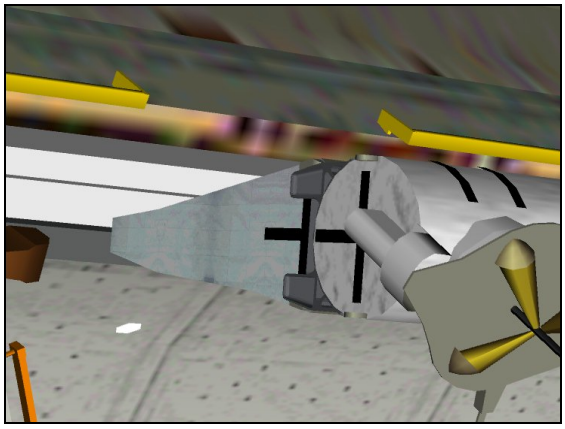


Figure 9.- OBSS 10cm from Latched
(Lab Stbd Zen viewing Fwd MPM).

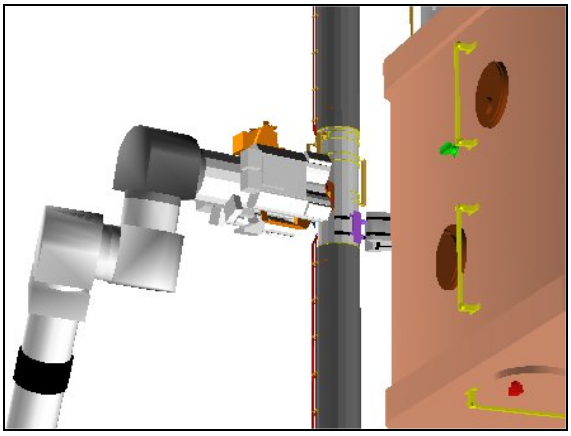


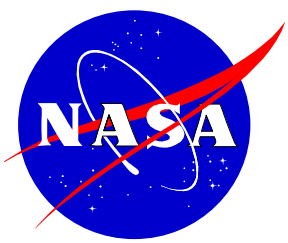
Figure 10.- OBSS 10cm from Latched
(P1 Lower Outboard viewing Mid MPM).

JSC-48540-12A.1

APPLICABLE FOR ISS-12A.1

INTERNATIONAL SPACE STATION

ROBOTICS FS



JSC-48540-12A.1

APPLICABLE FOR 12A.1

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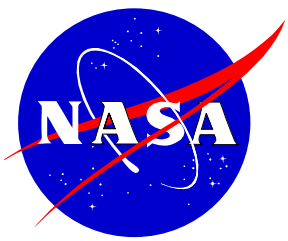
ROBOTICS FS