

PDRS Operations Checklist

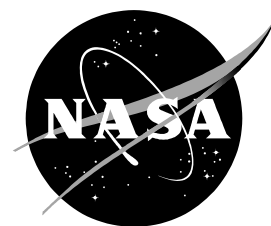
STS-117 Flight Supplement

**Mission Operations Directorate
EVA, Robotics, & Crew Systems
Operations Division**

**Final
February 9, 2007**

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

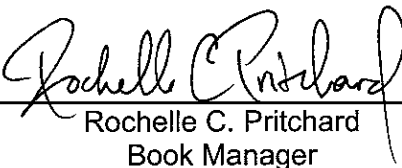


MISSION OPERATIONS DIRECTORATE

**PDRS OPERATIONS CHECKLIST
STS-117 FLIGHT SUPPLEMENT**

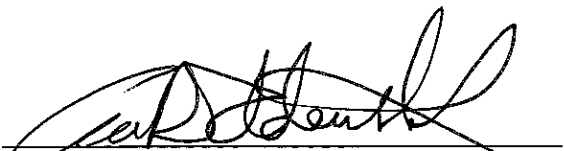
FINAL
February 9, 2007

PREPARED BY:

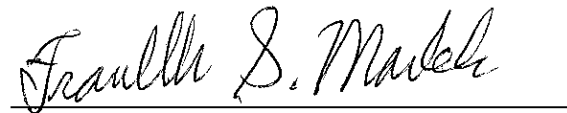


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Incorporates the following:	
482#:	PDRS FS-0001 PDRS FS-0002 PDRS FS-0003 PDRS FS-0004A PDRS FS-0005

AREAS OF TECHNICAL RESPONSIBILITY

Book Manager	DX22/R. Pritchard	281-483-2642
RMS Procedures	DX22/R. Pritchard	281-483-2642
	DX22/T. Clemens	281-244-6474
	DX22/G. Pollock	281-483-0883
RMS Training	DX25/J. Sugar	281-244-8598
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RMS Analysis	DX24/M. A. Austin	281-483-2964
PRLA Procedures	DF52/E. Eskola	281-483-4067

PDRS OPERATIONS CHECKLIST
 STS-117 FLIGHT SUPPLEMENT

LIST OF EFFECTIVE PAGES

FINAL 02/09/07

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FS iv	*	117/FIN	FS 2-22	117/FIN
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FS 1-21		117/FIN	FS 4-7	117/FIN
FS 1-22		117/FIN	FS 4-8	117/FIN
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FS 2-4		117/FIN	FS 4-12	117/FIN
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FS 2-7		117/FIN	FS 5-3	117/FIN
FS 2-8		117/FIN	FS 5-4	117/FIN
FS 2-9		117/FIN	FS 5-5	117/FIN
FS 2-10		117/FIN	FS 5-6	117/FIN
FS 2-11		117/FIN	FS 5-7	117/FIN
FS 2-12		117/FIN	FS 5-8	117/FIN
FS 2-13		117/FIN	FS 6-1	* 117/FIN
FS 2-14		117/FIN	FS CC 6-2	* 117/FIN
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* – Omit from flight book

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NOMINAL S3/S4 OPS

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**NOMINAL
S3/S4 OPS**

VERIFY UPLINKS

I

NOMINAL
S3/S4 OPS

1. CHECK PL ID 1

SM 94 PDRS CONTROL
PL ID – ITEM 3 +1 EXEC

	X	Y	Z	PITCH	YAW	ROLL	PL ID
√	-1279	-151	-553	95	359	328	1
	SY	SP	EP	WP	WY	WR	
√	0.0	+25.0	-25.0	+5.0	0.0	0.0	

2. CHECK PL ID 2

SM 94 PDRS CONTROL
PL ID – ITEM 3 +2 EXEC

	X	Y	Z	PITCH	YAW	ROLL	PL ID
√	-1216	-141	-1141	95	359	358	2

3. CHECK AUTOSEQUENCES 1, 2, AND 3 START POINTS

SM 94 PDRS CONTROL

√PL ID, ITEM 3: 2
AUTO 1 – ITEM 13 +1 +2 +3 EXEC

BRAKES – OFF (tb-OFF)
MODE – AUTO 1, ENTER

SM 94 PDRS CONTROL

√START PT, ITEM 17: 1

MODE – AUTO 2, ENTER

SM 94 PDRS CONTROL

√START PT, ITEM 17: 54

MODE – AUTO 3, ENTER

SM 94 PDRS CONTROL

√START PT, ITEM 17: 58

BRAKES – ON (tb-ON)

4. CHECK AUTOSEQUENCES 4, 5, AND 6 START POINTS

SM 94 PDRS CONTROL

√PL ID, ITEM 3: 2
AUTO 1 – ITEM 13 +4 +5 +6 EXEC

BRAKES – OFF (tb-OFF)
MODE – AUTO 1, ENTER

SM 94 PDRS CONTROL

√START PT, ITEM 17: 90

MODE – AUTO 2, ENTER

SM 94 PDRS CONTROL

√START PT, ITEM 17: 95

MODE – AUTO 3, ENTER

SM 94 PDRS CONTROL

√START PT, ITEM 17: 145

BRAKES – ON (tb-ON)

5. CHECK PL ID 4

SM 94 PDRS CONTROL

PL ID – ITEM 3 +4 EXEC

	X	Y	Z	PITCH	YAW	ROLL	PL ID
√	-1335	+25	-553	46	270	0	4

* display singularity

6. CHECK AUTOSEQUENCES 7 AND 8 START POINTS

SM 94 PDRS CONTROL

√PL ID, ITEM 3: 4

AUTO 1 – ITEM 13 +Z +8 EXEC

BRAKES – OFF (tb-OFF)

MODE – AUTO 1, ENTER

SM 94 PDRS CONTROL

√START PT, ITEM 17: 148

MODE – AUTO 2, ENTER

SM 94 PDRS CONTROL

√START PT, ITEM 17: 156

BRAKES – ON (tb-ON)

7. CHECK PL ID 5

SM 94 PDRS CONTROL

PL ID – ITEM 3 +5 EXEC

	X	Y	Z	PITCH	YAW	ROLL	PL ID
√	-1279	-251	-601	46	270	0	5

* display singularity

8. RESET TO PL ID 0

SM 94 PDRS CONTROL

PL ID – ITEM 3 +0 EXEC

	X	Y	Z	PITCH	YAW	ROLL	PL ID
√	-1261	-146	-551	5	2	0	0

S3/S4 GRAPPLE

- A7U 1. SETUP
 CCTV – config for grapple
 – install PDRS TARGET OVERLAY FOR CTVM
 – RMS WRIST, zoom 34.0 HFOV
 focus 5 ft
 Maintain eyepoint ~18 in when using grapple overlay

MON 1	P1LO
MON 2	A
DNLK	Elbow
DTV	D

SM 94 PDRS CONTROL

- √PL ID, ITEM 3: 0
 √INIT ID, ITEM 24: 0

CAUTION
 Payload Bay Flood Lights must be OFF
 until S3/S4 trunnions are clear of v-guides

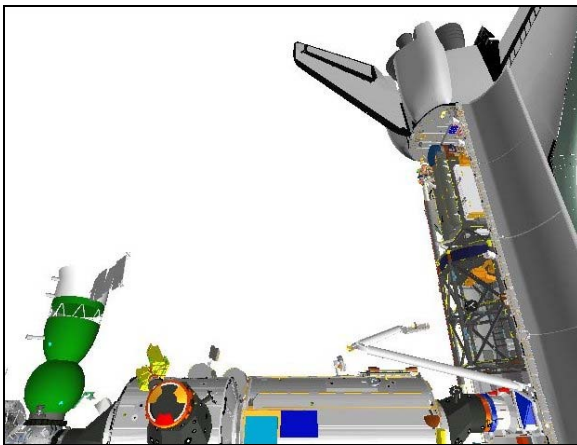
2. MNVR TO PRE-GRAPPLE
 RATE – as required (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – as desired

NOTE

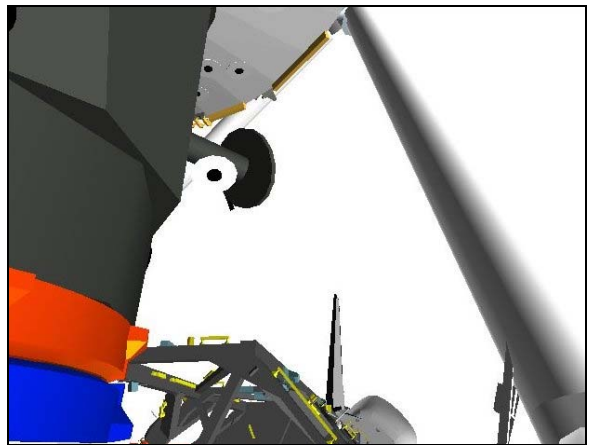
At pre-grapple posn, clearance between SRMS and US Lab ~ 29 in.
 Monitor clearance between SRMS and US Lab using Elbow camera.
 Monitor WP reach limit during maneuver to pre-grapple posn

Mnvr to PRE-GRAPPLE posn:

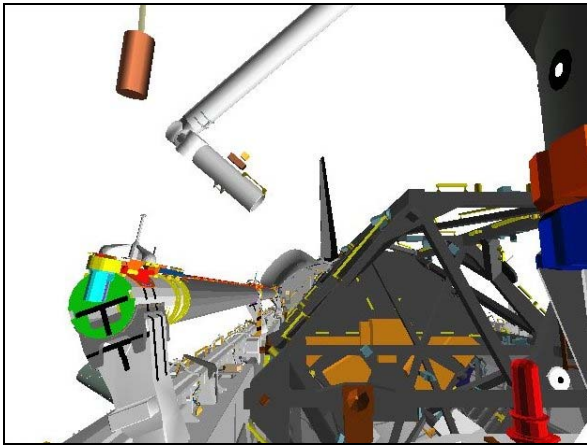
X	Y	Z	PITCH	YAW	ROLL	PL ID
-829	+95	-501	270	49	91	0
SY	SP	EP	WP	WY	WR	
-60.3	+60.7	-108.8	-107.5	+27.4	+188.7	



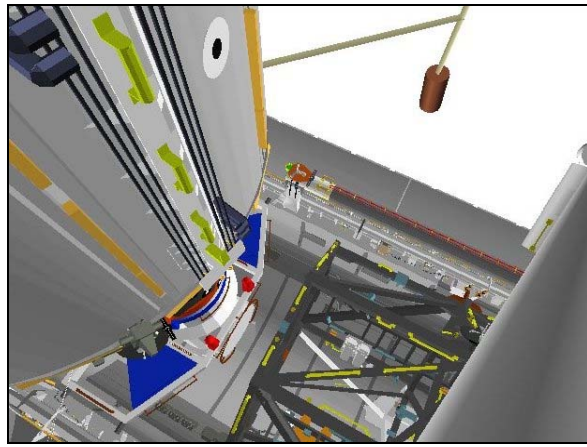
P1 LOWER OUTBOARD (90,30)



CCTV A (-10,30)



CCTV D (0,10)



ELBOW (-40,-20)

3. S3/S4 GRAPPLE

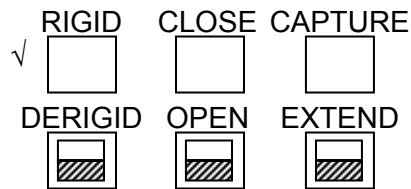
MON 1	P1LO
MON 2	A
DNLK	Wrist
DTV	D

- √RATE – VERN (RATE MIN tb-ON)
- √BRAKES – OFF (tb-OFF)
- MODE – END EFF, ENTER

Mnvr to grapple envelope

CAUTION
Monitor EE tb timing to prevent EE motor burnout

EE MODE – AUTO
CAPTURE sw – depress (mom)

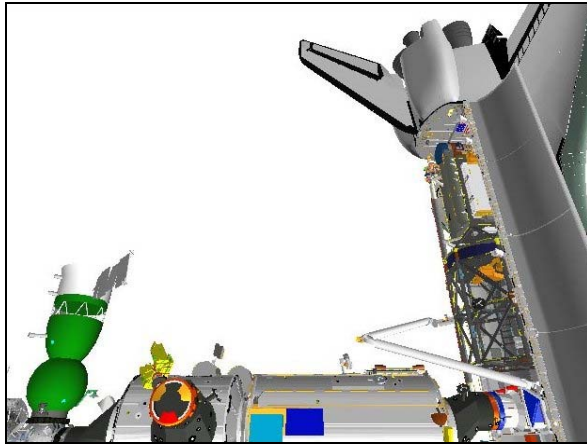


CRITICAL TIMES (28 sec total):
 CAPTURE tb – gray, then
 CLOSE tb – gray, 3 sec max, then
 RIGID tb – gray, 25 sec max

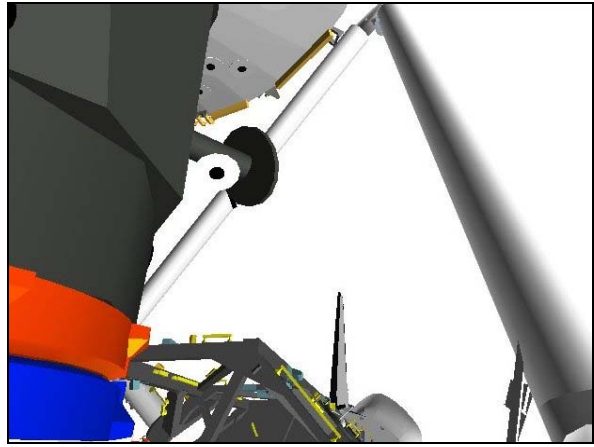
- * If manual grapple reqd: *
- * EE MODE – MAN *
- * CAPTURE sw – depress (hold until CLOSE tb-gray, 3 sec max) *
- * MAN CONTR – RIGID (hold until RIGID tb-gray, 25 sec max) *

EE MODE – OFF
BRAKES – ON (tb-ON)

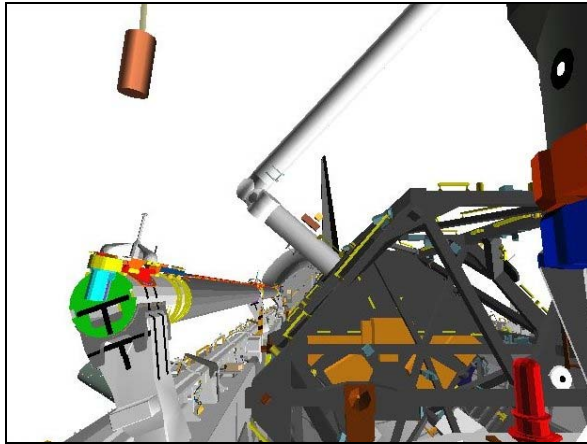
SM 94 PDRS CONTROL
 PL ID – ITEM 3 +4 EXEC
 INIT ID – ITEM 24 +4 EXEC



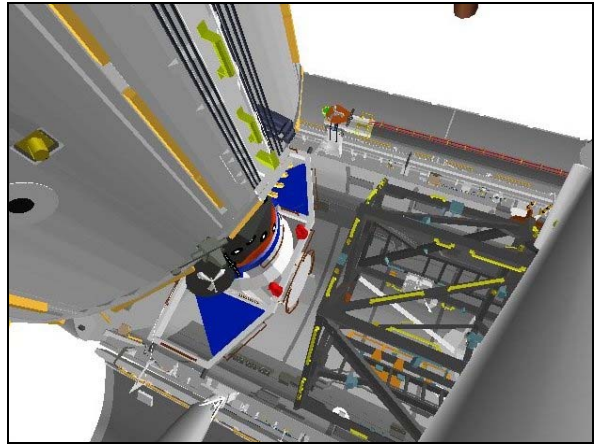
P1 LOWER OUTBOARD (90,30)



CCTV A (-10,30)



CCTV D (0,10)



ELBOW (-40,-20)

Record POS/ATT and Joint Angles:

	X	Y	Z	PITCH	YAW	ROLL	PL ID
Expected	-1002	0	-414	0	0	0	4
	SY	SP	EP	WP	WY	WR	4
Expected	-54.1	+63.7	-121.1	-96.4	+33.0	+185.0	

Record POS/ATT and Joint Angles in S3/S4 CONTINGENCY REBERTH
(OFF-NOMINAL S3/S4 OPS)

Review GENERIC END EFFECTOR CUE CARD – ISS/SHUTTLE DOCKED OPS

S3/S4 UNBERTH

1. SETUP

A7U CCTV – config for unberth

MON 1	P1LO
MON 2	Elbow
DNLK	D/A
DTV	B/C

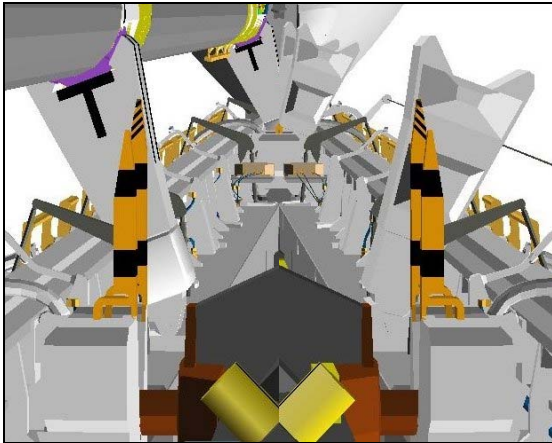
SM 94 PDRS CONTROL

- √PL ID, ITEM 3: 4
- √INIT ID, ITEM 24: 4
- √BRAKES – ON (tb-ON)

PCS MSS: SSRMS: Thrusters: Thruster Controls for MSS Ops

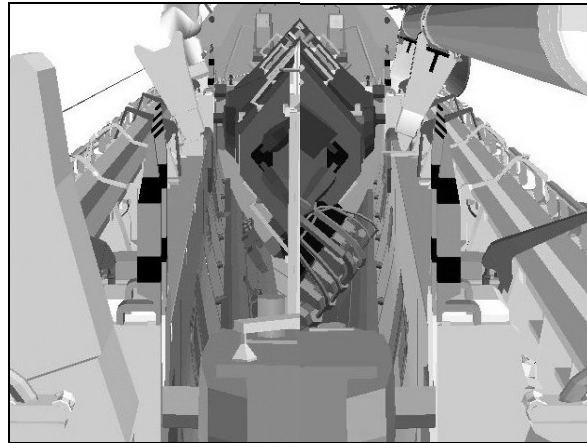
Verify 'Desat Request:' – Inh

If using shuttle attitude control:
DAP: FREE



CCTV D (-5,-4)

CCTV A (5,-4)



CCTV B (-3,-8)

CCTV C (3,-8)

2. ACTIVATE LATCHES

NOTE

When LOGIC switches taken OFF, KU will mode to standby. MPM and MRL tbs – bp

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

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

SM 97 PL RETENTION

- √PL SEL 1 RDY-FOR-LAT 1,2,3,4 (eight) – 1
- √LAT 1,2,3,4 (eight) – 1
- √2 RDY-FOR-LAT 1,2 (four) – 1
- √LAT 1,2 (four) – 1

- * If any rel msw shows '1' expect *
- * single motor time (60 sec) *

- 3. AKA RELEASE
 PL RETEN PL SEL - 2
 √LAT 1,2 tb - LAT
 √RDY 1,2 tb - gray

Note single motor times (> 30 sec)
 PL RETEN LAT 1,2 (two) - REL (tb-REL), 60 sec max
 - OFF

- 4. PRLA RELEASE
 PL RETEN PL SEL - 1
 √LAT 1,2,3,4 tb - LAT
 √RDY 1,2,3,4 tb - gray

Note single motor times (> 30 sec)
 PL RETEN LAT 1,2 (two) - REL (tb-REL), 60 sec max
 - OFF
 3,4 (two) - REL (tb-REL), 60 sec max
 - OFF

- 5. DEACTIVATE LATCHES
 PL RETEN LOGIC PWR SYS (1,2) - OFF
 BAY MECH PWR SYS (1,2) - OFF

R13L

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

|

6. MNVR TO INTERMEDIATE POSN

MON 1	P1LO
MON 2	Elbow
DNLK	D/A
DTV	B/C

√RATE – VERN (RATE MIN tb-ON)
 BRAKES – OFF (tb-OFF)
 MODE – ORB LD, ENTER

NOTE

At Intermediate posn, clearance between S3/S4 and OBSS ~ 7 in.
 Monitor clearance between S3/S4 and OBSS using Camera C

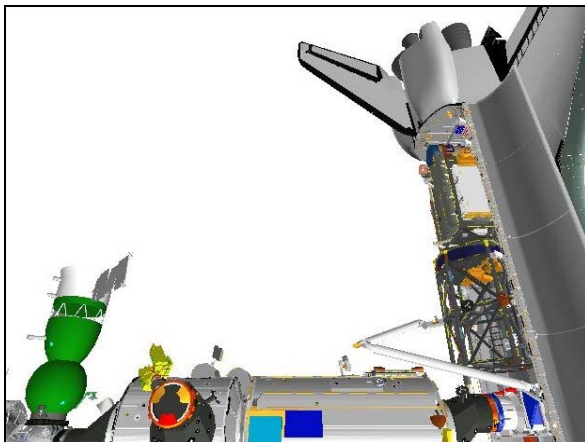
Mnvr S3/S4 up until unconstrained and Z = -434

A6U

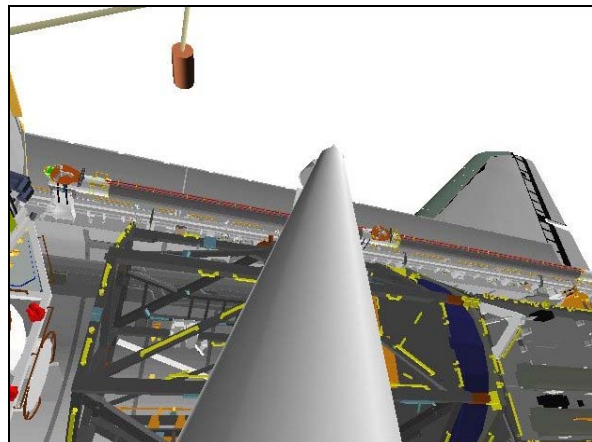
√PL RETEN RDY 1,2,3,4 tb (four) – bp

Mnvr to INTERMEDIATE posn:

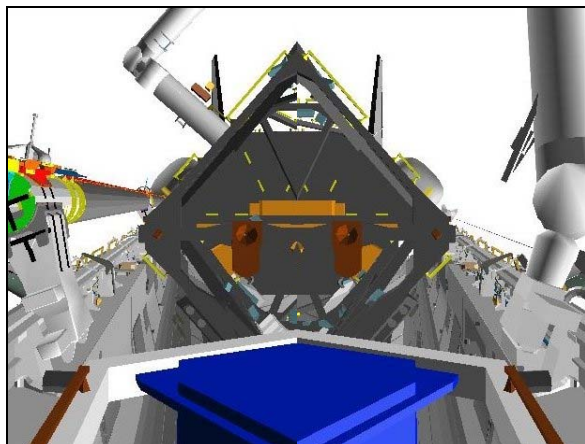
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1002	0	-434	0	0	0	4
SY	SP	EP	WP	WY	WR	
-55.0	+66.8	-119.7	-101.1	+32.2	+185.4	



P1 LOWER OUTBOARD (90,30)

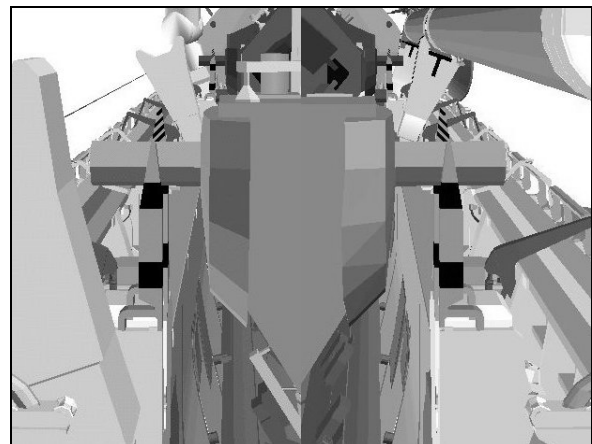


ELBOW (-5,-15)



CCTV D (-5,-4)

CCTV A (5,-4)



CCTV B (-3,-8)

CCTV C (3,-8)

7. MNVR TO PORT POSN

MON 1	P1LO
MON 2	Elbow
DNLK	D/A
DTV	B/C

- √RATE – VERN (RATE MIN tb-ON)
- √BRAKES – OFF (tb-OFF)
- √MODE – ORB LD

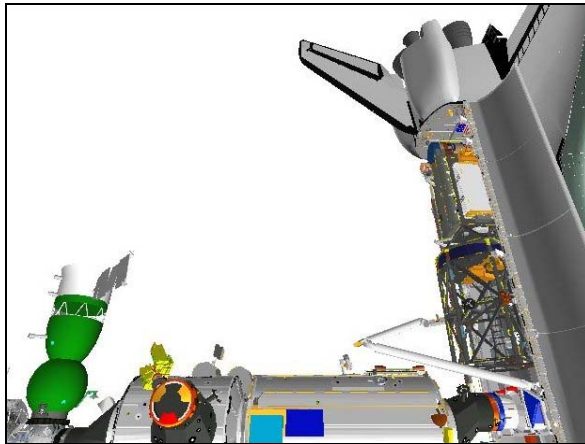
NOTE

At Port posn, clearance between S3/S4 and OBSS ~ 8 in.
 Clearance between S3/S4 and aft port v-guide ~ 1 in.
 Monitor clearance between S3/S4 and OBSS using Camera C.
 Monitor clearance between S3/S4 and v-guides using Camera B

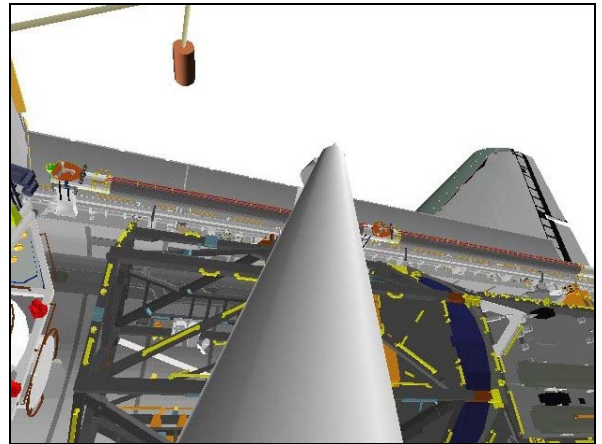
Mnvr S3/S4 port to Y = -2

Mnvr to PORT posn:

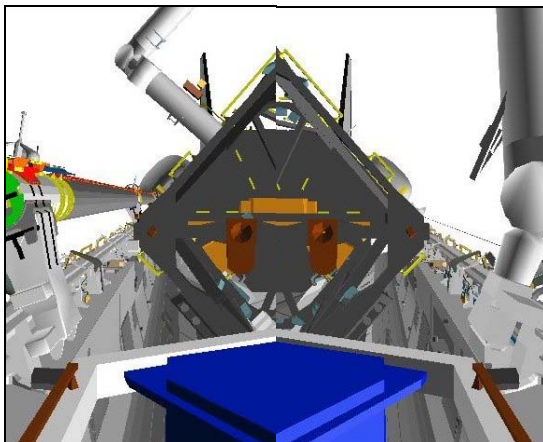
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1002	-2	-434	0	0	0	4
SY	SP	EP	WP	WY	WR	
-54.7	+67.2	-120.1	-101.1	+32.4	+185.3	



P1 LOWER OUTBOARD (90,30)

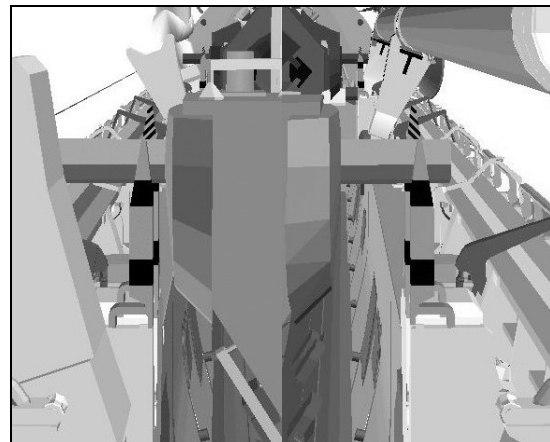


ELBOW (-5,-15)



CCTV D (-5,-4)

CCTV A (5,-4)



CCTV B (-3,-8)

CCTV C (3,-8)

8. MNVR TO LOW HOVER POSN

MON 1	US Lab
MON 2	Elbow
DNLK	A
DTV	C

√RATE – VERN (RATE MIN tb-ON)

√BRAKES – OFF (tb-OFF)

√MODE – ORB LD

NOTE

At Low Hover posn, clearance between S3/S4 and OBSS ~ 18 in.

Clearance between S3/S4 and aft port v-guide ~ 16 in.

Monitor clearance between S3/S4 and OBSS using Camera C.

Monitor clearance between S3/S4 and v-guides using Camera B.

Monitor WP reach limit during maneuver to low hover posn

Mnvr S3/S4 up until Z = -475

Mnvr to LOW HOVER posn:

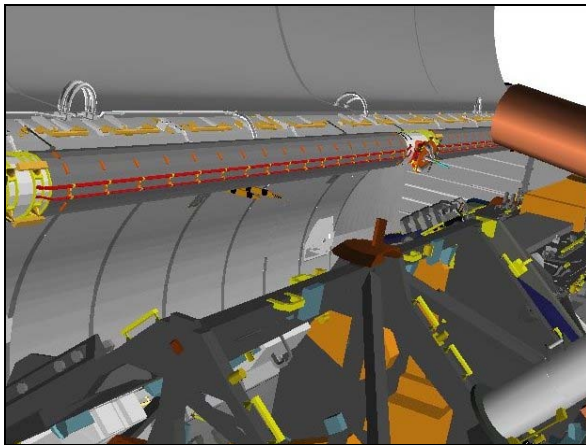
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1002	-2	-475	0	0	0	4
SY	SP	EP	WP	WY	WR	
-56.4	+72.4	-116.1	-110.7	+30.9	+186.1	

A7U

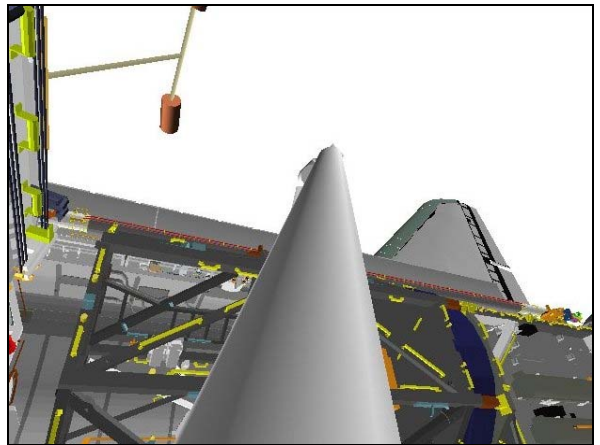
PL BAY FLOOD AFT (two) – ON

MID (two) – ON

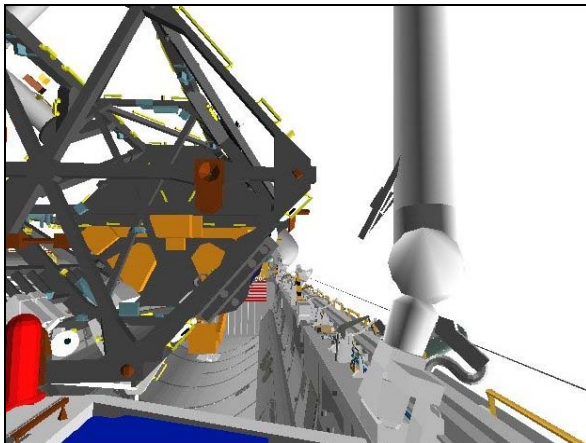
FWD (two) – ON



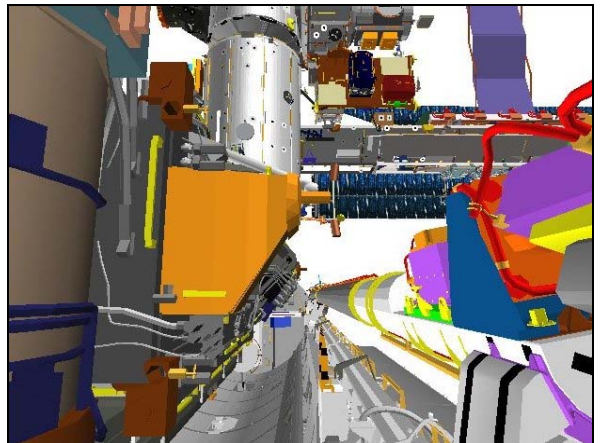
US LAB (-30,-30)



ELBOW (-5,-15)



CCTV A (5,5)



CCTV C (0,10)

9. MNVR TO ROLL POSN

MON 1	US Lab
MON 2	Elbow
DNLK	B
DTV	C

√RATE – VERN (RATE MIN tb-ON)

√BRAKES – OFF (tb-OFF)

√MODE – ORB LD

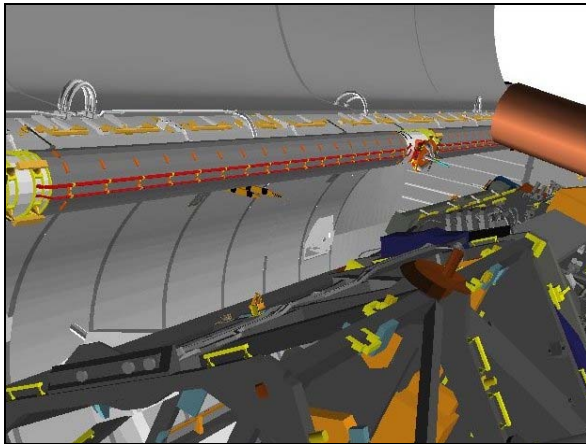
NOTE

At Roll posn, clearance between S3/S4 and aft port v-guide ~ 9 in.
Monitor clearance between S3/S4 and v-guides using Camera B

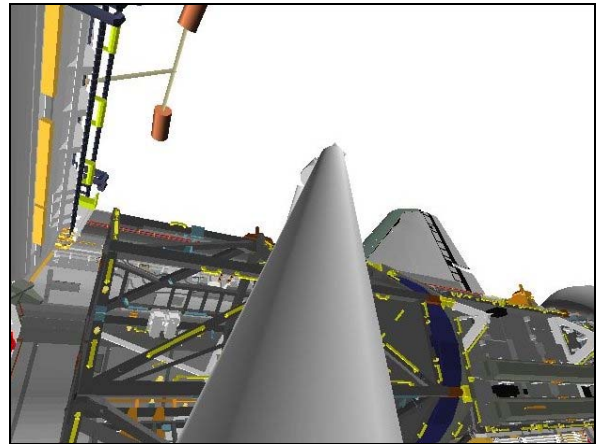
Mnvr to ROLL posn:

X	Y	Z	PITCH	YAW	ROLL	PL ID
-1002	-2	-475	0	0	15	4
SY	SP	EP	WP	WY	WR	
-54.4	+80.8	-118.4	-99.9	+27.8	+176.7	

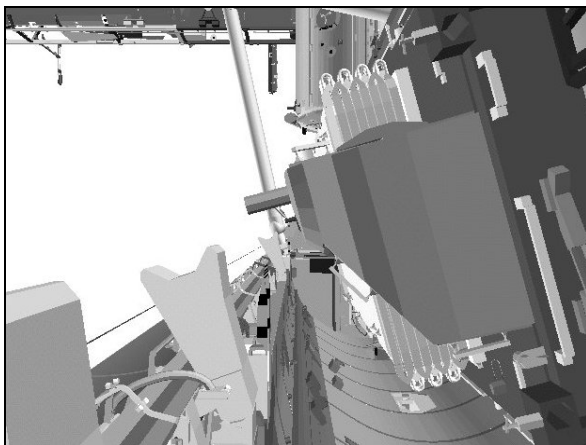
BRAKES – ON (tb-ON)



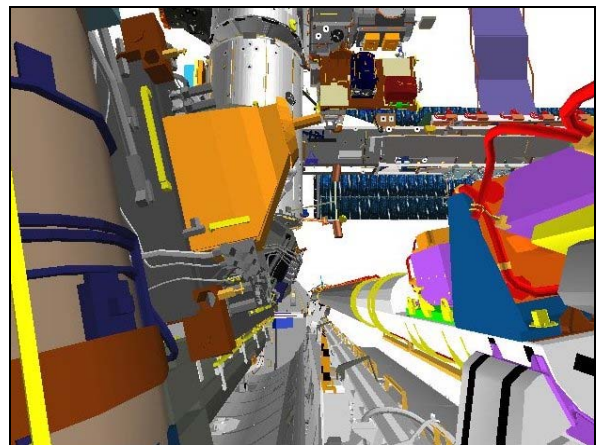
US LAB (-30,-30)



ELBOW (-5,-15)



CCTV B (0,0)



CCTV C (0,10)

10. MNVR TO TILT POSN

MON 1	P1LO
MON 2	Elbow
DNLK	B
DTV	C

SM 94 PDRS CONTROL

PL ID – ITEM 3 +5 EXEC

INIT ID – ITEM 24 +5 EXEC

√RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – ORB LD, ENTER

Mnvr to TILT posn:

X	Y	Z	PITCH	YAW	ROLL	PL ID
-725	-19	-539	22	0	15	5
SY	SP	EP	WP	WY	WR	
-60.2	+86.1	-116.0	-104.2	+41.2	+190.5	

BRAKES – ON (tb-ON)

If using ISS attitude control and attitude maintenance required:

√MCC

If using shuttle attitude control and attitude maintenance required:

DAP: LVLH

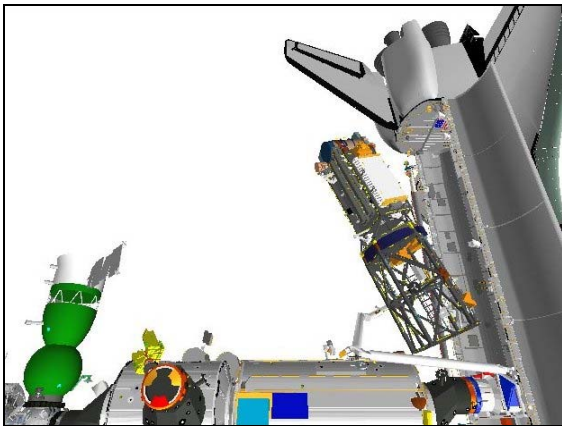
When rates damped:

DAP: FREE > 2 sec

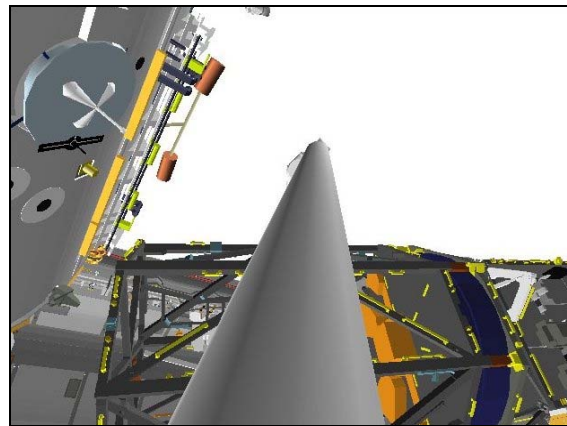
Then DAP: AUTO

When in attitude:

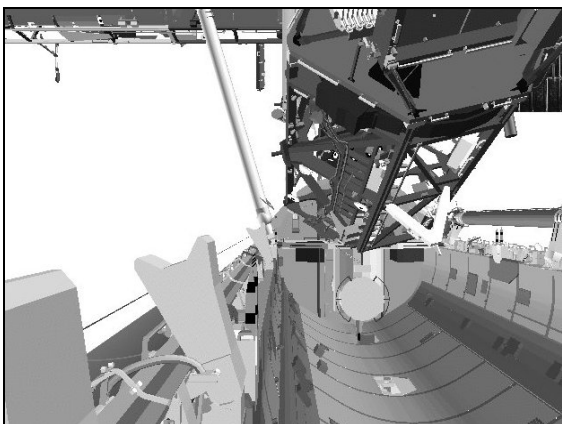
DAP: FREE



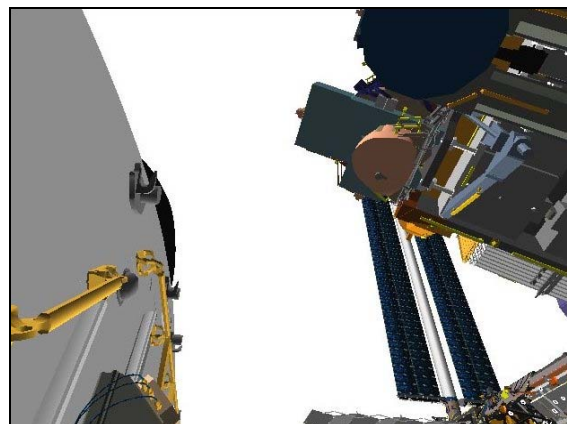
P1 LOWER OUTBOARD (90,30)



ELBOW (-5,-15)



CCTV B (0,0)



CCTV C (-80,45)

11. MNVR TO HIGH HOVER

MON 1	P1LO
MON 2	Elbow
DNLK	D
DTV	C

√RATE – VERN (RATE MIN tb-ON)
 BRAKES – OFF (tb-OFF)
 MODE – ORB LD, ENTER

NOTE

Monitor WP reach limit during maneuver to high hover posn

Mnvr to HIGH HOVER posn (within 2 in/1°):

X	Y	Z	PITCH	YAW	ROLL	PL ID
-785	-19	-603	22	0	15	5
SY	SP	EP	WP	WY	WR	
-52.3	+80.4	-95.9	-112.9	+46.4	+182.3	

BRAKES – ON (tb-ON)

If using ISS attitude control and attitude maintenance required:

√MCC

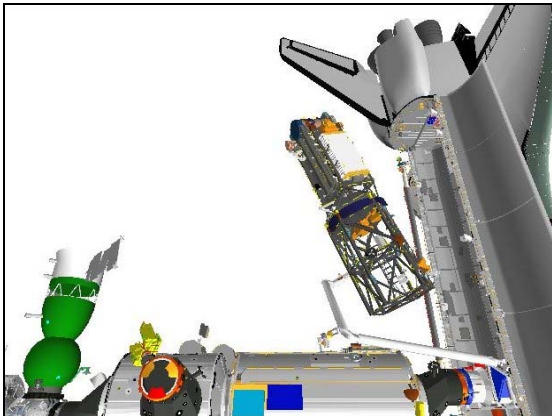
If using shuttle attitude control and attitude maintenance required:

DAP: LVLH

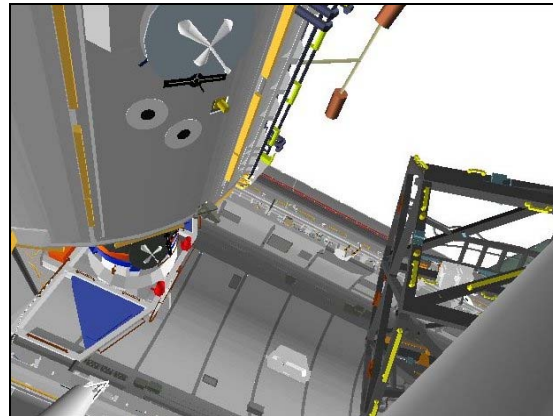
When rates damped:

DAP: FREE > 2 sec

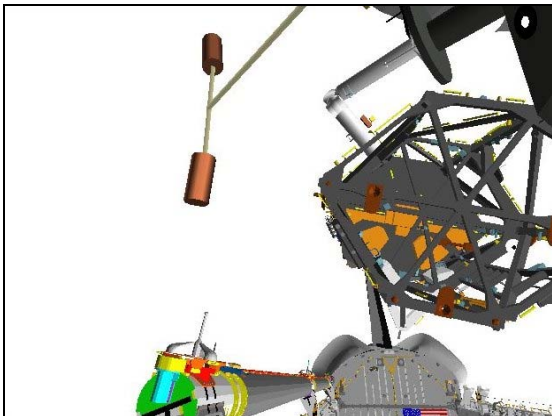
Then DAP: AUTO



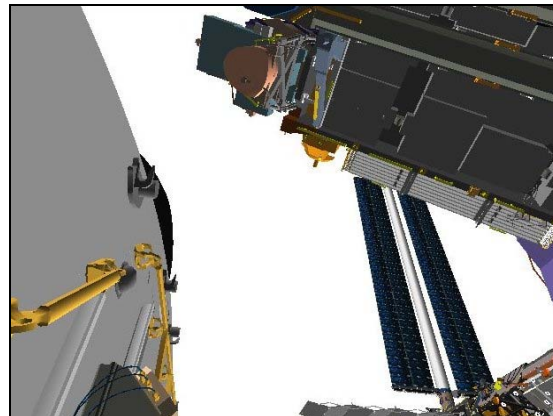
P1 LOWER OUTBOARD (90,30)



ELBOW (-50,-30)



CCTV D (-10,25)



CCTV C (-80,45)

S3/S4 HANDOFF

- A7U 1. SETUP
CCTV – config as reqd

MON 1	P1LO (S1LO)
MON 2	Elbow
DNLK	D
DTV	C

SM 94 PDRS CONTROL

PL ID – ITEM 3 +4 EXEC

INIT ID – ITEM 24 +4 EXEC

AUTO 1 – ITEM 13 +7 EXEC

If using shuttle attitude control:

√DAP: FREE

2. EXECUTE AUTO SEQUENCE

√RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – AUTO 1, ENTER

√START PT, ITEM 17: 148

√READY It – ON

AUTO SEQ – PROCEED (IN PROG It on)

Auto posn	X / SY	Y / SP	Z / EP	PITCH / WP	YAW / WY	ROLL / WR	PL ID
148	-1066	-2	-647	22	0	15	4
	-52.3	+80.4	-95.9	-112.9	+46.4	+182.3	
149	-1090	+90	-670	30	330	45	4
	-42.2	+88.9	-96.3	-70.7	+37.1	+113.4	
150	-1130	+120	-750	45	325	55	4
	-37.8	+79.0	-77.3	-61.8	+32.3	+94.5	
151	-1150	+230	-795	80	330	80	4
	-37.7	+56.1	-61.5	-27.9	+15.0	+78.4	
152	-1130	+275	-795	90	350	90	4
	-41.7	+41.5	-55.8	-4.7	+4.2	+88.4	
153	-1050	+355	-790	98	355	115	4
	-47.2	+30.3	-43.7	-6.4	-16.1	+86.6	
154	-939	+331	-834	90	359	177	4
	-49.2	+23.3	-21.6	-61.7	-71.6	+63.8	
155	-800	+375	-850	95	0	190	4
	-63.2	+23.3	-21.6	-61.7	-71.6	+63.8	

BRAKES – ON (tb-ON)

√MODE – not DIRECT

If using ISS attitude control and attitude maintenance required:

√MCC

If using shuttle attitude control and attitude maintenance required:

GNC 20 DAP CONFIG

Load DAP A15

Wait 30 seconds

DAP: LVLH

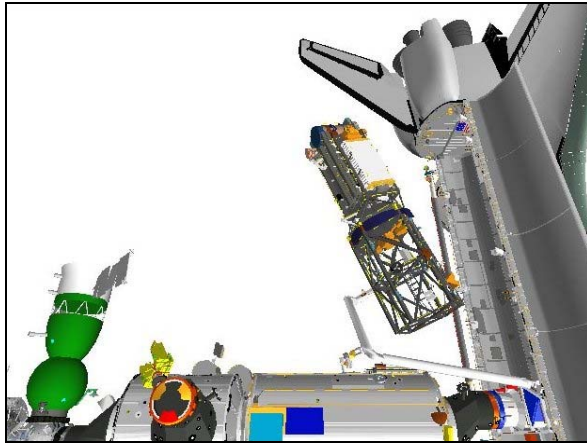
When rates damped:

DAP: FREE > 2 sec

Then DAP: AUTO

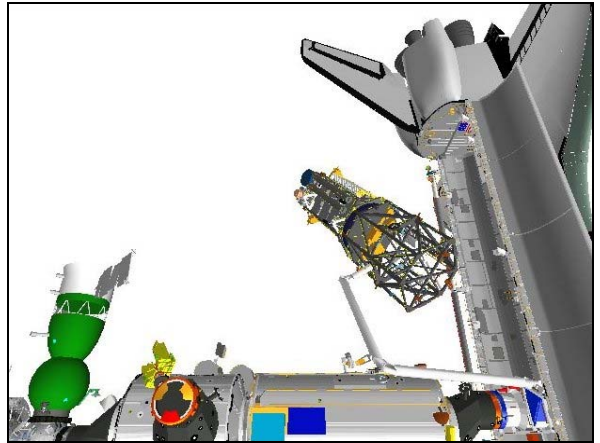
Notify SSRMS operator that S3/S4 is at HANDOFF posn with Brakes ON

Auto posn 148:

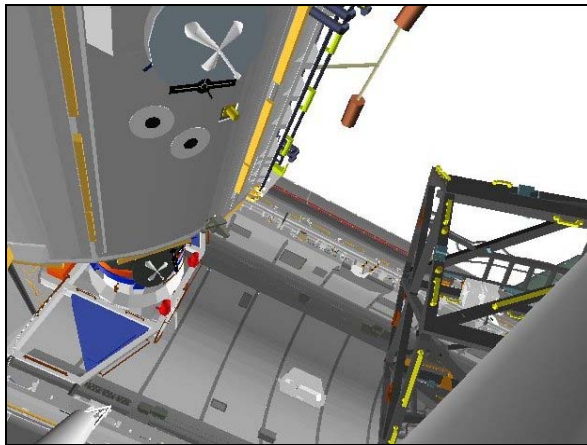


P1 LOWER OUTBOARD (90,30)

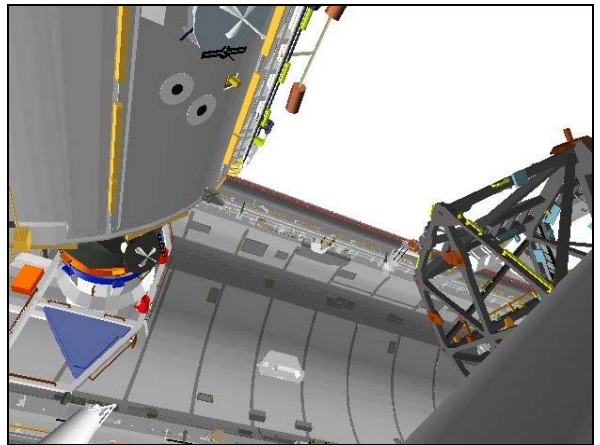
Auto posn 149:



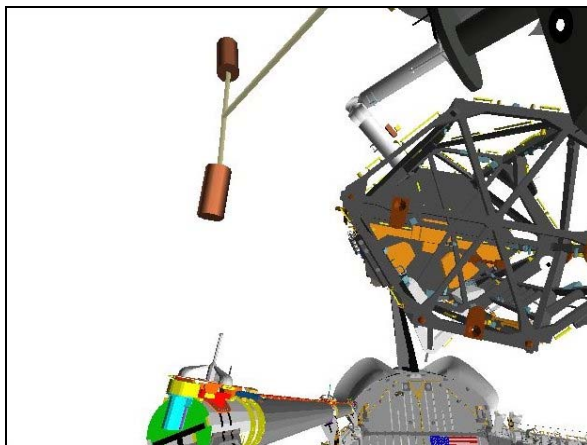
P1 LOWER OUTBOARD (90,30)



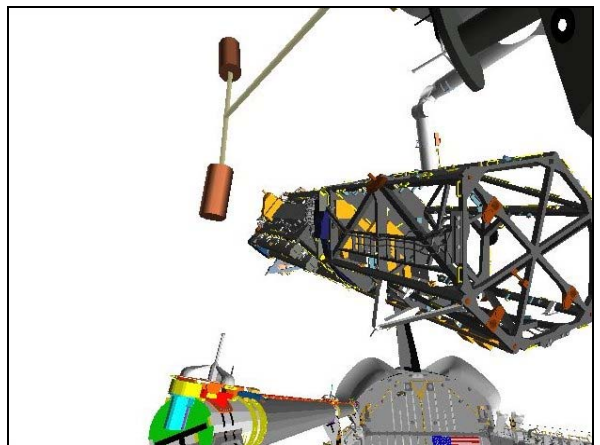
ELBOW (-50,-30)



ELBOW (-50,-30)

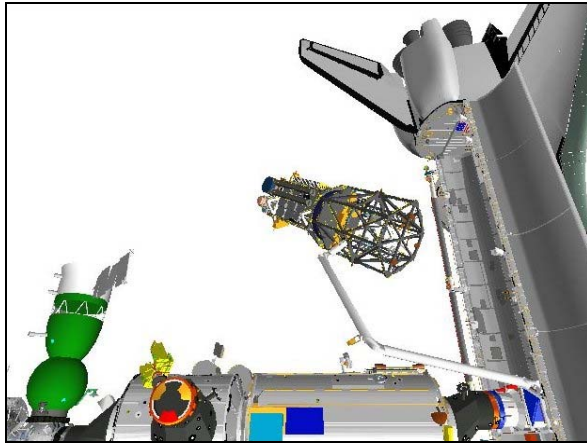


CCTV D (-10,25)



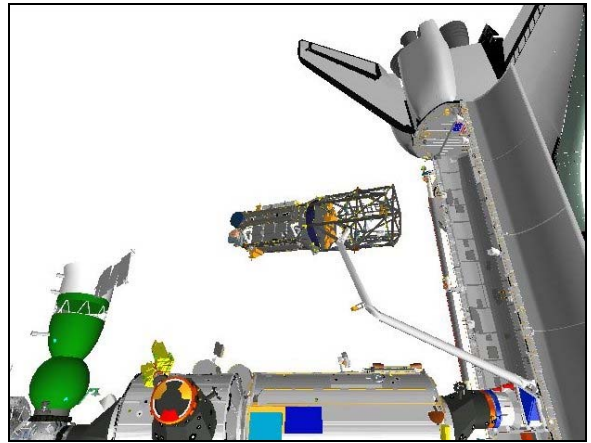
CCTV D (-10,25)

Auto posn 150:

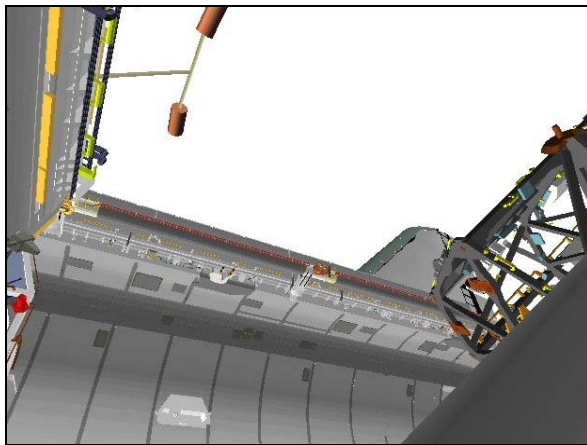


P1 LOWER OUTBOARD (90,30)

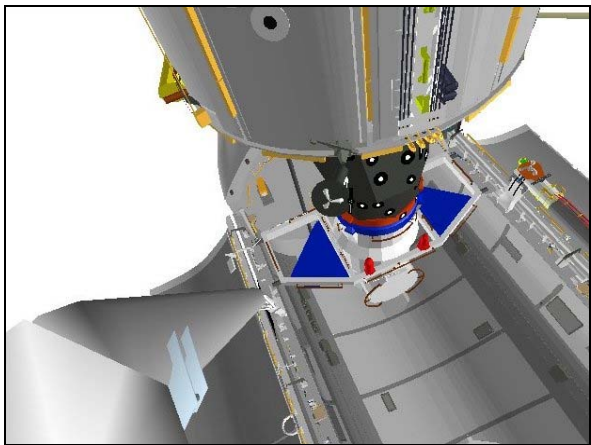
Auto posn 151:



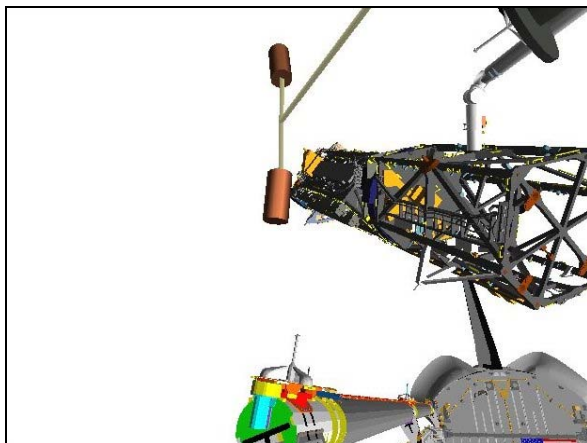
P1 LOWER OUTBOARD (90,30)



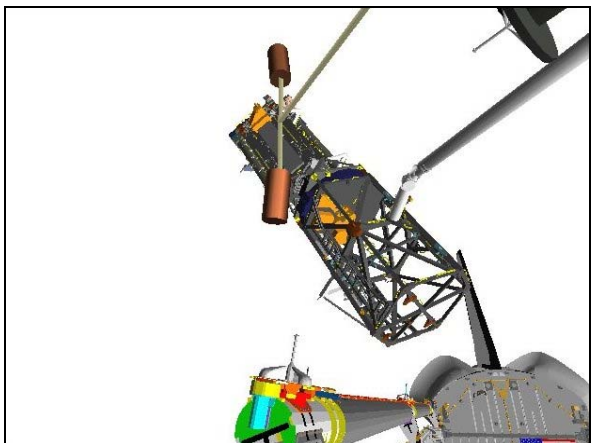
ELBOW (-50,-30)



ELBOW (-125,-30)

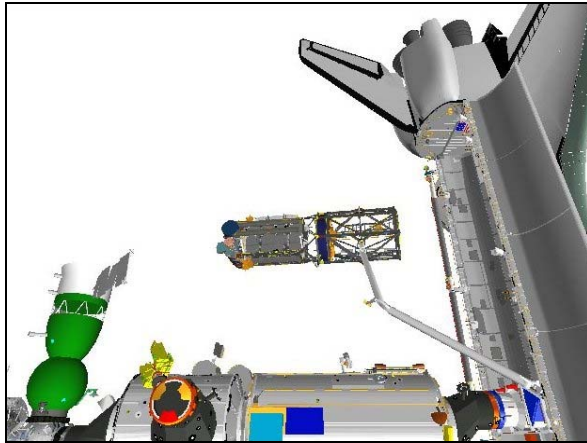


CCTV D (-20,25)



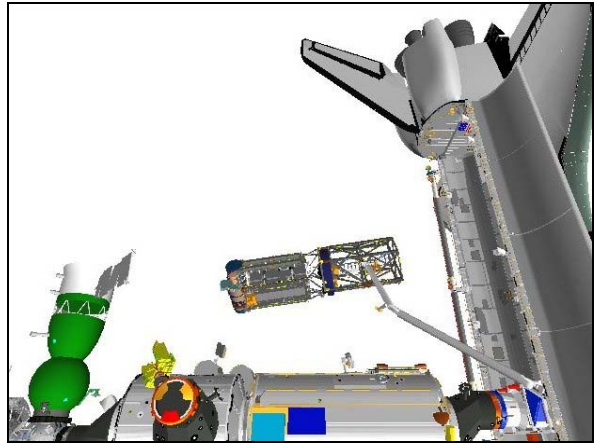
CCTV D (-20,25)

Auto posn 152:

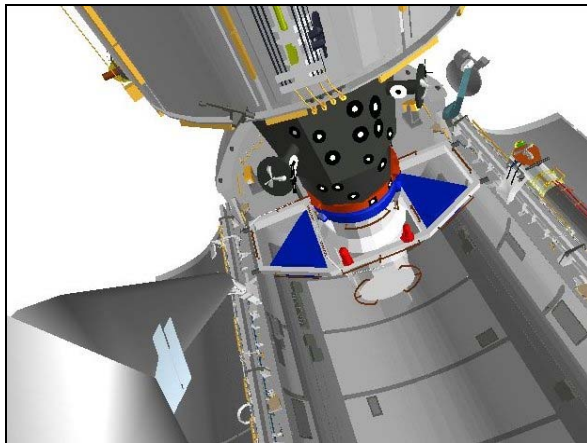


P1 LOWER OUTBOARD (90,30)

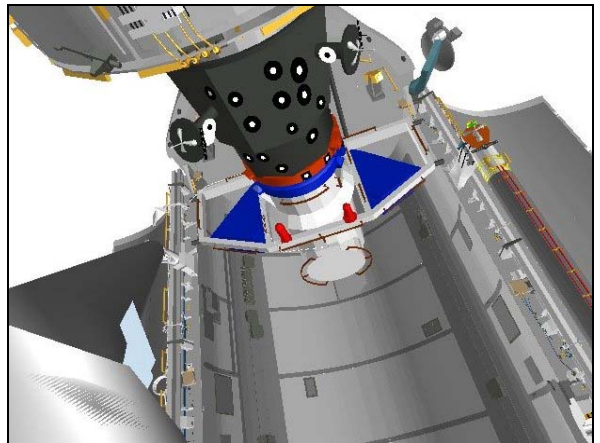
Auto posn 153:



P1 LOWER OUTBOARD (90,30)



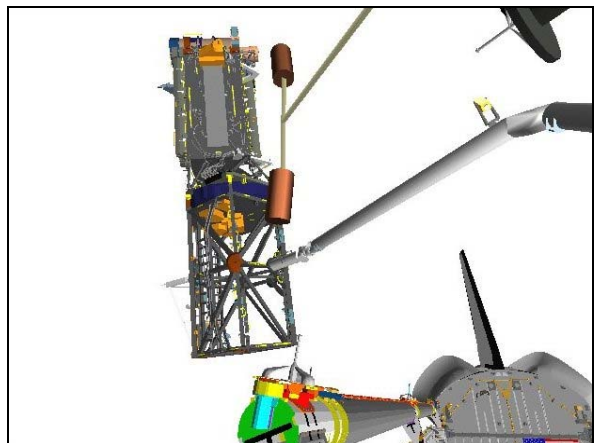
ELBOW (-125,-30)



ELBOW (-125,-30)

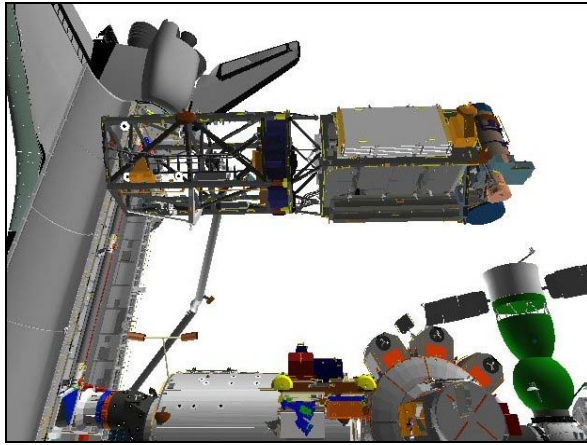


CCTV D (-20,25)



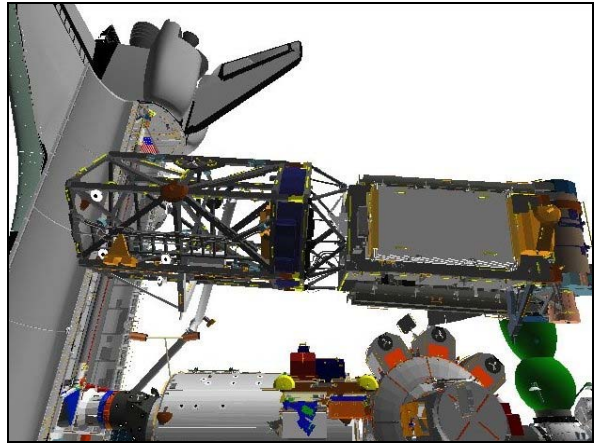
CCTV D (-20,25)

Auto posn 154:

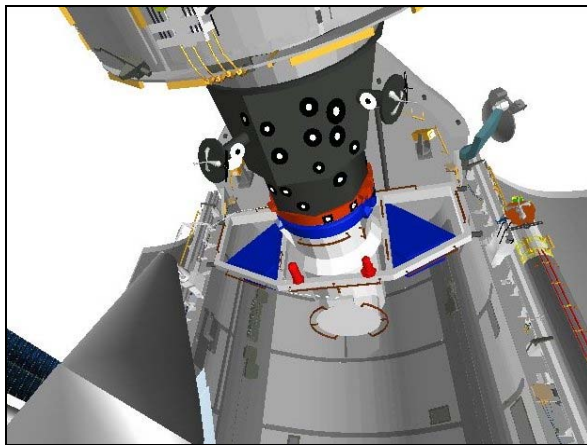


S1 LOWER OUTBOARD (90,30)

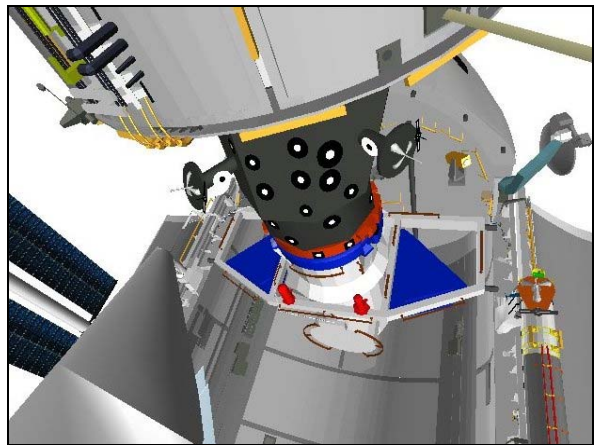
Auto posn 155:



S1 LOWER OUTBOARD (90,30)



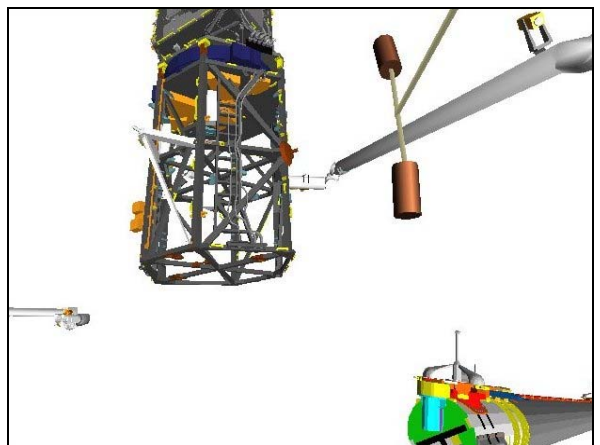
ELBOW (-145,-15)



ELBOW (-145,-15)



CCTV D (-40,25)



CCTV D (-40,25)

S3/S4 UNGRAPPLE

- A7U 1. SETUP
CCTV – RMS WRIST, zoom 34.0 HFOV
focus 5 ft

MON 1	S1LO
MON 2	A
DNLK	Wrist
DTV	D

SM 94 PDRS CONTROL
PL ID – ITEM 3 +0 EXEC
INIT ID – ITEM 24 +0 EXEC

2. S3/S4 UNGRAPPLE
On SSRMS operator GO to ungrapple:

NOTE

CONTR ERR It and 'S96 PDRS CNTL' msg may occur due to Consistency/Envelope Check error

RATE – COARSE (RATE MIN tb-OFF)

SM 94 PDRS CONTROL
AUTO BRAKE INH – ITEM 10 EXEC (*)

BRAKES – OFF (tb-OFF)

MODE – TEST, ENTER
Wait 5 sec

BRAKES – ON (tb-ON)

SM 94 PDRS CONTROL
AUTO BRAKE ENA – ITEM 9 EXEC (*)

RATE – VERN (RATE MIN tb-ON)
BRAKES – OFF (tb-OFF)
MODE – END EFF, ENTER

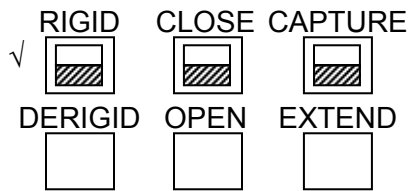
CAUTION

Monitor EE tb timing to prevent EE motor burnout

NOTE

When OPEN tb – gray, mnvr arm clear of S3/S4 GF.
Back off until SY approx -56.0°

EE MODE – AUTO
RELEASE sw – depress (mom)



CRITICAL TIMES (28 sec total):
 DERIGID tb – gray, 5 sec max, then
 OPEN tb – gray, 3 sec max, then
 EXTEND tb – gray, 20 sec max

- * If manual release reqd: *
- * EE MODE – MAN *
- * MAN CONTR – DERIGID (hold until DERIGID *
- tb-gray, 5 sec max) *
- * RELEASE sw – depress (hold until OPEN tb-gray, *
- 3 sec max) *
- * *
- * Mnv r arm clear, then *
- * EE MAN CONTR – DERIGID (hold until EXTEND *
- tb-gray, 20 sec max) *

EE MODE – OFF

BRAKES – ON (tb-ON)

If using ISS attitude control and attitude maintenance required:

√MCC

If using shuttle attitude control and attitude maintenance required:

DAP: LVLH

When rates damped:

DAP: FREE > 2 sec

Then DAP: AUTO

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OFF-NOMINAL S3/S4 OPS

S3/S4 SJ GRAPPLE	FS 2-2
UNBERTH.....	FS 2-8
UNGRAPPLE.....	FS 2-15
CONTINGENCY REBERTH	FS 2-17

**OFF-NOMINAL
S3/S4 OPS**

S3/S4 SJ GRAPPLE

1. SETUP
 A7U CCTV – perform PAN/TILT RESET
 – fully zoom out for SJ pictures
 – config for grapple
 – install PDRS TARGET OVERLAY FOR CTVM
 – RMS WRIST, zoom 34.0 HFOV
 focus 5 ft

Maintain eyepoint ~18 in when using grapple overlay

MON 1	P1LO
MON 2	A (D)
DNLK	Elbow
DTV	C

SM 94 PDRS CONTROL

- √PL ID, ITEM 3: 0
- √INIT ID, ITEM 24: 0

CAUTION
 Payload Bay Flood Lights must be OFF
 until S3/S4 trunnions are clear of v-guides

2. SJ MNVR TO PRE-GRAPPLE
 PARAM – Joint Angle
 If SINGLE MODE available:
 RATE – VERN (RATE MIN tb-ON)
 BRAKES – OFF (tb-OFF)
 MODE – best available

NOTE

At pre-grapple posn, clearance between SRMS and US Lab ~ 29 in.
 Monitor clearance between SRMS and US Lab using Elbow camera.
 Monitor WP reach limit during maneuver to pre-grapple posn

Mnvr to PRE-GRAPPLE posn:

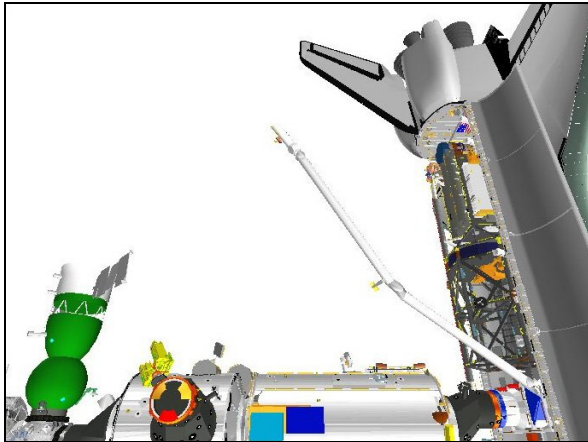
	SY	SP	EP	WP	WY	WR	
Pre-cradle	0.0	+25.0	-25.0	+5.0	0.0	0.0	
1: SP +		+60.7					
2: SY -	-60.3						
3: EP -			-108.8				
4: WP -				-107.5			
5: WY +					+27.4		
6: WR +						+188.7	
Pre-grapple	-60.3	+60.7	-108.8	-107.5	+27.4	+188.7	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-829	+95	-501	270	49	91	0

- If SINGLE MODE:
 BRAKES – ON (tb-ON)
 MODE – not DIRECT

OFF-NOMINAL
S3/S4 OPS

Step 1:

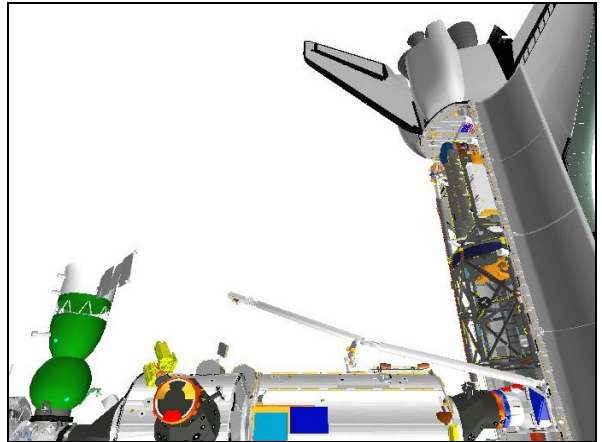
Drive SP+ (for 35.7°)
From +25.0° to +60.7°



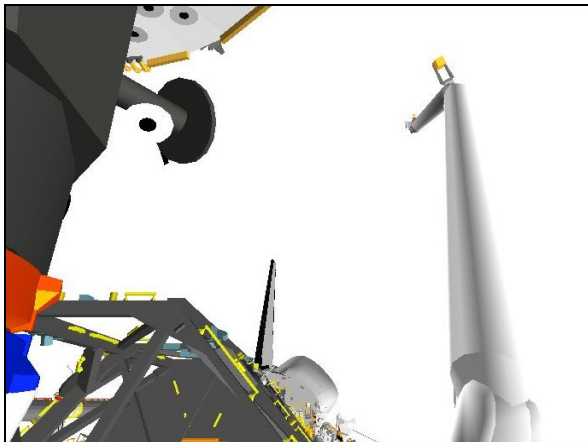
P1 LOWER OUTBOARD (90,30)

Step 2:

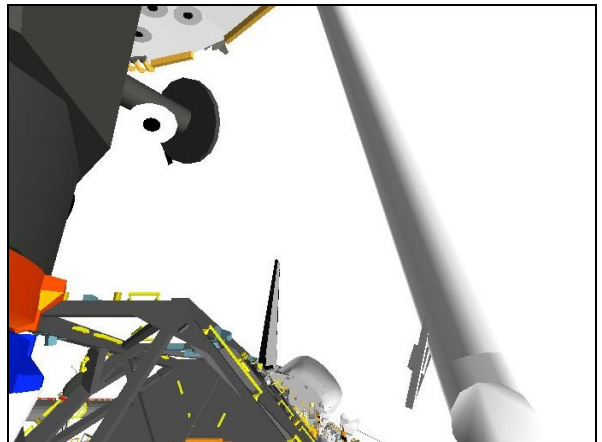
Drive SY- (for 60.3°)
From 0.0 to -60.3°



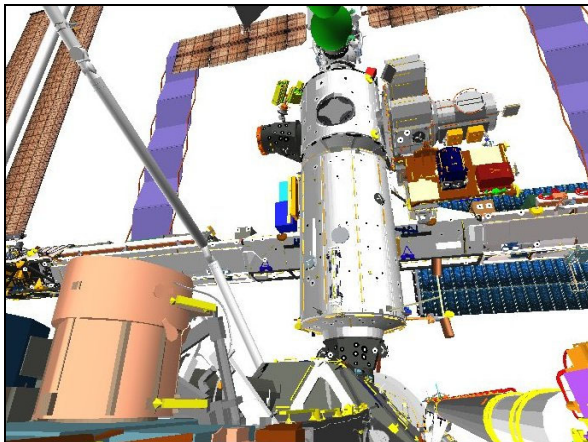
P1 LOWER OUTBOARD (90,30)



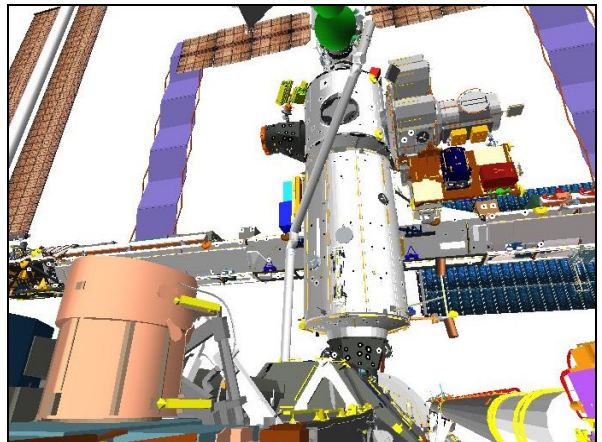
CCTV A (0,25)



CCTV A (0,25)



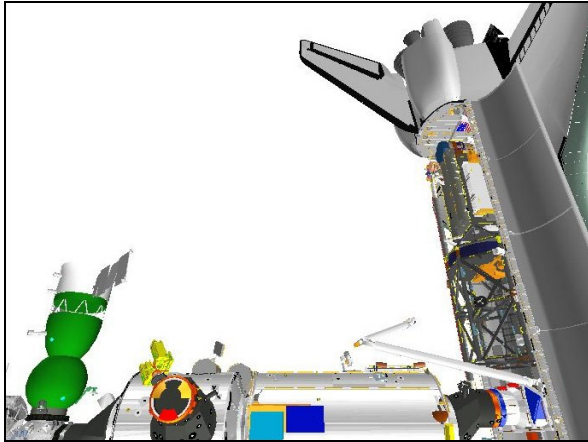
CCTV C (-15,25)



CCTV C (-15,25)

Step 3:

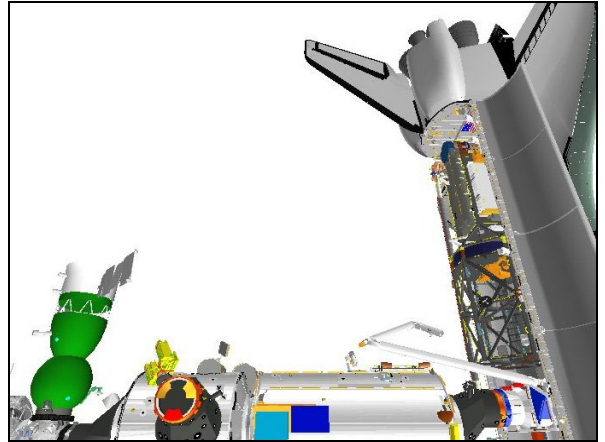
Drive EP- (for 83.8°)
From -25.0° to -108.8°



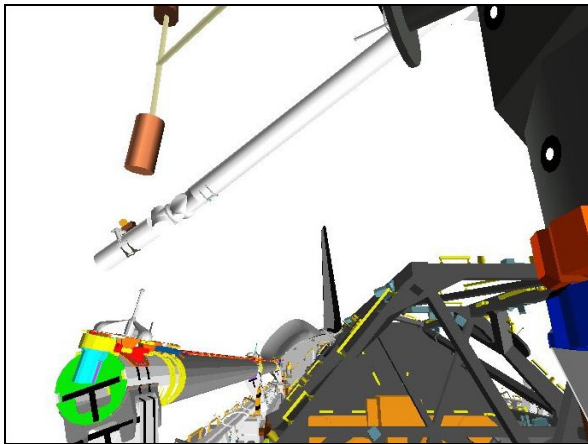
P1 LOWER OUTBOARD (90,30)

Step 4:

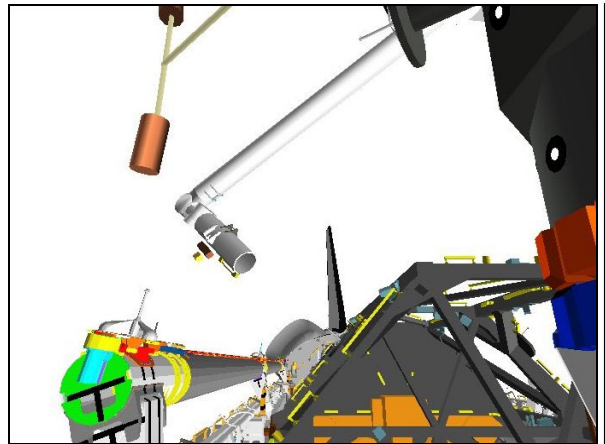
Drive WP- (for 112.5°)
From +5.0° to -107.5°



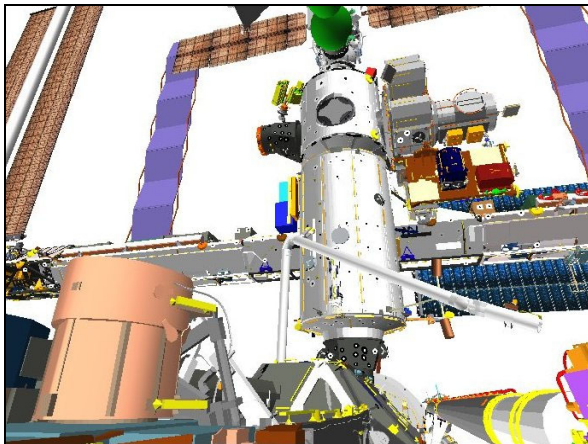
P1 LOWER OUTBOARD (90,30)



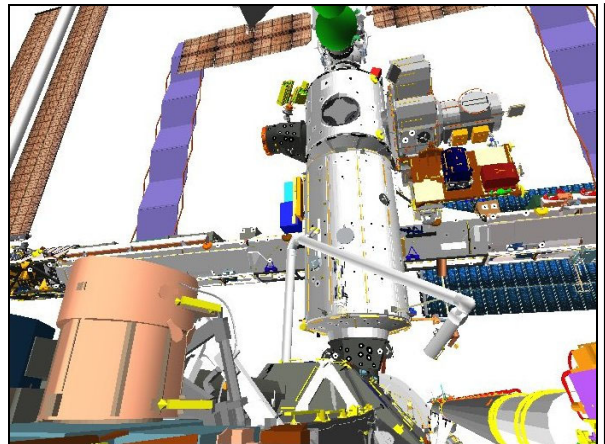
CCTV D (0,20)



CCTV D (0,20)



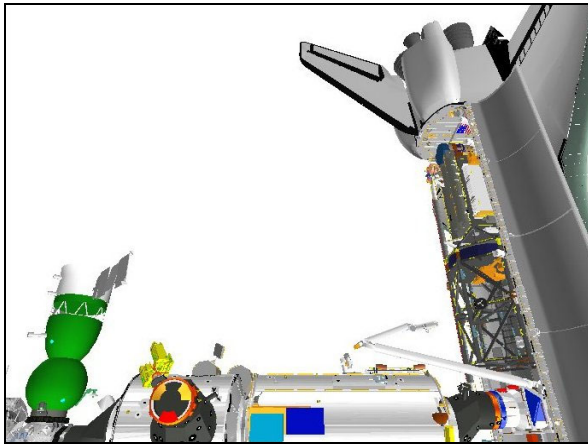
CCTV C (-15,25)



CCTV C (-15,25)

Step 5:

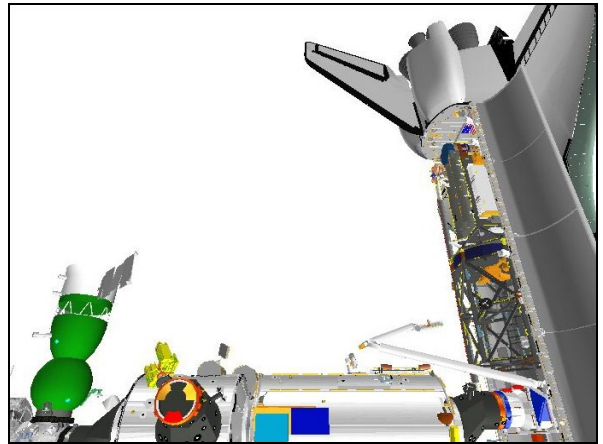
Drive WY+ (for 27.4°)
From 0.0° to +27.4°



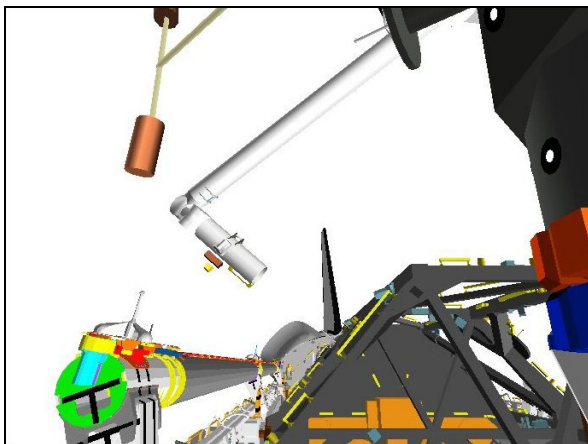
P1 LOWER OUTBOARD (90,30)

Step 6:

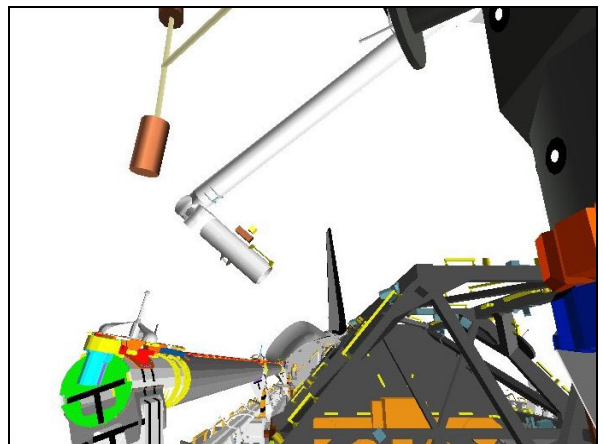
Drive WR+ (for 188.7°)
From 0.0° to +188.7°



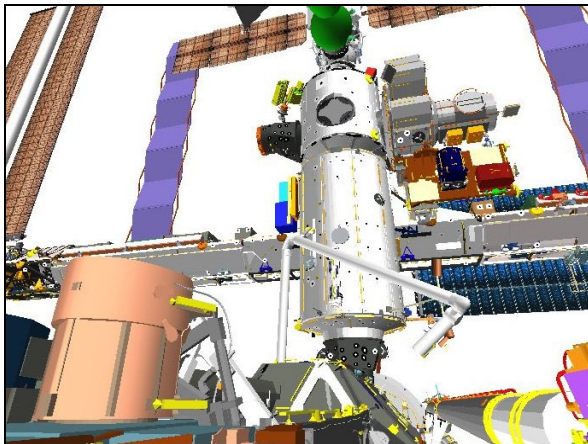
P1 LOWER OUTBOARD (90,30)



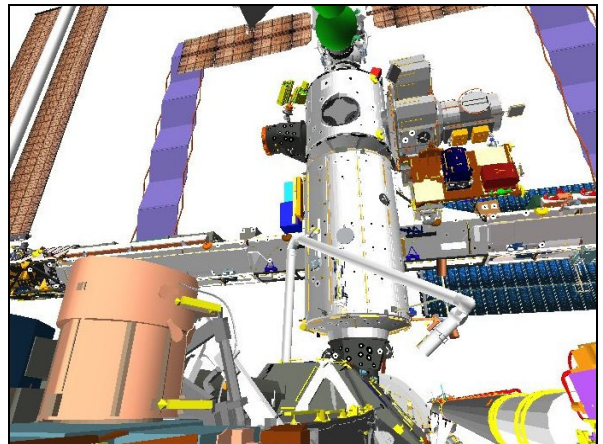
CCTV D (0,20)



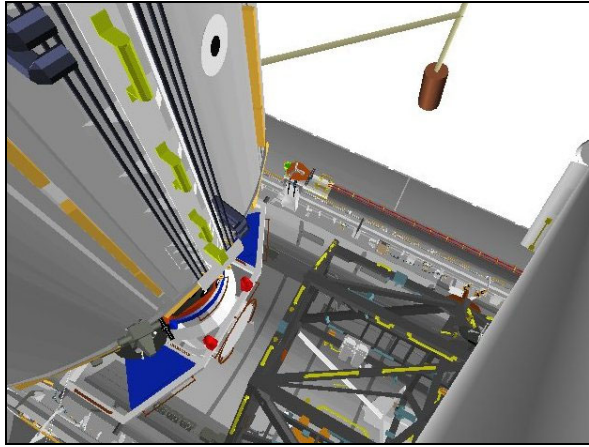
CCTV D (0,20)



CCTV C (-15,25)



CCTV C (-15,25)



ELBOW (-40,-20)

3. SJ MNVR TO S3/S4 GRAPPLE

√CCTV – config for grapple

MON 1	P1LO
MON 2	D
DNLK	Wrist
DTV	A

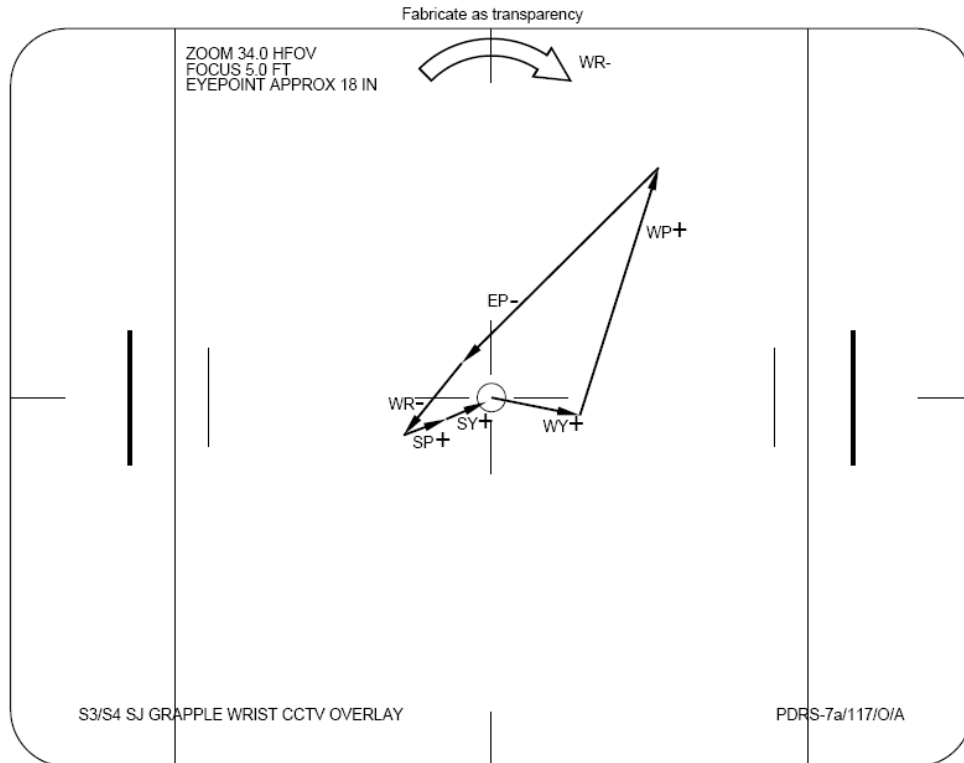
If SINGLE MODE available:

√RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – best available

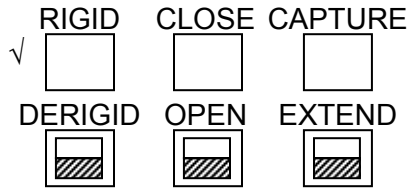
Drive joints per S3/S4 SJ GRAPPLE WRIST CCTV OVERLAY and diagram until EE within grapple envelope



4. S3/S4 GRAPPLE

CAUTION
Monitor EE tb timing to prevent EE motor burnout

EE MODE – AUTO (if available)
CAPTURE sw – depress (mom)



CRITICAL TIMES (28 sec total):
CAPTURE tb – gray, then
CLOSE tb – gray, 3 sec max, then
RIGID tb – gray, 25 sec max

- * If manual grapple reqd: *
- * EE MODE – MAN *
- * CAPTURE sw – depress (hold until CLOSE tb-gray, 3 sec max) *
- * MAN CONTR – RIGID (hold until RIGID tb-gray, 25 sec max) *

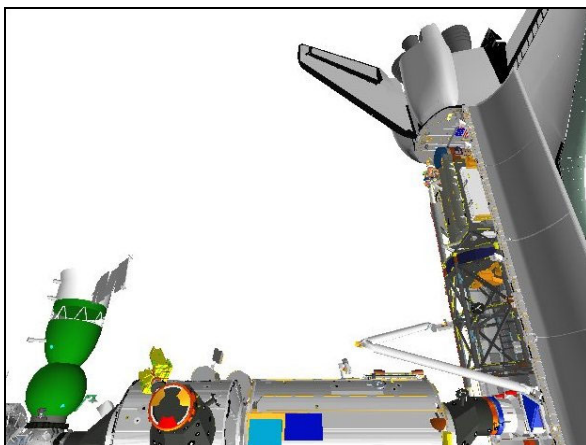
EE MODE – OFF

If SINGLE MODE:
BRAKES – ON (tb-ON)
MODE – not DIRECT

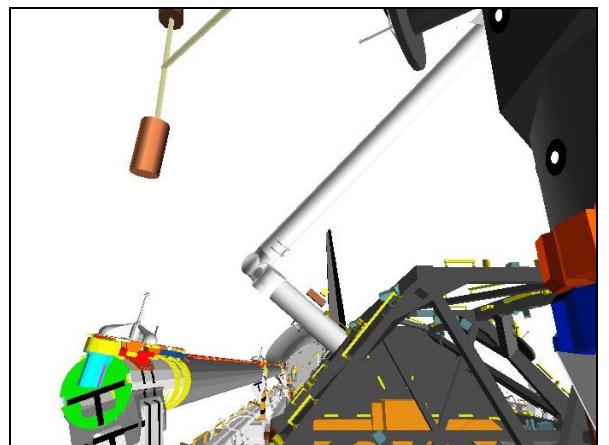
SM 94 PDRS CONTROL
PL ID, ITEM 3 +4 EXEC
INIT ID, ITEM 24 +4 EXEC

Record POS/ATT and Joint Angles:

	X	Y	Z	PITCH	YAW	ROLL	PL ID
							4
Expected	-1002	0	-414	0	0	0	4
	SY	SP	EP	WP	WY	WR	
Expected	-54.1	+63.7	-121.1	-96.4	+33.0	+185.0	



P1 LOWER OUTBOARD (90,30)



CCTV D (0,20)

Record POS/ATT and Joint Angles in P3/P4 CONTINGENCY REBERTH

Review GENERIC END EFFECTOR CUE CARD – ISS/SHUTTLE DOCKED OPS

S3/S4 SJ UNBERTH

1. SETUP

Perform S3/S4 UNBERTH, steps 1-5 (NOMINAL S3/S4 OPS)

2. SJ UNBERTH

If SINGLE MODE available:

RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – best available

Mnvr S3/S4 up until unconstrained

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

Drive joint per SJ S3/S4 UNBERTH JOINT ANGLE HISTOGRAM until Z = -462

SJ S3/S4 UNBERTH JOINT ANGLE TABLE (reference only)

ΔSY	ΔSP	ΔEP	ΔWP	ΔWY	ΔWR
-1.8	+7.2	+3.5	-11.3	-1.6	+0.9

Δz	z	SY	SP	EP	WP	WY	WR
Fully Berthed	-414	-54.1	+63.7	-121.1	-96.4	+33.0	+185.0
2	-416	-54.2	+64.0	-121.0	-96.9	+32.9	+185.0
4	-418	-54.3	+64.4	-120.9	-97.3	+32.9	+185.1
6	-420	-54.3	+64.7	-120.8	-97.8	+32.8	+185.1
8	-422	-54.4	+65.0	-120.7	-98.3	+32.7	+185.2
10	-424	-54.5	+65.4	-120.5	-98.8	+32.7	+185.2
12	-426	-54.6	+65.7	-120.4	-99.2	+32.6	+185.2
14	-428	-54.6	+66.0	-120.3	-99.7	+32.5	+185.3
16	-430	-54.7	+66.3	-120.2	-100.2	+32.5	+185.3
18	-432	-54.8	+66.6	-120.0	-100.7	+32.4	+185.4
20	-434	-54.9	+67.0	-119.9	-101.1	+32.3	+185.4
22	-436	-54.9	+67.3	-119.7	-101.6	+32.2	+185.4
24	-438	-55.0	+67.6	-119.6	-102.1	+32.2	+185.5
31	-445	-55.3	+68.6	-119.1	-103.7	+31.9	+185.6
38	-452	-55.5	+69.6	-118.5	-105.4	+31.7	+185.7
45	-459	-55.8	+70.5	-117.9	-107.0	+31.5	+185.9
48-in Hover	-462	-55.9	+70.9	-117.6	-107.7	+31.4	+185.9

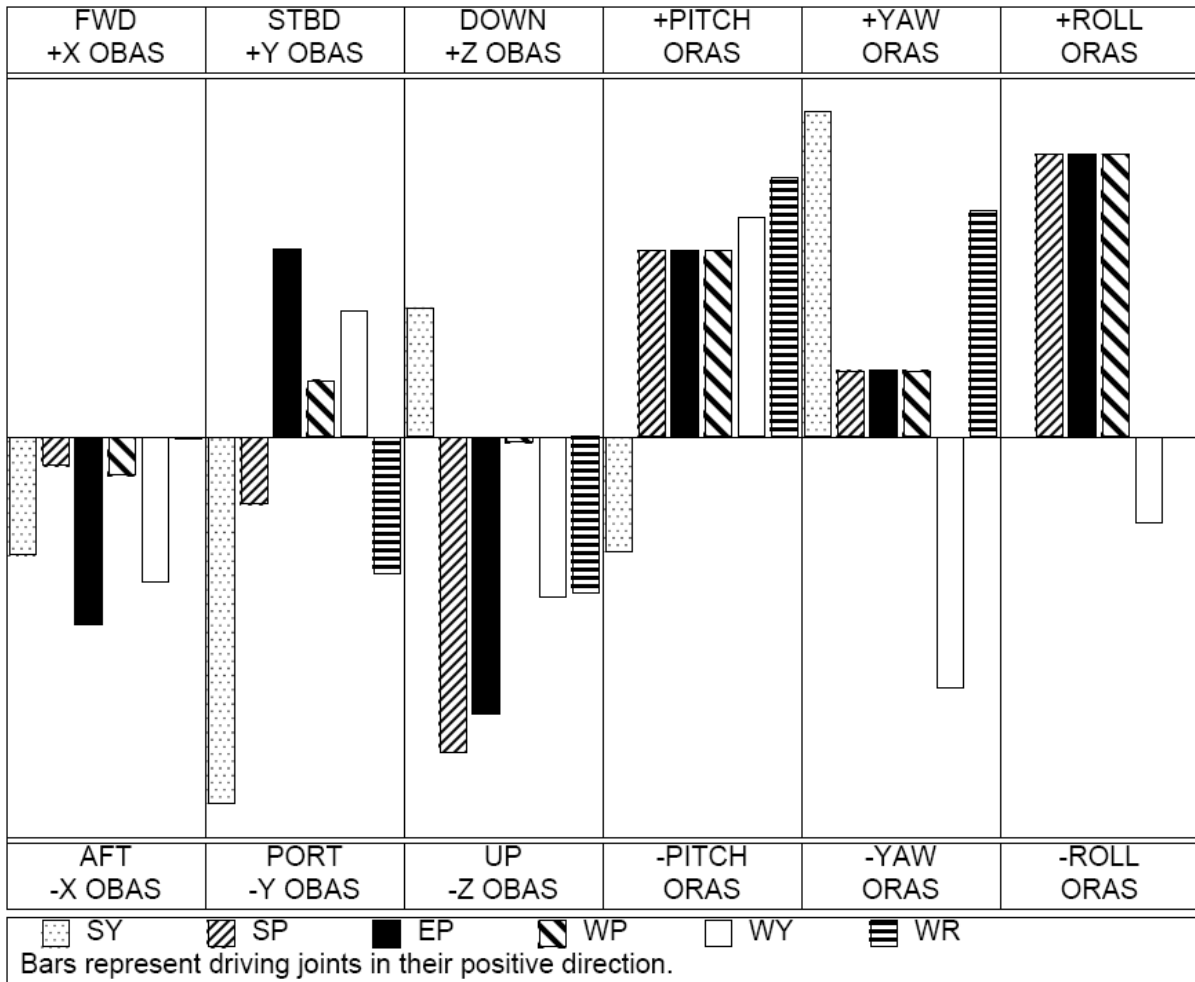
A7U

PL BAY FLOOD AFT (two) – ON

MID (two) – ON

FWD (two) – ON

SJ S3/S4 UNBERTH JOINT ANGLE HISTOGRAM



To get:	Drive:	To get:	Drive:
+X (fwd)	-EP, -WY	+PITCH	+WR, +WY
+Y (stbd)	-SY, +EP	+YAW	+SY, -WY
+Z (down)	-SP, -EP	+ROLL	+WP, +SP

Driving:	Results In:	Driving:	Results In:
+SY	-Y (port), +YAW	+WP	+Y (stbd), +ROLL
+SP	-Z (up), +ROLL	+WY	-Z (up), -YAW
+EP	-Z (up), +ROLL	+WR	-Z (up), +PITCH

ΔSY	ΔSP	ΔEP	ΔWP	ΔWY	ΔWR
-1.8	+7.2	+3.5	-11.3	-1.6	+0.9

JOINT ORDER
+SP
-WP
+EP
-SY

Correct -WY, +WR as needed

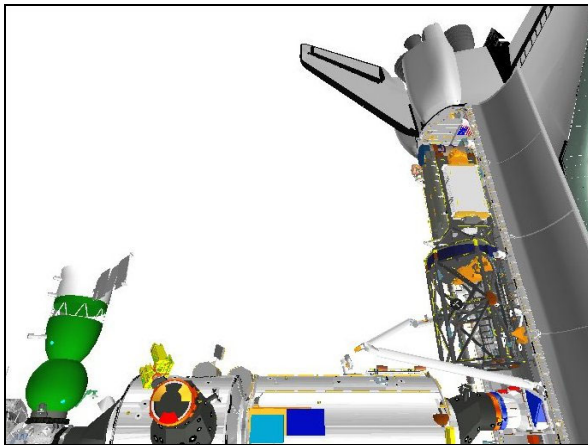
3. MNVR TO HANDOFF

MON 1	P1LO (US Lab)
MON 2	C (B)
DNLK	Elbow
DTV	D

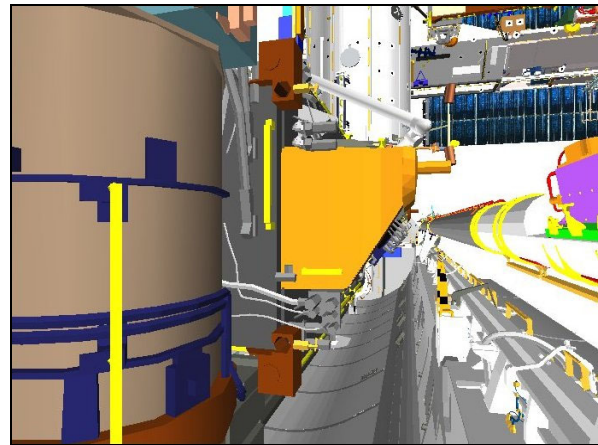
If SINGLE MODE available:
 RATE – VERN (RATE MIN tb-ON)
 BRAKES – OFF (tb-OFF)
 MODE – best available

Mnvr to S3/S4 HANDOFF posn:

	SY	SP	EP	WP	WY	WR	
48-in hover	-55.9	+70.9	-117.6	-107.7	+31.4	+185.9	
1: SP +		+78.0					
2: EP +			-21.6				
3: SP –		+38.0					
4: WP +				-61.7			
5: WY –					-71.6		
6: SP –		+23.3					
7: WR –						+63.8	
8: SY –	-63.2						
Handoff	-63.2	+23.3	-21.6	-61.7	-71.6	+63.8	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-800	+375	-850	95	0	190	4



P1 LOWER OUTBOARD (90,30)



CCTV C (-15,0)

If SINGLE MODE:
 BRAKES – ON (tb-ON)
 MODE – not DIRECT

If using ISS attitude control and attitude maintenance required:
 √MCC

If using shuttle attitude control and attitude maintenance required:

GNC 20 DAP CONFIG

Load DAP A15

Wait 30 seconds

DAP: LVLH

When rates damped:

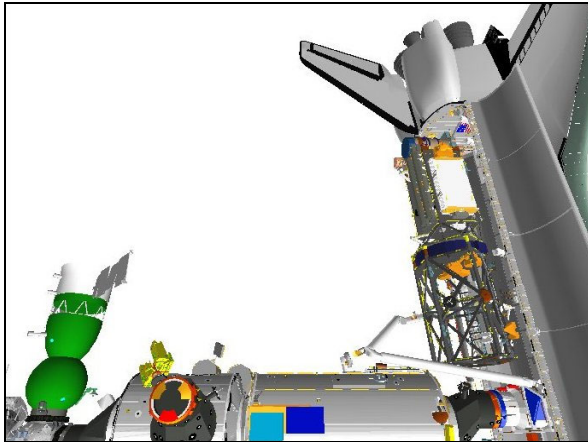
DAP: FREE > 2 sec

Then DAP: AUTO

Notify SSRMS operator that S3/S4 is at the Handoff posn with Brakes ON

Step 1:

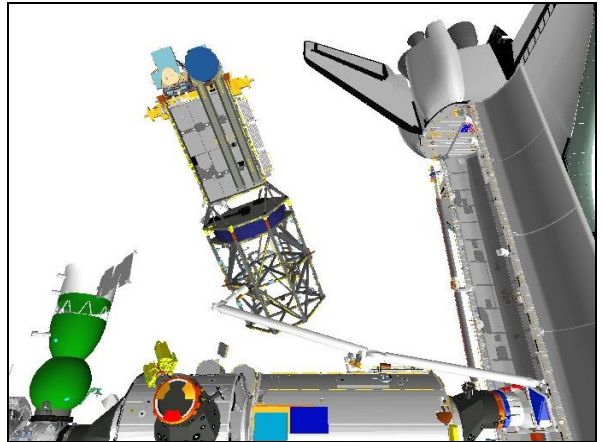
Drive SP+ (for 7.1°)
From +70.9° to +78.0°



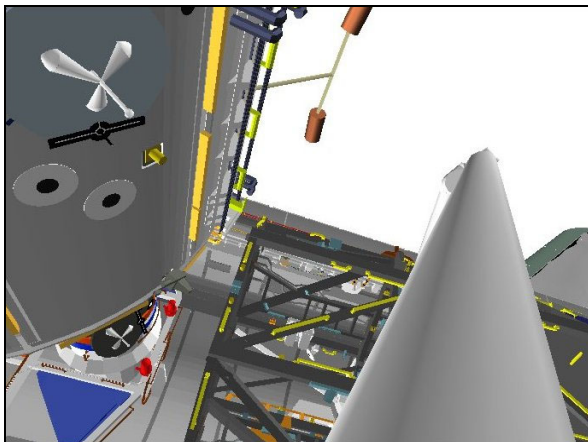
P1 LOWER OUTBOARD (90,30)

Step 2:

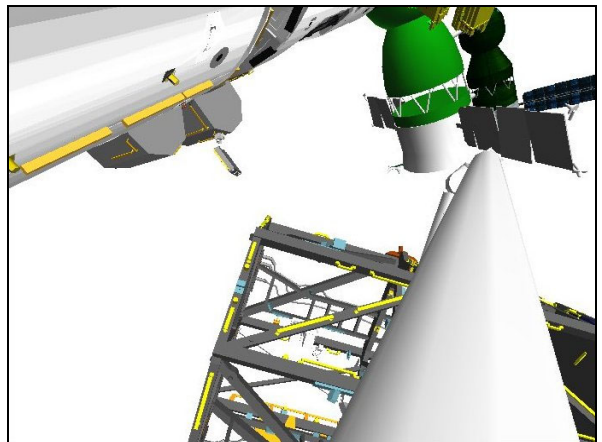
Drive EP- (for 96.0°)
From -117.6° to -21.6°



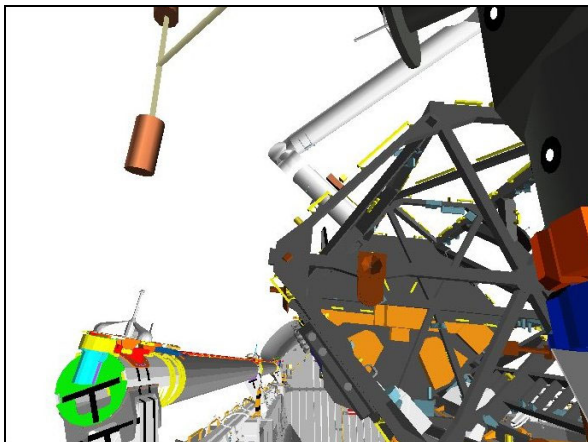
P1 LOWER OUTBOARD (90,30)



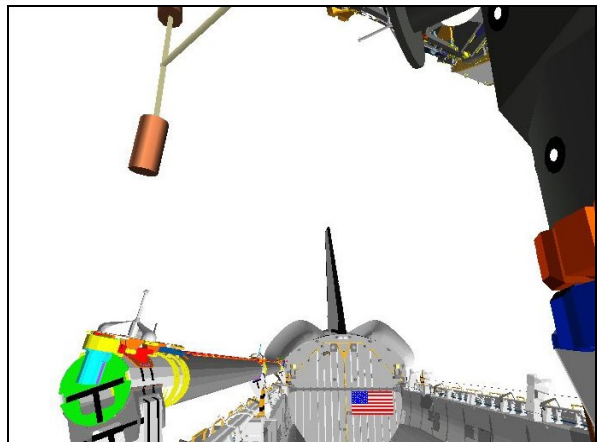
ELBOW (-25,-15)



ELBOW (-25,-15)



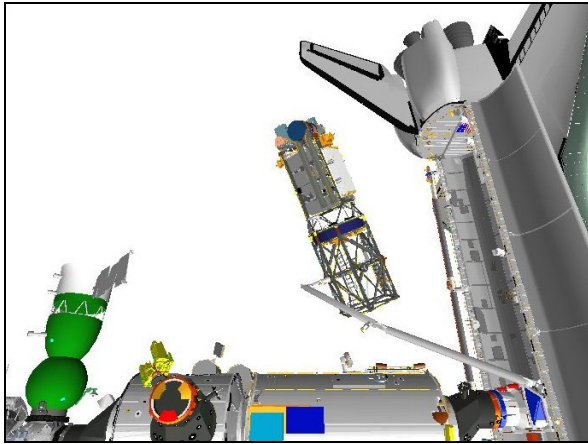
CCTV D (0,20)



CCTV D (0,20)

Step 3:

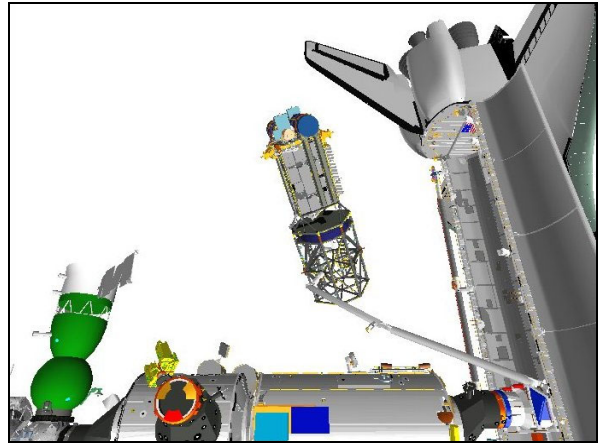
Drive SP- (for 40.0°)
From +78.0° to +38.0°



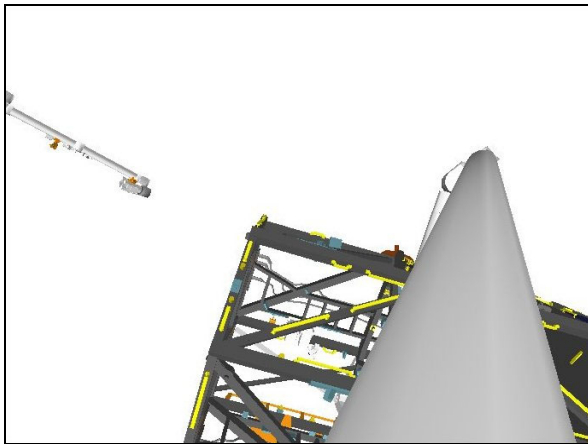
P1 LOWER OUTBOARD (90,30)

Step 4:

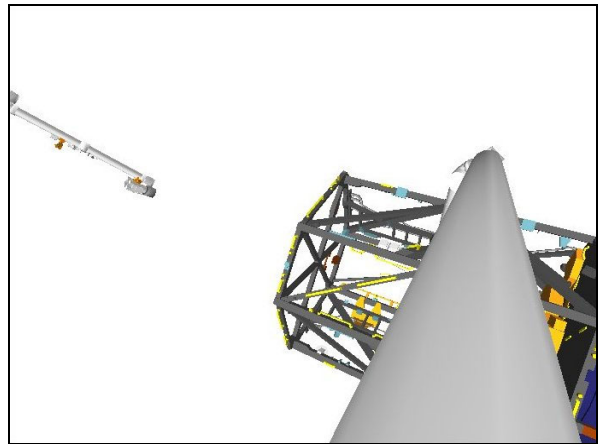
Drive WP- (for 46.0°)
From -107.7° to -61.7°



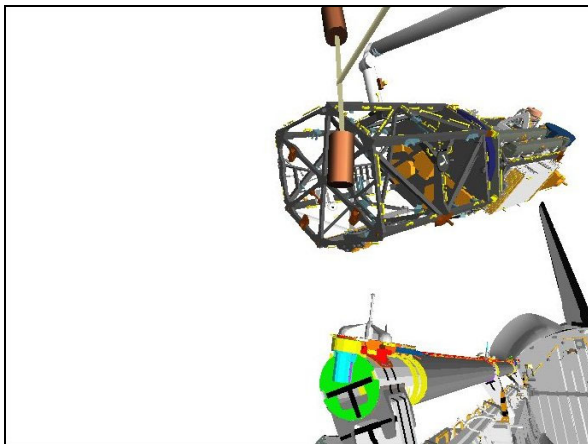
P1 LOWER OUTBOARD (90,30)



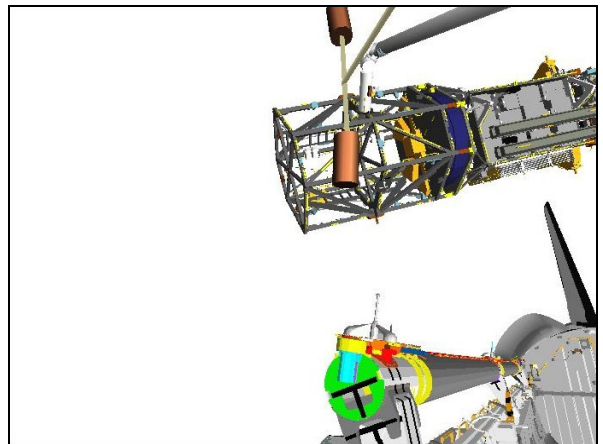
ELBOW (-25,-15)



ELBOW (-25,-15)



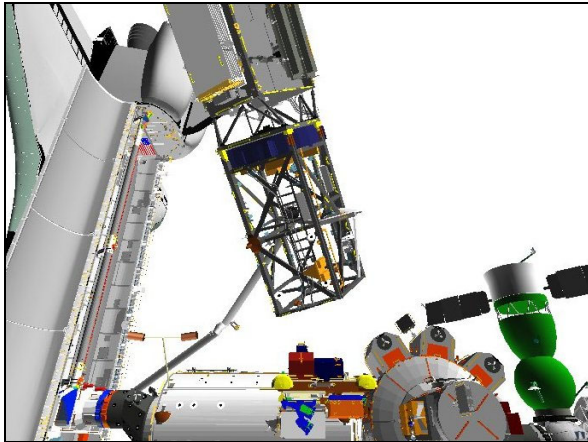
CCTV D (-30,20)



CCTV D (-30,20)

Step 5:

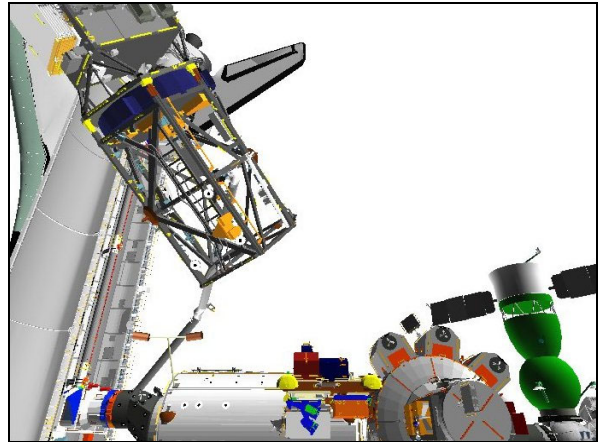
Drive WY- (for 103.0°)
From +31.4° to -71.6°



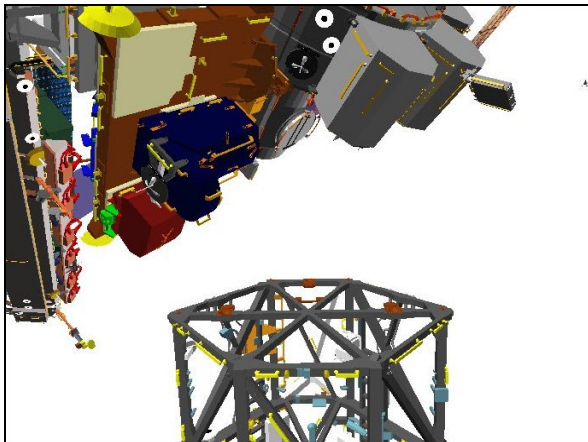
S1 LOWER OUTBOARD (90,30)

Step 6:

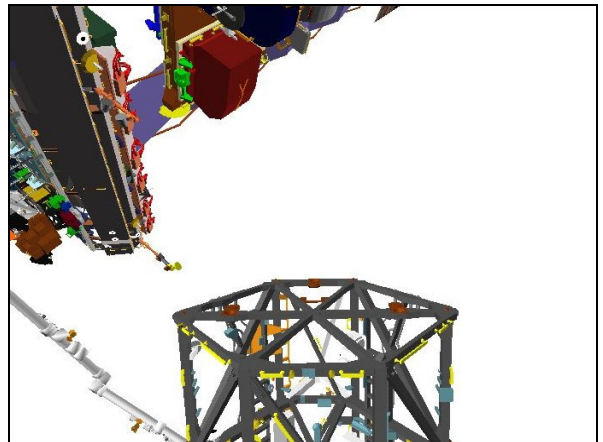
Drive SP- (for 14.7°)
From +38.0° to +23.3°



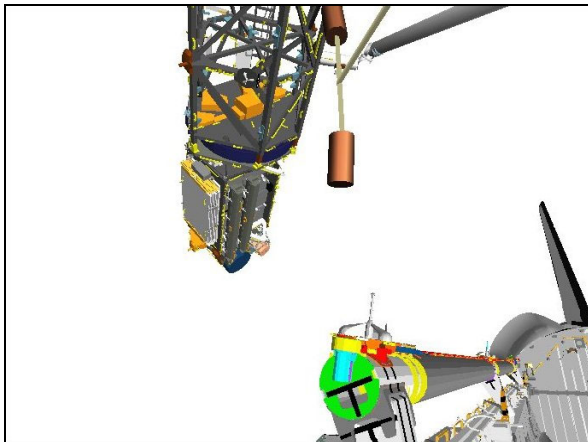
S1 LOWER OUTBOARD (90,30)



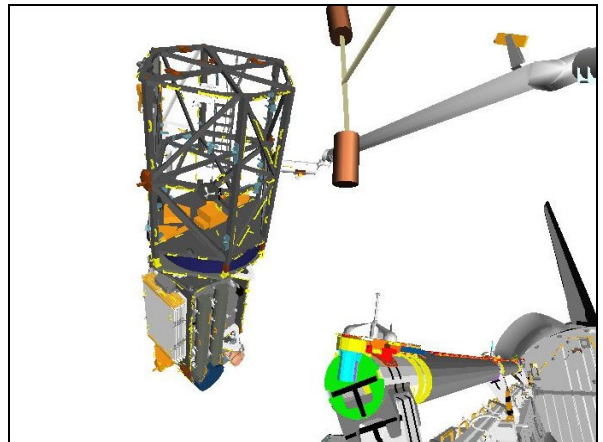
ELBOW (-25,35)



ELBOW (-25,35)



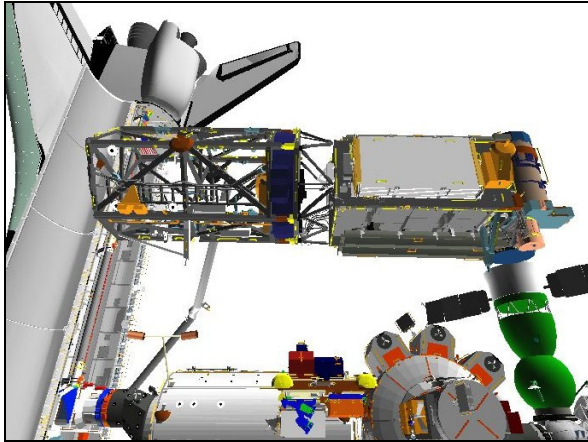
CCTV D (-30,20)



CCTV D (-30,20)

Step 7:

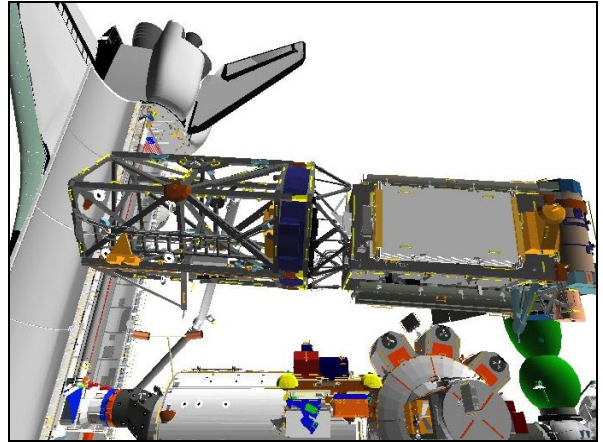
Drive WR- (for 122.1°)
From +185.9° to +63.8°



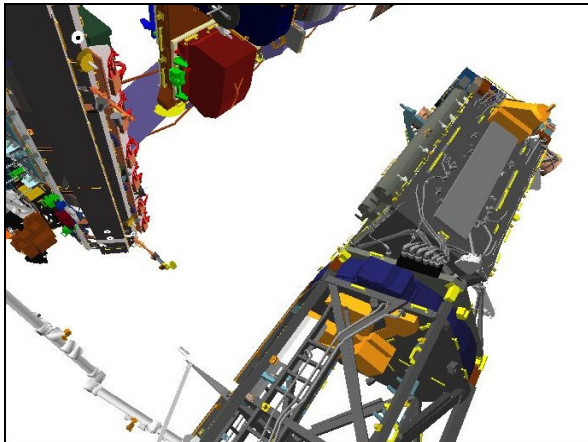
S1 LOWER OUTBOARD (90,30)

Step 8:

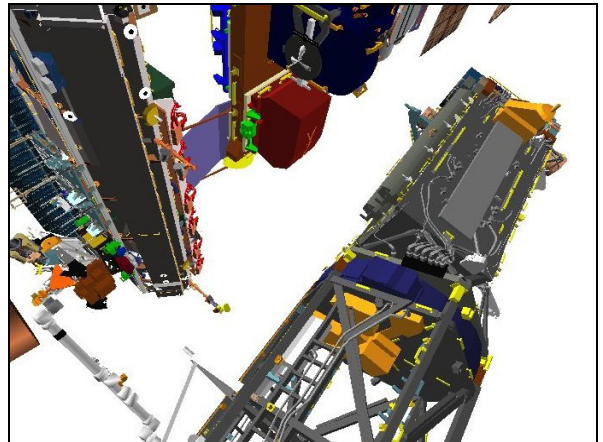
Drive SY- (for 7.3°)
From -55.9° to -63.2°



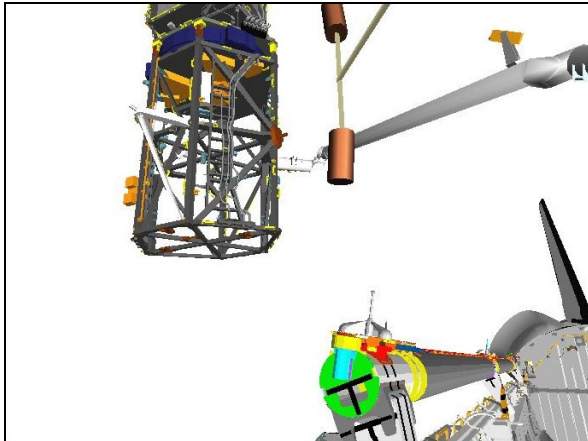
S1 LOWER OUTBOARD (90,30)



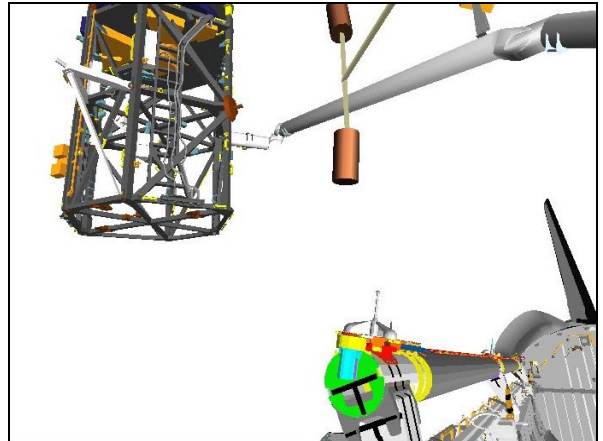
ELBOW (-25,35)



ELBOW (-25,35)



CCTV D (-30,20)



CCTV D (-30,20)

S3/S4 SJ UNGRAPPLE

- A7U 1. SETUP
 CCTV – config to monitor EE/Grapple fixture interface
 – RMS WRIST, zoom 34.0 HFOV
 focus 5 ft

SM 94 PDRS CONTROL
 PL ID, ITEM 3 +0 EXEC
 INIT ID, ITEM 24 +0 EXEC

2. S3/S4 UNGRAPPLE
 On SSRMS operator GO to ungrapple:

MON 1	P1LO
MON 2	A
DNLK	Wrist
DTV	D

If TEST MODE available:

NOTE

CONTR ERR It and 'S96 PDRS CNTL' msg may occur due to the Consistency/Envelope Check error

RATE – COARSE (RATE MIN tb-OFF)

SM 94 PDRS CONTROL

AUTO BRAKE INH – ITEM 10 EXEC (*)

BRAKES – OFF (tb-OFF)

MODE – TEST, ENTER

Wait 5 sec

BRAKES – ON (tb-ON)

SM 94 PDRS CONTROL

AUTO BRAKE ENA – ITEM 9 EXEC (*)

RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

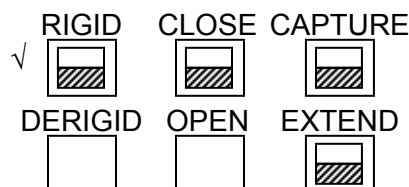
MODE – best available

CAUTION
Monitor EE tb timing to prevent EE motor burnout

EE MODE – MAN

MAN CONTR – DERIGID (hold until DERIGID tb-gray, 5 sec max)

RELEASE sw – depress (hold until OPEN tb-gray, 3 sec max)



CRITICAL TIMES (28 sec total):

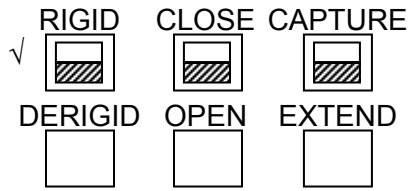
DERIGID tb – gray, 5 sec max, then

OPEN tb – gray, 3 sec max, then

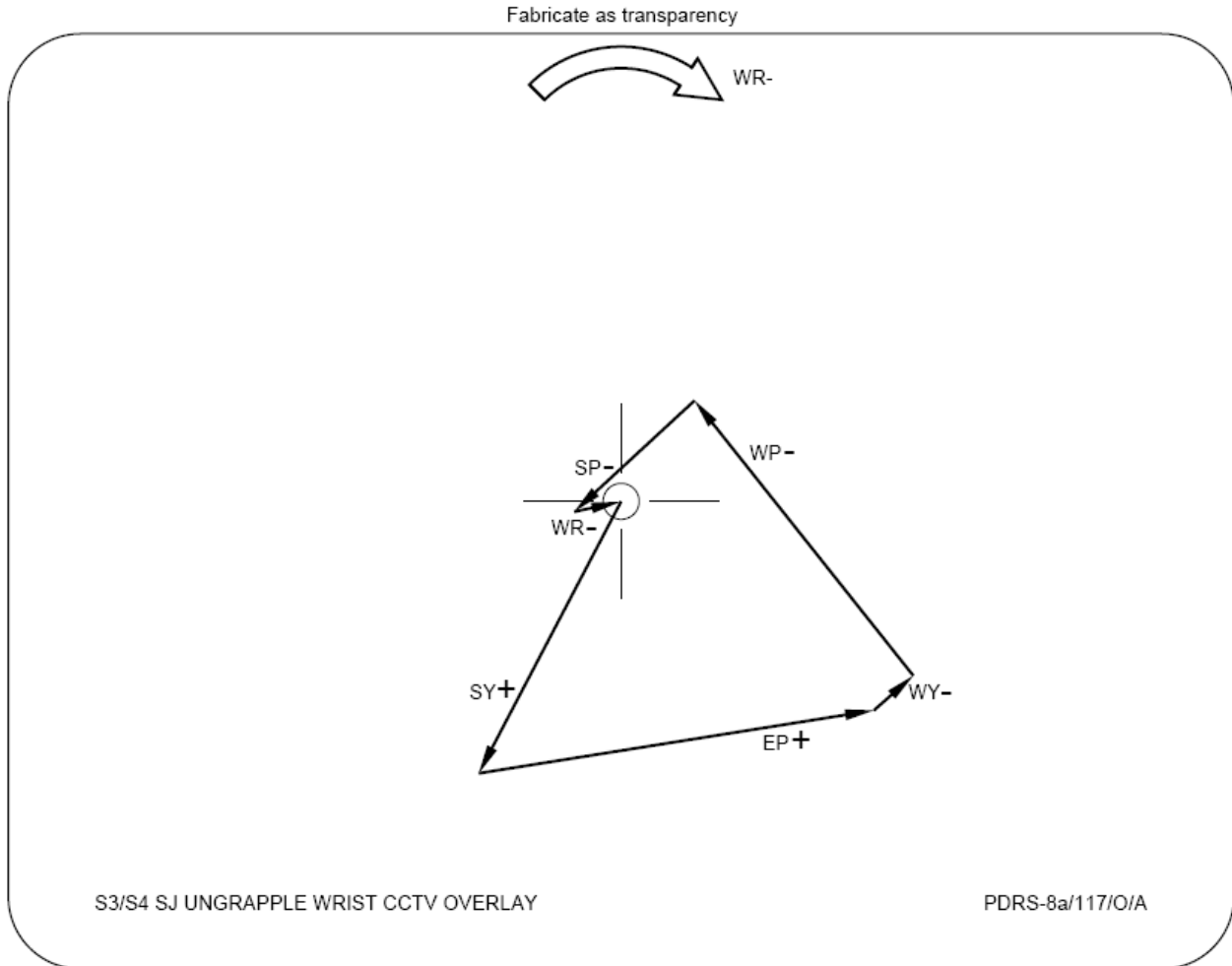
3. MNVR ARM CLEAR OF S3/S4

Drive joints per S3/S4 SJ UNGRAPPLE WRIST CCTV OVERLAY until EE clear of grapple fixture and SY approx -56.0°

EE MAN CONTR – DERIG (hold until EXTEND tb-gray, 20 sec max)
MODE – OFF



CRITICAL TIMES (28 sec total):
EXTEND tb – gray, 20 sec max



BRAKES – ON (tb-ON)
✓MODE – not DIRECT

If using ISS attitude control and attitude maintenance required:
✓MCC

If using shuttle attitude control and attitude maintenance required:
DAP: LVLH
When rates damped:
DAP: FREE > 2 sec
Then DAP: AUTO

Go to 1A/3A SAW VIEWING, VIEWING SUPPORT

S3/S4 CONTINGENCY REBERTH

1. SETUP
A7U CCTV – config as reqd

MON 1	S1LO (P1LO)
MON 2	Elbow
DNLK	D
DTV	C

SM 94 PDRS CONTROL

- √PL ID, ITEM 3: 4
 - √INIT ID, ITEM 24: 4
 - AUTO MODE 1 – ITEM 13 +8 EXEC
- √BRAKES – ON (tb-ON)

2. MNVR TO S3/S4 HIGH HOVER POSN

S3/S4 HANDOFF posn:

X	Y	Z	PITCH	YAW	ROLL	PL ID
-800	+375	-850	95	0	190	4
SY	SP	EP	WP	WY	WR	
-63.2	+23.3	-21.6	-61.7	-71.6	+63.8	

If using shuttle attitude control:
DAP: FREE

- √RATE – VERN (RATE MIN tb-ON)
- BRAKES – OFF (tb-OFF)
- MODE – AUTO 1, ENTER
- √START PT, ITEM 17: 156
- √READY It – ON
- AUTO SEQ – PROCEED (IN PROG It on)

Auto posn	X / SY	Y / SP	Z / EP	PITCH / WP	YAW / WY	ROLL / WR	PL ID
156	-800	+375	-850	95	0	190	4
	-63.2	+23.3	-21.6	-61.7	-71.6	+63.8	
157	-939	+331	-834	90	359	177	4
	-49.2	+23.3	-21.6	-61.7	-71.6	+63.8	
158	-1050	+355	-790	98	355	115	4
	-47.2	+30.3	-43.7	-6.4	-16.1	+86.6	
159	-1130	+275	-795	90	350	90	4
	-41.7	+41.5	-55.8	-4.7	+4.2	+88.4	
160	-1150	+230	-795	80	330	80	4
	-37.7	+56.1	-61.5	-27.9	+15.0	+78.4	
161	-1130	+120	-750	45	325	55	4
	-37.8	+79.0	-77.3	-61.8	+32.3	+94.5	
162	-1090	+90	-670	30	330	45	4
	-42.2	+88.9	-96.3	-70.7	+37.1	+113.4	
163	-1066	-2	-647	22	0	15	4
	-52.3	+80.4	-95.9	-112.9	+46.4	+182.3	

BRAKES – ON (tb-ON)

- If using ISS attitude control and attitude maintenance required:
√MCC

If using shuttle attitude control and attitude maintenance required:

GNC 20 DAP CONFIG

Load DAP A12

Wait 30 seconds

DAP: LVLH

When rates damped:

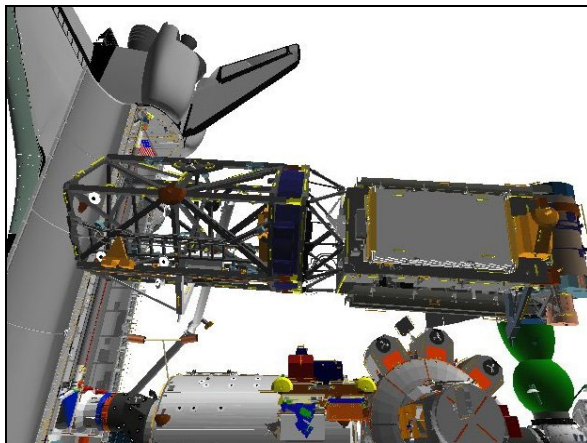
DAP: FREE > 2 sec

Then DAP: AUTO

When in attitude:

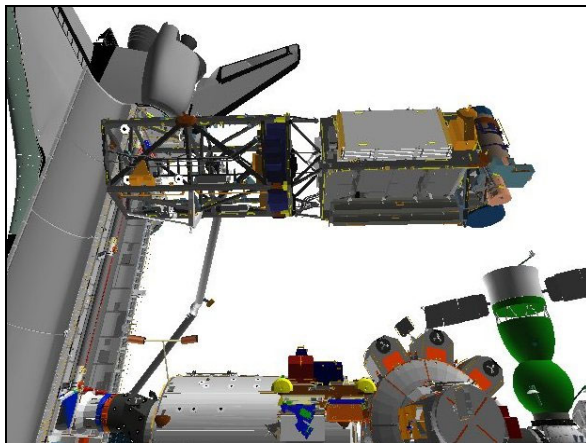
DAP: FREE

Auto posn 156:

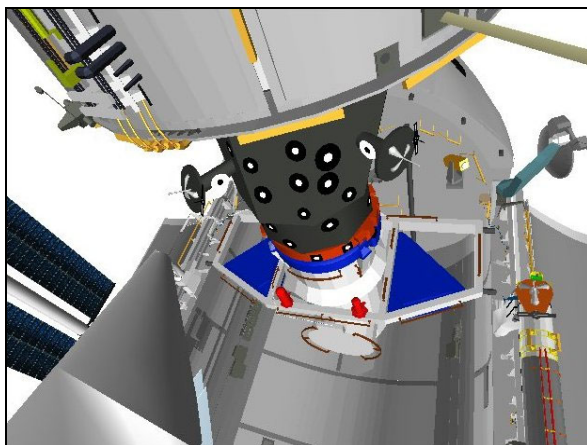


S1 LOWER OUTBOARD (90,30)

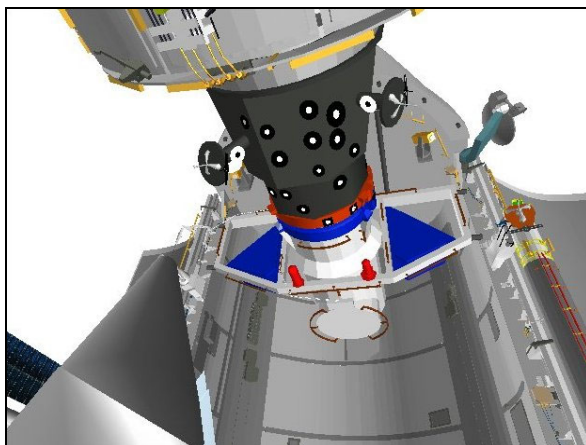
Auto posn 157:



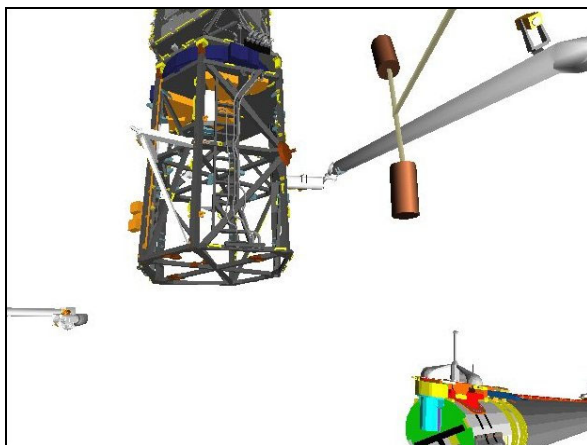
S1 LOWER OUTBOARD (90,30)



ELBOW (-145,-15)



ELBOW (-145,-15)



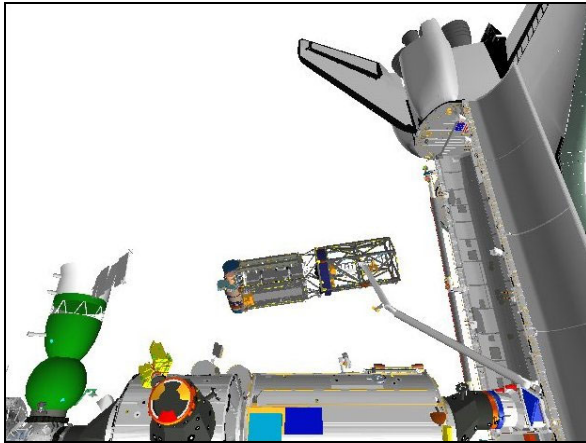
CCTV D (-40,25)



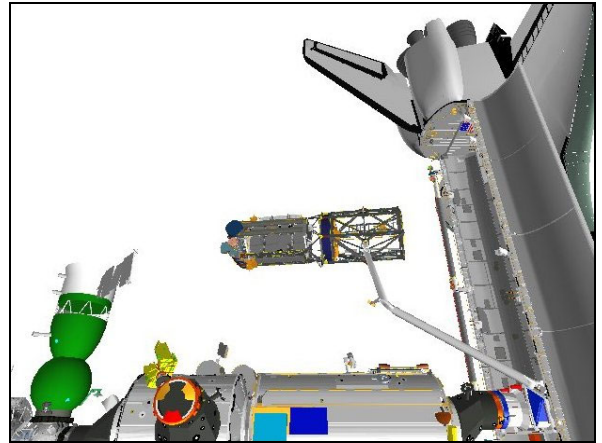
CCTV D (-40,25)

Auto posn 158:

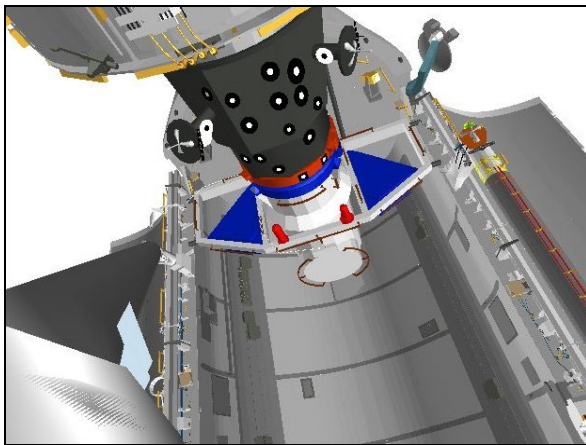
Auto posn 159:



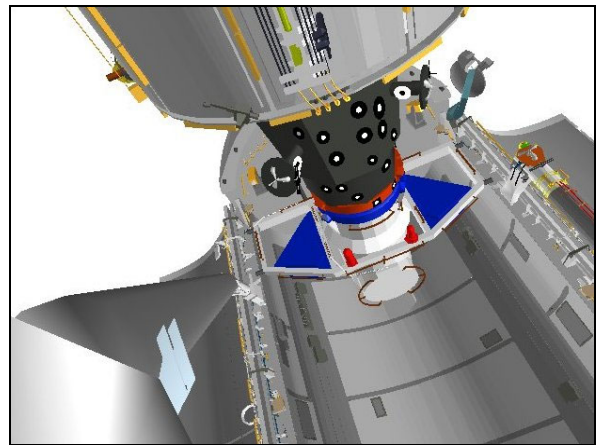
P1 LOWER OUTBOARD (90,30)



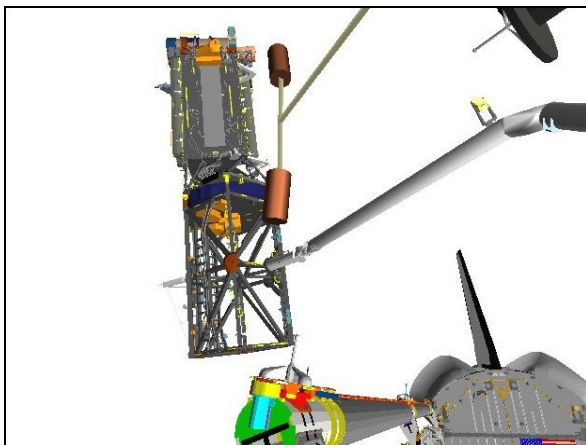
P1 LOWER OUTBOARD (90,30)



ELBOW (-125,-30)



ELBOW (-125,-30)

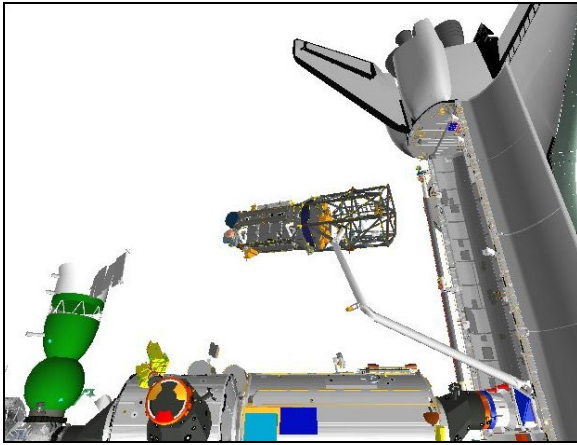


CCTV D (-20,25)



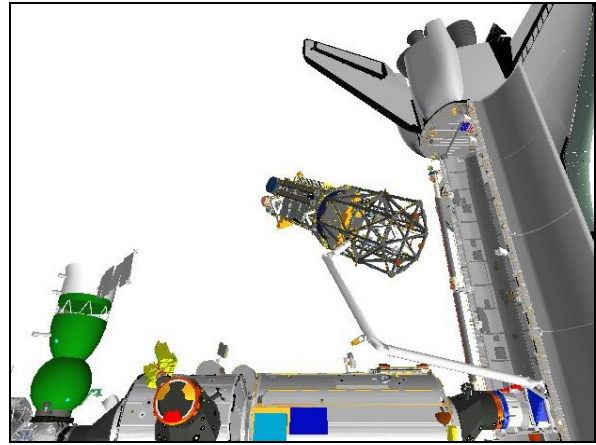
CCTV D (-20,25)

Auto posn 160:

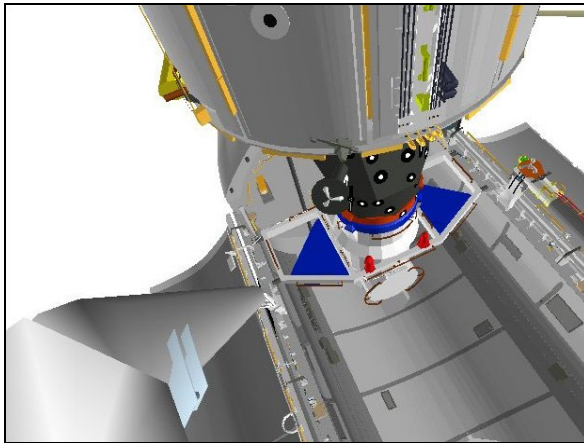


P1 LOWER OUTBOARD (90,30)

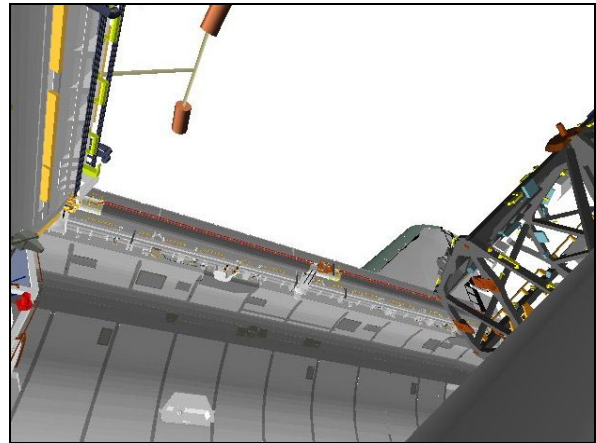
Auto posn 161:



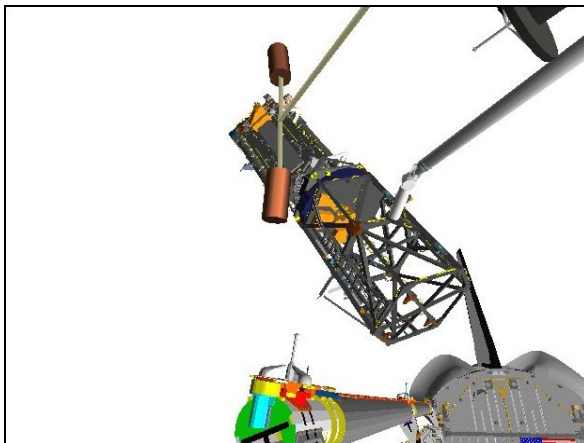
P1 LOWER OUTBOARD (90,30)



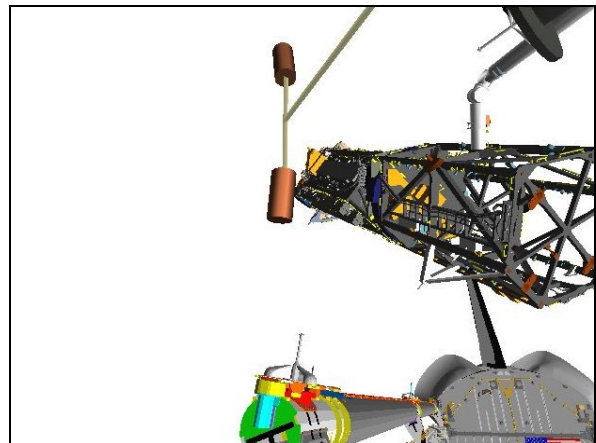
ELBOW (-125,-30)



ELBOW (-50,-30)

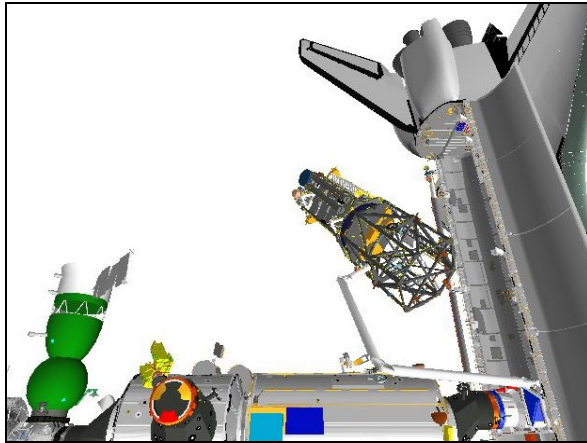


CCTV D (-20,25)



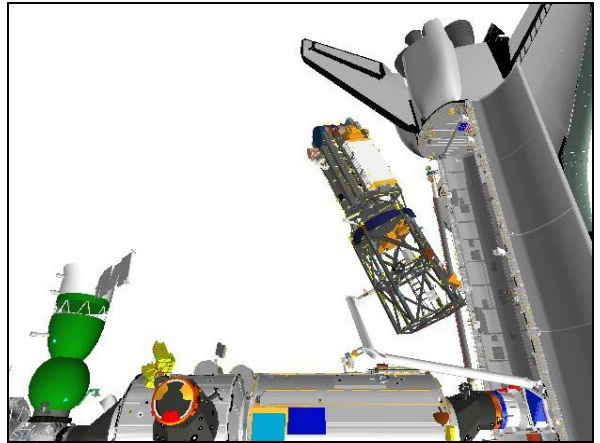
CCTV D (-20,25)

Auto posn 162:

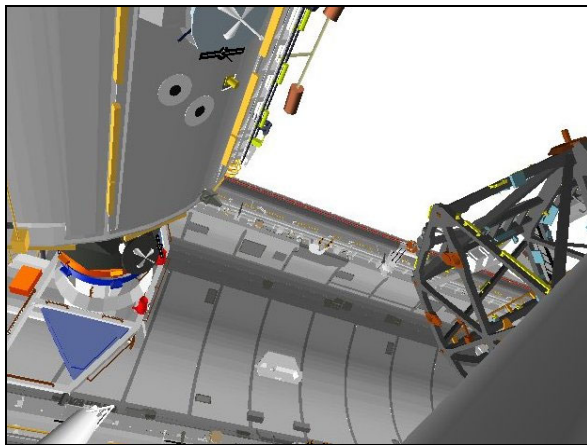


P1 LOWER OUTBOARD (90,30)

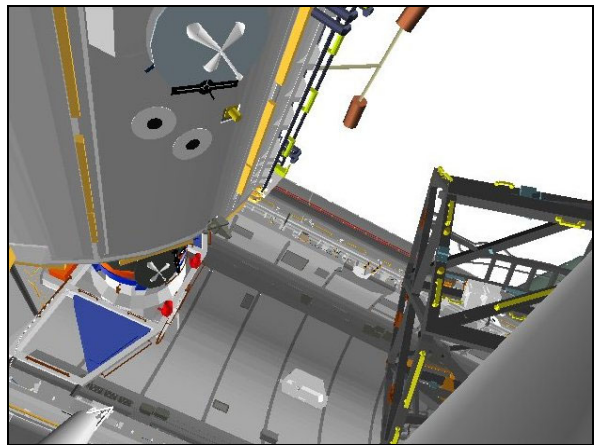
Auto posn 163:



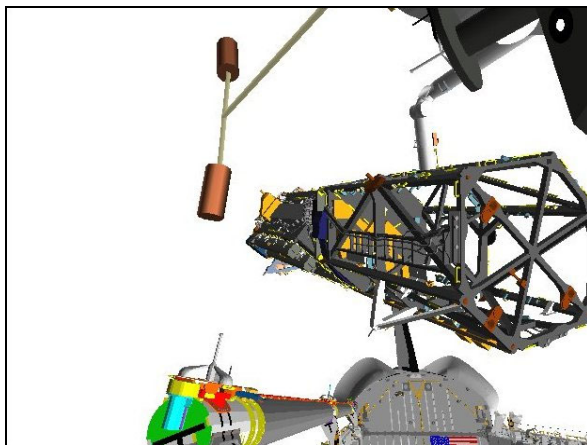
P1 LOWER OUTBOARD (90,30)



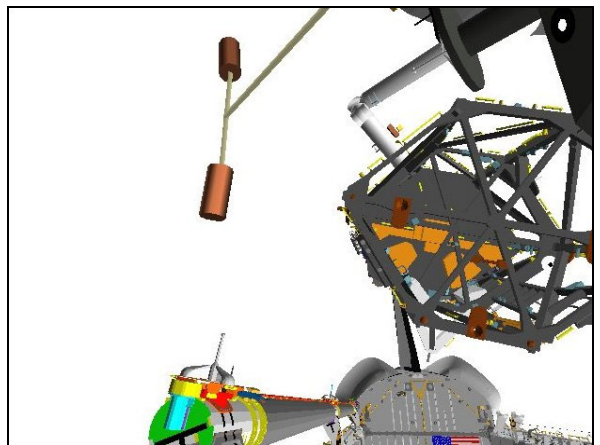
ELBOW (-50,-30)



ELBOW (-50,-30)



CCTV D (-10,25)



CCTV D (-10,25)

3. MNVR TO S3/S4 TILT POSN

MON 1	P1LO
MON 2	Elbow
DNLK	B
DTV	C

SM 94 PDRS CONTROL
 PL ID – ITEM 3 +5 EXEC
 INIT ID – ITEM 24 +5 EXEC

If using shuttle attitude control:

√DAP: FREE

√RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – ORB LD, ENTER

Mnvr to TILT posn:

X	Y	Z	PITCH	YAW	ROLL	PL ID
-725	-19	-539	22	0	15	5
SY	SP	EP	WP	WY	WR	
-60.2	+86.1	-116.0	-104.2	+41.2	+190.5	

BRAKES – ON (tb-ON)

If using ISS attitude control and attitude maintenance required:

√MCC

If using shuttle attitude control and attitude maintenance required:

DAP: LVLH

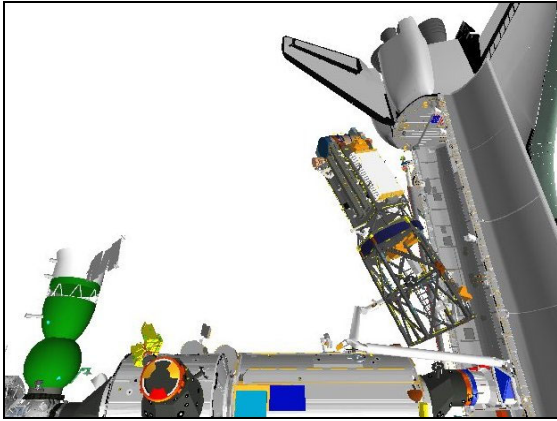
When rates damped:

DAP: FREE > 2 sec

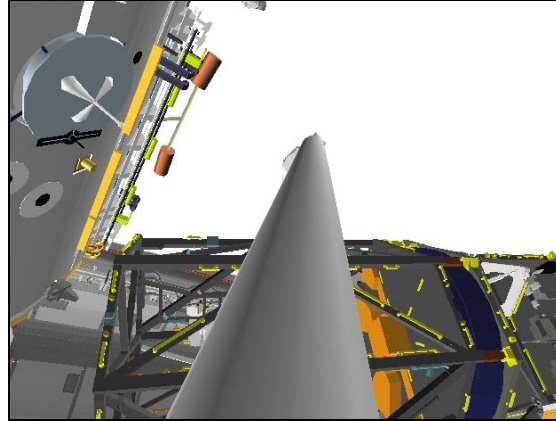
Then DAP: AUTO

When in attitude

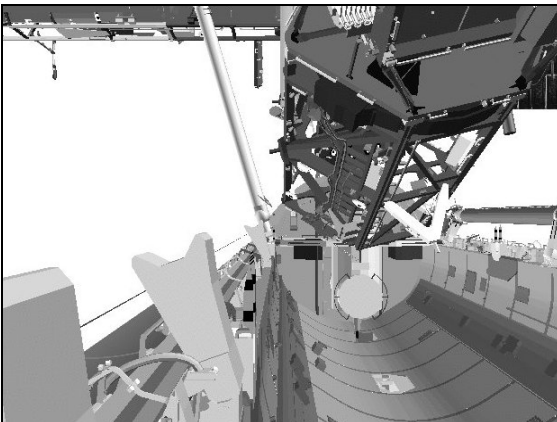
DAP: FREE



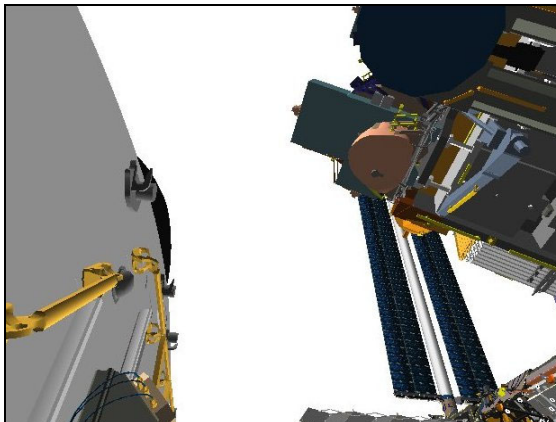
P1 LOWER OUTBOARD (90,30)



ELBOW (-5,-15)



CCTV B (0,0)



CCTV C (-80,45)

4. MNVR TO S3/S4 ROLL POSN

MON 1	US Lab
MON 2	Elbow
DNLK	B
DTV	C

PCS

MSS: SSRMS: Thrusters: Thruster Controls for MSS Ops

Verify 'Desat Request:' – Inh

- √RATE – VERN (RATE MIN tb-ON)
- √BRAKES – OFF (tb-OFF)
- √MODE – ORB LD

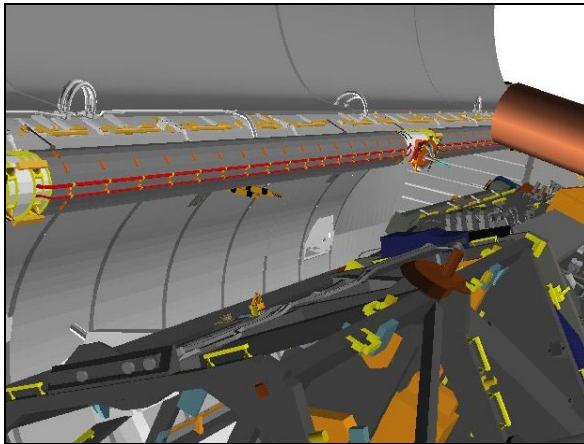
NOTE

At Roll posn, clearance between S3/S4 and aft port v-guide ~ 9 in.
Monitor clearance between S3/S4 and v-guides using Camera B

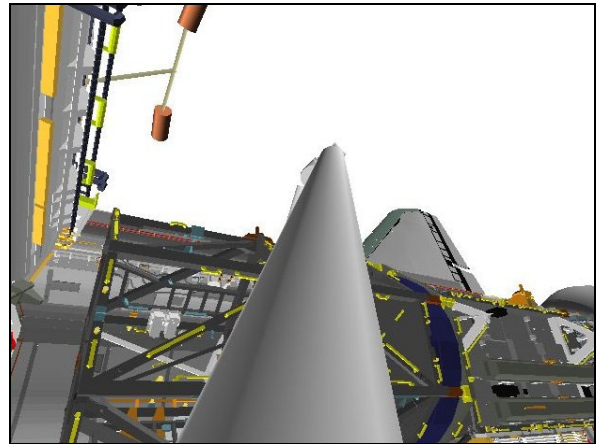
Mnvr to ROLL posn:

X	Y	Z	PITCH	YAW	ROLL	PL ID
-725	-19	-539	0	0	15	5
SY	SP	EP	WP	WY	WR	
-54.4	+80.8	-118.4	-99.9	+27.8	+176.7	

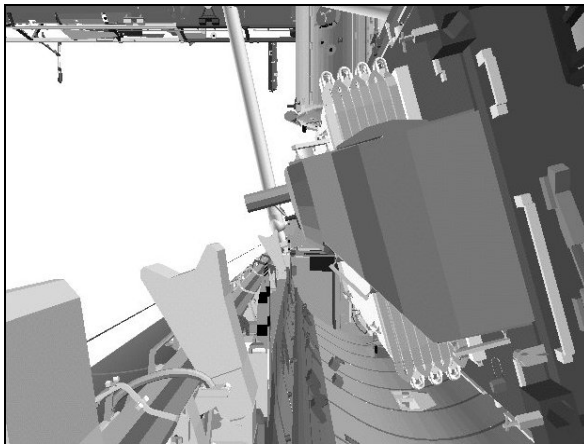
BRAKES – ON (tb-ON)



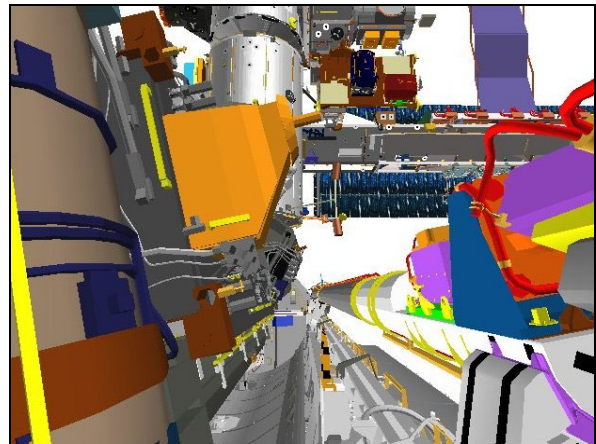
US LAB (-30,-30)



ELBOW (-5,-15)



CCTV B (0,0)



CCTV C (0,10)

5. MNVR TO LOW HOVER POSN

MON 1	US Lab
MON 2	Elbow
DNLK	A
DTV	C

SM 94 PDRS CONTROL

PL ID – ITEM 3 +4 EXEC

INIT ID – ITEM 24 +4 EXEC

√RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – ORB LD, ENTER

NOTE

At Low Hover posn, clearance between S3/S4 and OBSS ~ 18 in.

Clearance between S3/S4 and aft port v-guide ~ 16 in.

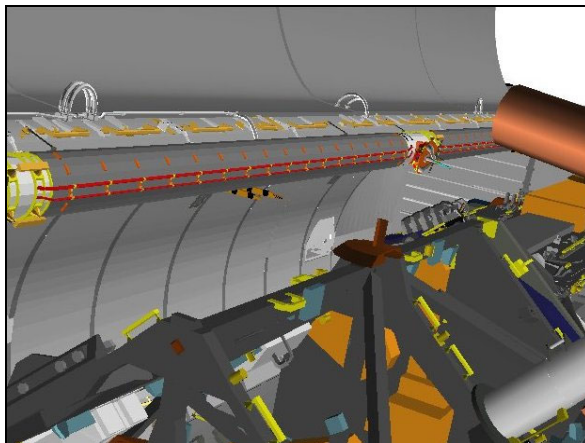
Monitor clearance between S3/S4 and OBSS using Camera C.

Monitor clearance between S3/S4 and v-guides using Camera B.

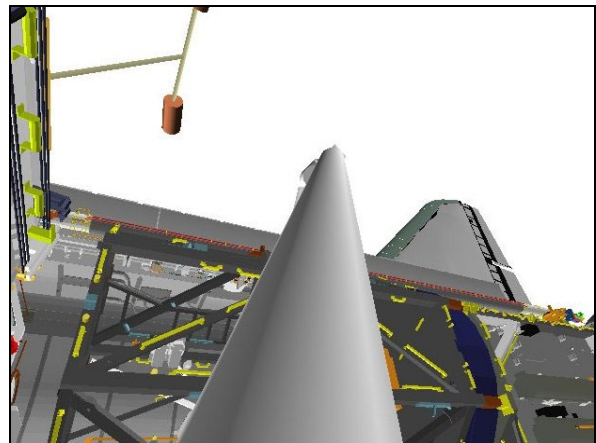
Monitor WP reach limit during maneuver to low hover posn

Mnvr to LOW HOVER posn:

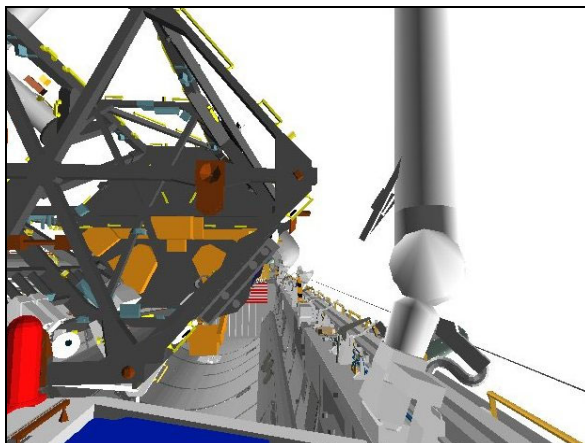
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1002	-2	-475	0	0	0	4
SY	SP	EP	WP	WY	WR	
-56.4	+72.4	-116.1	-110.7	+30.9	+186.1	



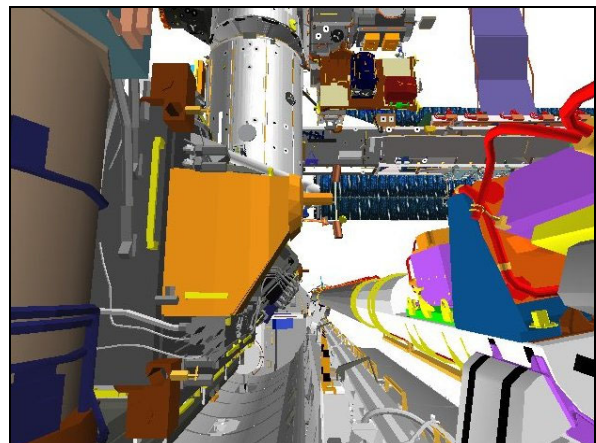
US LAB (-30,-30)



ELBOW (-5,-15)



CCTV A (5,5)



CCTV C (0,10)

6. MNVR TO PORT POSN

MON 1	P1LO
MON 2	Elbow
DNLK	D/A
DTV	B/C

- √RATE – VERN (RATE MIN tb-ON)
- √BRAKES – OFF (tb-OFF)
- √MODE – ORB LD

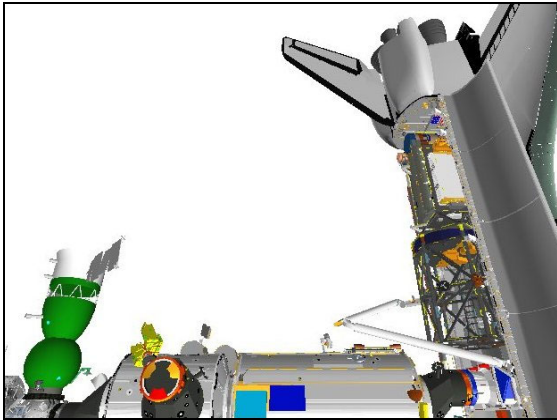
NOTE

At Port posn, clearance between S3/S4 and OBSS ~ 8 in.
 Clearance between S3/S4 and aft port v-guide ~ 1 in.
 Monitor clearance between S3/S4 and OBSS using Camera C.
 Monitor clearance between S3/S4 and v-guides using Camera B

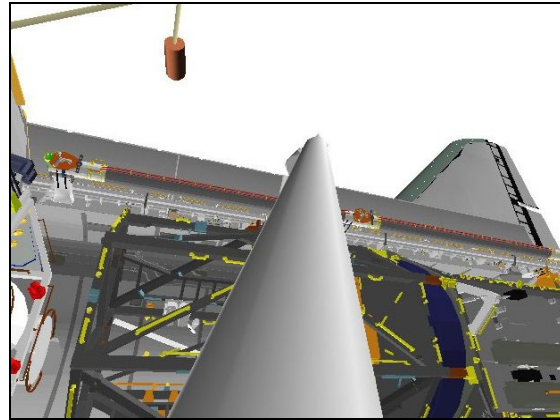
- A7U
- PL BAY FLOOD AFT (two) – OFF
 - MID (two) – OFF
 - FWD (two) – OFF

Mnvr to PORT posn:

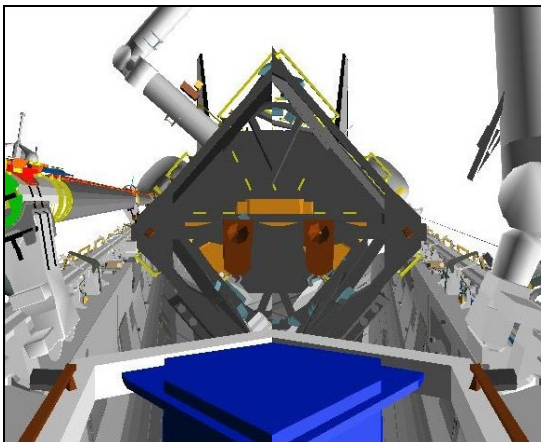
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1002	-2	-434	0	0	0	4
SY	SP	EP	WP	WY	WR	
-54.7	+67.2	-120.1	-101.1	+32.4	+185.3	



P1 LOWER OUTBOARD (90,30)

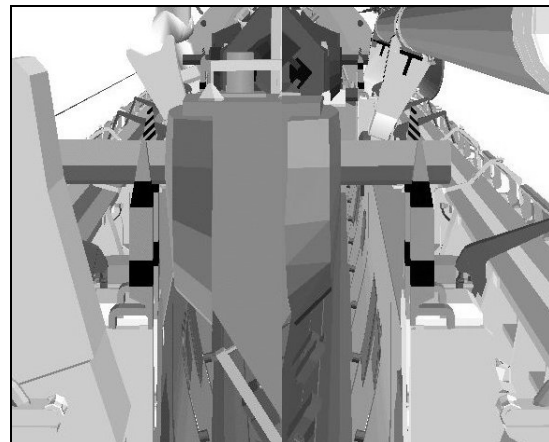


ELBOW (-5,-15)



CCTV D (-5,-4)

CCTV A (5,-4)



CCTV B (-3,-8)

CCTV C (3,-8)

7. MNVR TO INTERMEDIATE POSN

MON 1	P1LO
MON 2	Elbow
DNLK	D/A
DTV	B/C

√RATE – VERN (RATE MIN tb-ON)

√BRAKES – OFF (tb-OFF)

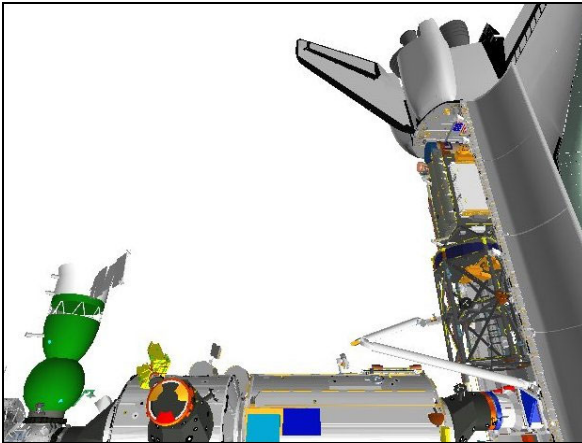
√MODE – ORB LD

NOTE

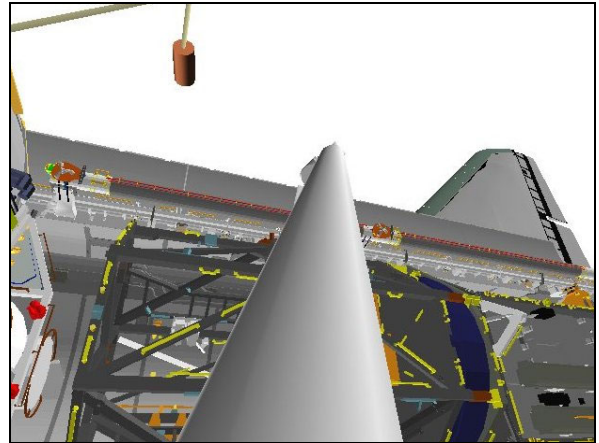
At Intermediate posn, clearance between S3/S4 and OBSS ~ 7 in.
Monitor clearance between S3/S4 and OBSS using Camera C

Mnvr to INTERMEDIATE posn:

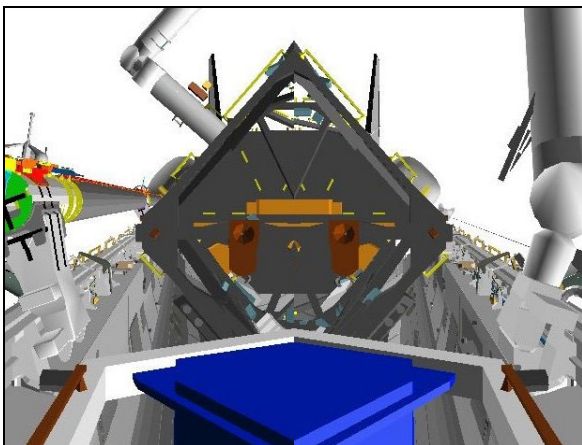
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1002	0	-434	0	0	0	4
SY	SP	EP	WP	WY	WR	
-55.0	+66.8	-119.7	-101.1	+32.2	+185.4	



P1 LOWER OUTBOARD (90,30)

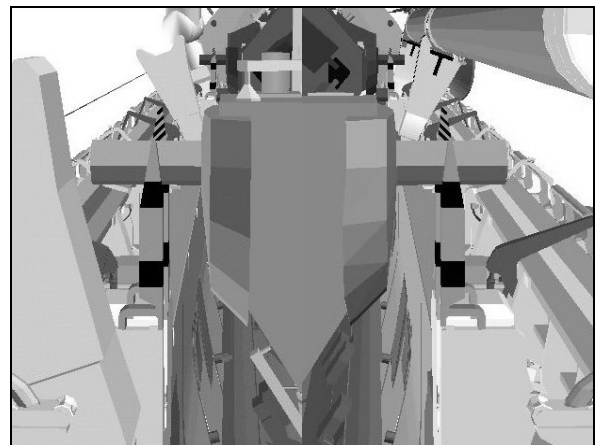


ELBOW (-5,-15)



CCTV D (-5,-4)

CCTV A (5,-4)



CCTV B (-3,-8)

CCTV C (3,-8)

8. MNVR TO S3/S4 BERTH POSN

CAUTION

Monitor clearances between STBD trunnions and OBSS during berth. Minimum clearance of approximately 3 inches expected

- √RATE – VERN (RATE MIN tb-ON)
- √BRAKES – OFF (tb-OFF)
- √MODE – ORB LD

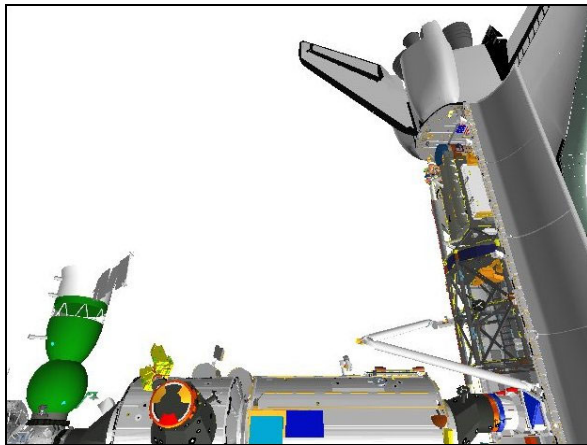
MON 1	P1LO
MON 2	Elbow
DNLK	D/A
DTV	B/C

CAUTION

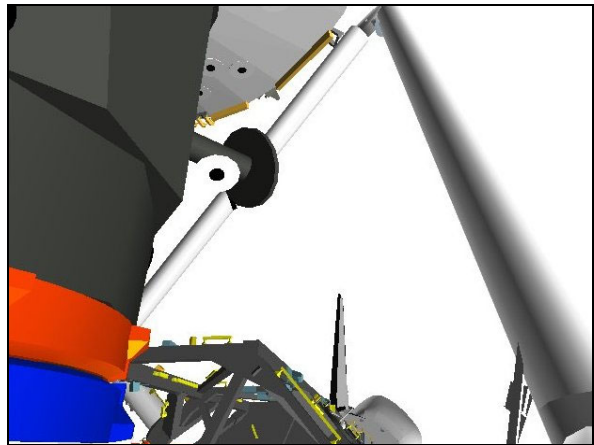
Payload Bay Flood Lights must be OFF when S3/S4 trunnions enter v-guides

Mnvr to S3/S4 BERTH posn (insert data from S3/S4 GRAPPLE):

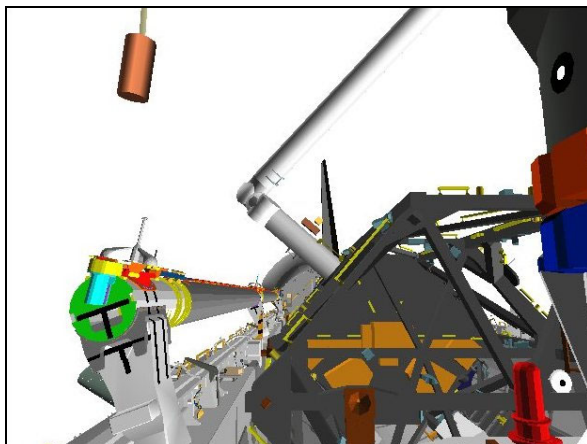
X	Y	Z	PITCH	YAW	ROLL	PL ID
						4
SY	SP	EP	WP	WY	WR	



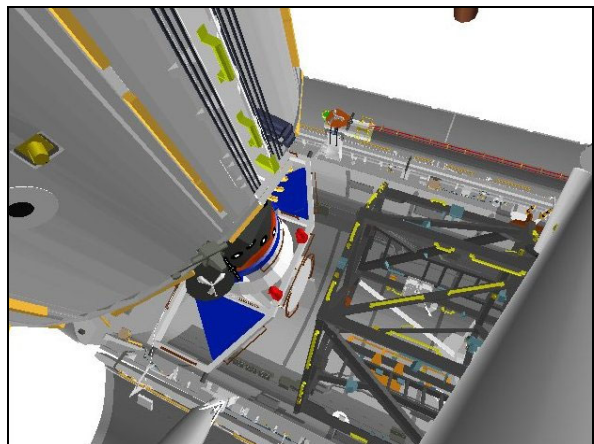
P1 LOWER OUTBOARD (90,30)



CCTV A (-10,30)



CCTV D (0,10)



ELBOW (-40,-20)

9. ACTIVATE LATCHES

NOTE

When LOGIC switches taken OFF, KU will
mode to standby. MPM and MRL tbs – bp

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

SM 97 PL RETENTION

√PL SEL 1 RDY-FOR-LAT 1,2,3,4 (eight) – 1
√LAT 1,2,3,4 (eight) – 0

- * If any LAT msw shows '1', drive latch *
- * for single motor time (60 sec) *

Note single motor times (> 30 sec)

R13L PL BAY MECH PWR SYS (1,2) – ON
A6U RETEN LOGIC PWR SYS (1,2) – ON

10. AKA LATCH

PL RETEN PL SEL – 2
√LAT 1,2 tb – REL
√RDY 1,2 tb – bp

Note single motor times (> 30 sec)

PL RETEN LAT 1,2 – LAT (tb-LAT), 60 sec max
– OFF
√RDY 1,2 tb – gray

11. PRLA LATCH

PL RETEN PL SEL – 1
√LAT 1,2,3,4 tb – REL
√RDY 1,2,3,4 tb – gray

Note single motor times (> 30 sec)

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

BRAKES – ON (tb-ON)

12. DEACTIVATING LATCHES

R13L PL RETEN LOGIC PWR SYS (1,2) – OFF
A6U BAY MECH PWR SYS (1,2) – OFF
RETEN PL SEL – MON

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

A7U

- 13. S3/S4 UNGRAPPLE SETUP
 CCTV – RMS WRIST, zoom 34.0 HFOV
 focus 5 ft

MON 1	P1LO
MON 2	A
DNLK	Wrist
DTV	D

SM 94 PDRS CONTROL
 PL ID – ITEM 3 +0 EXEC
 INIT ID – ITEM 24 +0 EXEC

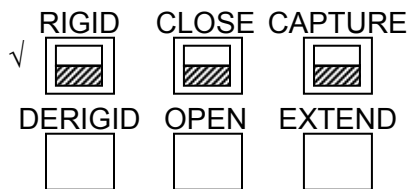
- 14. S3/S4 UNGRAPPLE
 RATE – VERN (RATE MIN tb-ON)
 BRAKES – OFF (tb-OFF)
 MODE – END EFF, ENTER

CAUTION
 Monitor EE tb timing to prevent EE motor burnout

NOTE

When OPEN tb – gray, mnvr arm clear of GF and S3/S4

EE MODE – AUTO
 RELEASE sw – depress (mom)



CRITICAL TIMES (28 sec total):
 DERIGID tb – gray, 5 sec max, then
 OPEN tb – gray, 3 sec max, then
 EXTEND tb – gray, 20 sec max

- * If manual release reqd: *
- * EE MODE – MAN *
- * MAN CONTR – DERIGID (hold until DERIGID *
- * tb-gray, 5 sec max) *
- * RELEASE sw – depress (hold until OPEN tb-gray, *
- * 3 sec max) *
- * *
- * Mnvr arm clear, then *
- * EE MAN CONTR – DERIGID (hold until EXTEND *
- * tb-gray, 20 sec max) *

EE MODE – OFF

BRAKES – ON (tb-ON)
 ✓MODE – not DIRECT
 JOINT – CRIT TEMP

If using ISS attitude control and attitude maintenance required:
 ✓MCC

If using shuttle attitude control and attitude maintenance required:
 DAP: LVLH
 When rates damped:
 DAP: FREE > 2 sec
 Then DAP: AUTO

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OBSS OPS

I

OBSS HANDOFF FROM SSRMS TO SRMS	FS 3-2
UNDOCK	FS 3-7

OBSS OPS

OBSS HANDOFF FROM SSRMS TO SRMS

1. SETUP

NOTE

Assumed starting posn is SAW Retract Viewing. Verify MT at WS 3 with SSRMS on PDGF 2 at 2B Clearance posn (SR: +98.7, SY: 0.0, SP: -41.2, EP: -85.6, WP: -214.8, WY: +212.4, WR: +77.6)

SM 94 PDRS CONTROL

- √PL ID, ITEM 3: 0
- √INIT ID, ITEM 24: 0

A7U CCTV – config as reqd

2. PRE-GRAPPLE MNVR

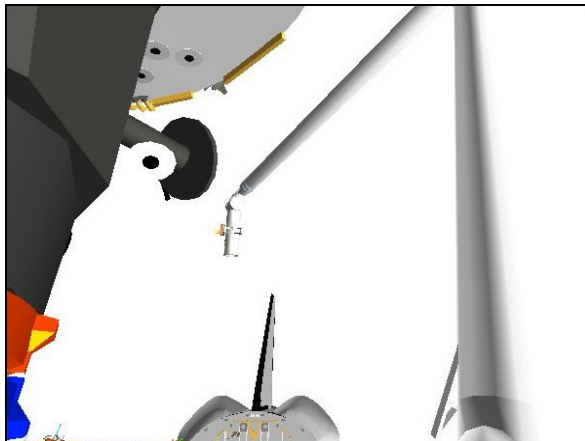
RHC RATE – as reqd (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – SINGLE, ENTER

Mnvr to OBSS PRE-GRAPPLE AT HANDOFF posn:

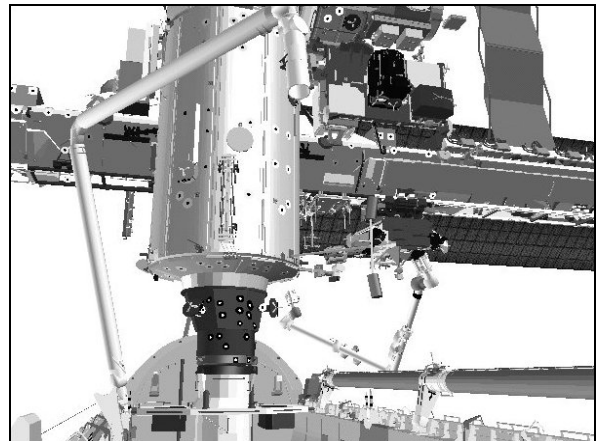
	SY	SP	EP	WP	WY	WR	
SAW Retract Viewing	+160.0	+25.0	-25.0	+5.0	0.0	0.0	
1: SY –	-33.3						
2: SP +		+80.0					
3: EP –			-90.0				
4: WP –				-77.3			
5: WY +					+23.8		
6: WR –						-39.8	
OBSS Pre-Grapple at Handoff	-33.3	+80.0	-90.0	-77.3	+23.8	-39.8	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-966	-1	-625	285	0	271	0

BRAKES – ON (tb-ON)

Notify SSRMS Operator that SRMS at OBSS PRE-GRAPPLE AT HANDOFF posn



CCTV A (0,30)



CCTV B (15,15)

OBSS OPS

3. CONFIGURE POWER

CAUTION
SPEE power must be applied within 90 min
to prevent sensor package damage

On SSRMS Operator GO to release STBD MRLs,
STBD RMS HTR A,B (two) – OFF

A6U EVENT TIMER MODE – UP
 CNTL – START

MA73C:C cb MCA PWR AC3 3Φ MID 2 – op
 √AC2 3Φ MID 2 – op
 √AC3 3Φ MID 4 – op

:D

R13L PL BAY MECH PWR SYS (two) – ON

4. STBD MRL RELEASE

SM 94 PDRS CONTROL

RMS STBD – ITEM 2 EXEC (*)
√STBD AFT, MID, FWD REL (six) = 0

NOTE
Expect single motor drive time for MRL release

STBD RMS RETEN LAT – REL (tb-REL) (18 sec max)
– OFF

If motor drive time > 18 sec, √MCC

SM 94 PDRS CONTROL

√STBD AFT, MID, FWD REL (six) = 1

5. RECONFIGURE POWER

R13L PL BAY MECH PWR SYS (two) – OFF

MA73C:C cb MCA PWR AC3 3Φ MID 2 – cl
 √AC2 3Φ MID 2 – op
 √AC3 3Φ MID 4 – op

:D

Give SSRMS Operator GO for OBSS Unberth
Monitor RFL Status

After OBSS Unberth,
SM 94 PDRS CONTROL
RMS PORT – ITEM 1 EXEC (*)

6. SETUP FOR GRAPPLE

A7U CCTV – config for grapple
 – install PDRS TARGET OVERLAY FOR CTVM
 – RMS WRIST, ZOOM: 34.0 HFOV
 FOCUS: 5 ft

Maintain eyepoint approx 18 in when using grapple overlay

R12(OBSS) √SPEE PWR – OFF
L12U(SSP1) √APCU 1 OUTPUT RLY – OP (tb-bp)

7. OBSS GRAPPLE AT HANDOFF POSN

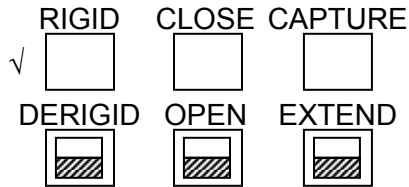
RHC

On SSRMS Operator GO for SRMS OBSS Grapple,
 RATE – VERN (RATE MIN tb-ON)
 BRAKES – OFF (tb-OFF)
 MODE – END EFF, ENTER

Mnvr to grapple envelope

CAUTION
 Monitor EE tb timing to prevent EE motor burnout

EE MODE – AUTO
 CAPTURE sw – depress (mom)



CRITICAL TIMES (28 sec total):
 CAPTURE tb – gray, then
 CLOSE tb – gray, 3 sec max, then
 RIGID tb – gray, 25 sec max

EE MODE – OFF
 BRAKES – ON (tb-ON)

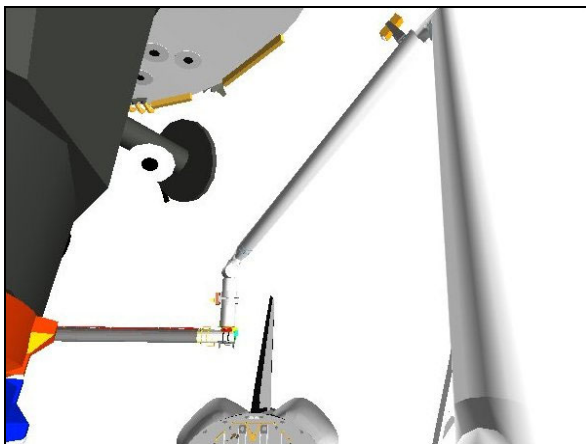
SM 94 PDRS CONTROL

 PL ID – ITEM 3 +2 EXEC
 INIT ID – ITEM 24 +2 EXEC

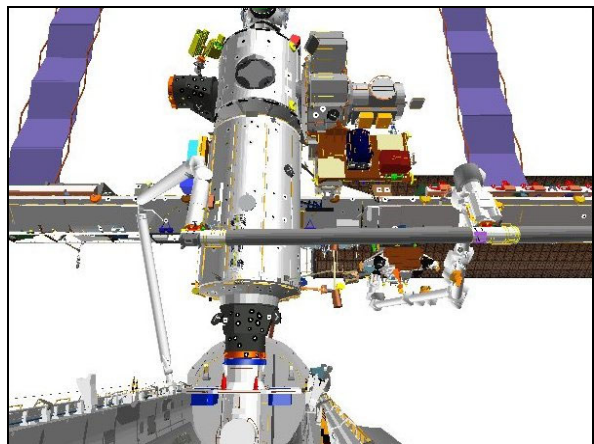
Expected OBSS HANDOFF posn:

	X	Y	Z	PITCH	YAW	ROLL	PL ID	
√	-986	+590	-561	15	270	0	2	*
	SY	SP	EP	WP	WY	WR		
√	-28.4	+75.5	-98.1	-62.5	+23.6	-45.1		

* display singularity



CCTV A (0,30)



CCTV C (0,20)

R12(OBSS) RSC PWR – OFF, ON

Perform ACTIVATION (LDRI/ITVC Cue Card, PHOTO/TV)

SSP1 √APCU 1,2 CONV (two) – OFF (tb-bp)

Perform LCH ACTIVATION (LCS Cue Card, PHOTO/TV)
 Perform LCC ACTIVATION (LCS Cue Card, PHOTO/TV)
 Perform LCC DEACTIVATION (LCS Cue Card, PHOTO/TV), steps 1 and 2

Review GENERIC END EFFECTOR CUE CARD – ISS/SHUTTLE DOCKED OPS

Give SSRMS Operator GO for OBSS Ungrapple

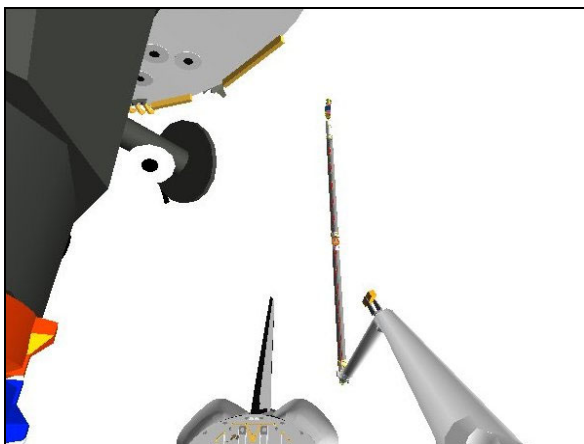
8. MNVR TO OBSS PARK
 On SSRMS Operator GO for mnvr to OBSS PARK posn

RHC RATE – as required (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – SINGLE, ENTER

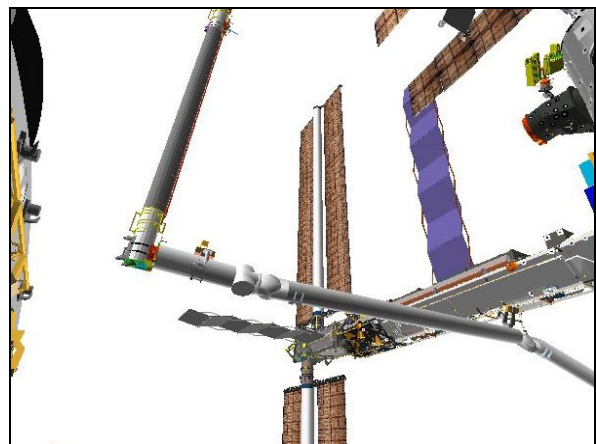
Mnvr to OBSS Park posn:

	SY	SP	EP	WP	WY	WR	
OBSS Handoff	-28.4	+75.5	-98.1	-62.5	+23.6	-45.1	
1: EP +			-25.0				
2: SP –		+25.0					
3: WR +						0.0	
4: WY –					0.0		
5: WP +				+5.0			
6: SY +	0.0						
OBSS Park	0.0	+25.0	-25.0	+5.0	0.0	0.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-1216	-141	-1141	95	359	358	2

BRAKES – ON (tb-ON)
 MODE – not DIRECT
 PARAM – PORT TEMP
 JOINT – CRIT TEMP



CCTV A (0,30)



CCTV C (-60,30)

A7U

9. RECONFIG PTU

DTV ← PL2

CAMR CMD PAN/TILT – HI RATE

PAN – L (to hard stop)

TILT – UP (to hard stop)

PAN/TILT – RESET

PAN: +80 (right)

TILT: -35 (dn)

MUX 1 L ← MIDDECK

LDRI MODE 2 pb – push (ITVC video)



OBSS ITVC (80,-35)

OBSS UNDOCK

1. SETUP

NOTE

Assumed starting posn is OBSS Park. Verify SSRMS on Lab PDGF at Undock posn (SR: +123.9, SY: -177.6, SP: -88.6, EP: +45.0, WP: -28.1, WY: -33.1, WR: +47.7)

SM 94 PDRS CONTROL

√PL ID, ITEM 3: 2

√INIT ID, ITEM 24: 2

A7U CCTV – config as reqd

2. MNVR TO OBSS UNDOCK

RHC RATE – as required (VERN within 10 ft)

BRAKES – OFF (tb-OFF)

MODE – SINGLE, ENTER

Mnvr to OBSS UNDOCK posn:

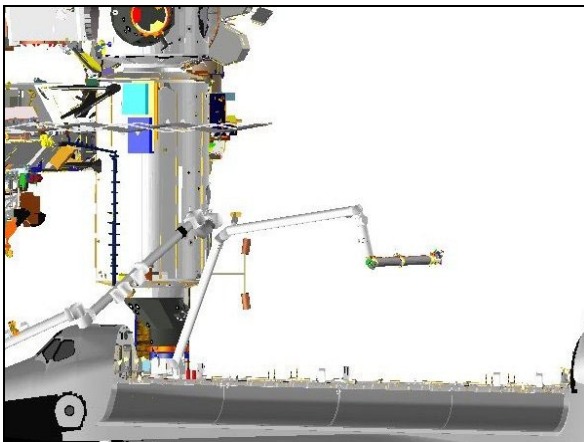
	SY	SP	EP	WP	WY	WR	
OBSS Park	0.0	+25.0	-25.0	+5.0	0.0	0.0	
1: SY +	+25.8						
2: WP –				-85.9			
3: SP +		+66.3					
4: WR –						-100.7	
5: WY +					+10.7		
6: EP –			-49.0				
OBSS Undock	+25.8	+66.3	-49.0	-85.9	+10.7	-100.7	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-1029	+229	-614	12	270	358	2

BRAKES – ON (tb-ON)

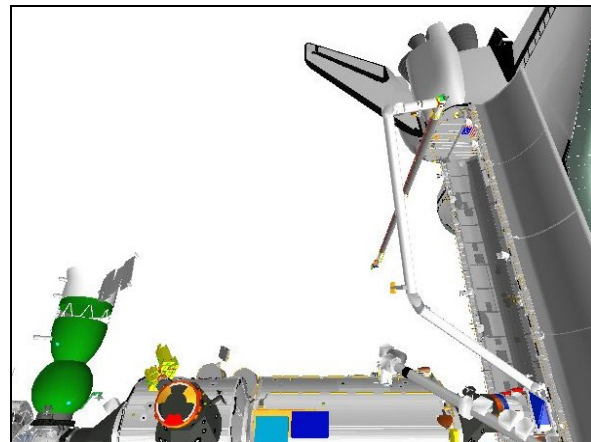
√MODE – not DIRECT

PARAM – PORT TEMP

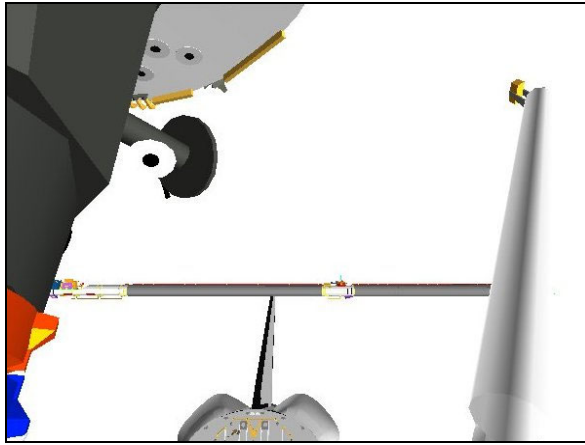
JOINT – CRIT TEMP



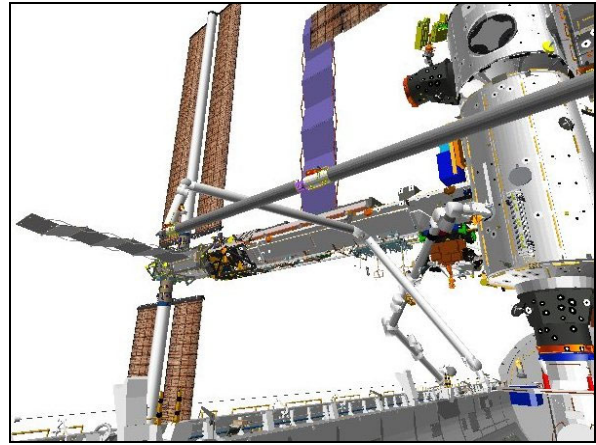
BIRD'S EYE



P1 LOWER OUTBOARD (90,30)



CCTV A (0,30)



CCTV C (-60,30)

3. MNVR TO OBSS HOVER

When undock complete

SM 94 PDRS CONTROL

PL ID – ITEM 3 +1 EXEC

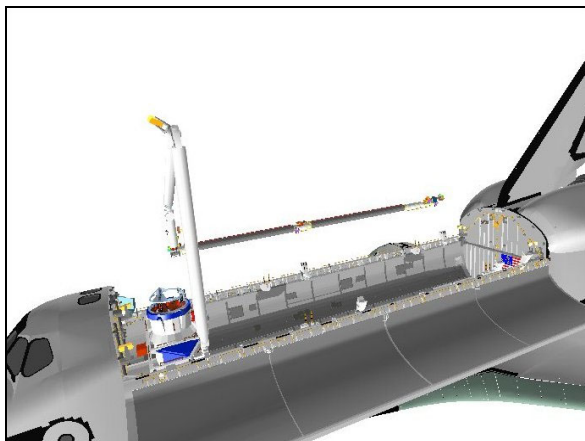
INIT ID – ITEM 24 +1 EXEC

RHC RATE – as reqd (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – SINGLE, ENTER

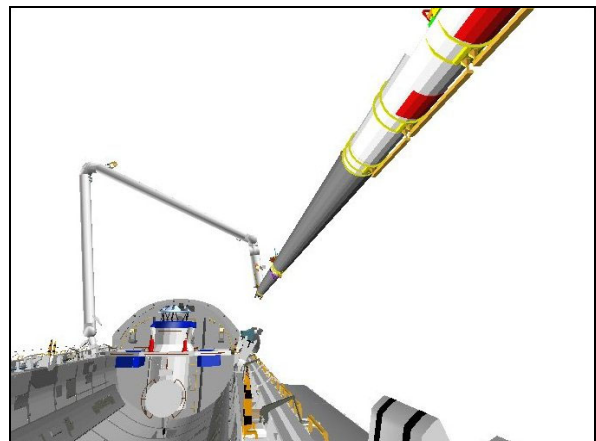
Mnvr to OBSS HOVER posn:

	SY	SP	EP	WP	WY	WR	
OBSS Undock	+25.8	+66.3	-49.0	-85.9	+10.7	-100.7	
1: SP +		+79.8					
2: WY –					0.0		
3: SY –	-90.0						
4: WP +				-20.0			
5: WR –						-250.0	
6: WP –				-55.7			
7: EP –			-123.1				
OBSS Hover	-90.0	+79.8	-123.1	-55.7	0.0	-250.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-680	+126	-496	0	0	341	1

BRAKES – ON (tb-ON)



BIRD'S EYE



CCTV C (10,15)

VIEWING SUPPORT

|

1A/3A SAW VIEWING	FS 4-2
S3/S4 INSTALL VIEWING	FS 4-4
SAW RETRACT VIEWING	FS 4-9
W/OBSS	FS 4-11

VIEWING
SUPPORT

1A/3A SAW VIEWING

1. SETUP

NOTE

Assumed SRMS starting posn is the approximate back off posn after S3/S4 ungrapple. MT at WS 2 with SSRMS on PDGF 2 at Handoff posn (SR: -79.4, SY: +38.5, SP: -127.7, EP: -39.6, WP: -73.6, WY: -6.8, WR: -9.8)

A7U

CCTV – config as reqd

MON 1	US Lab
MON 2	D
DNLK	Elbow
DTV	C

SM 94 PDRS CONTROL

√PL ID, ITEM 3: 0

√INIT ID, ITEM 24: 0

On SSRMS Operator GO to maneuver to the 1A/3A SAW Viewing position

RHC

2. MNVR TO 1A/3A SAW VIEWING POSITION

RATE – as reqd (VERN within 10 ft)

BRAKES – OFF (tb-OFF)

MODE – SINGLE, ENTER

Mnvr to 1A/3A SAW VIEWING posn:

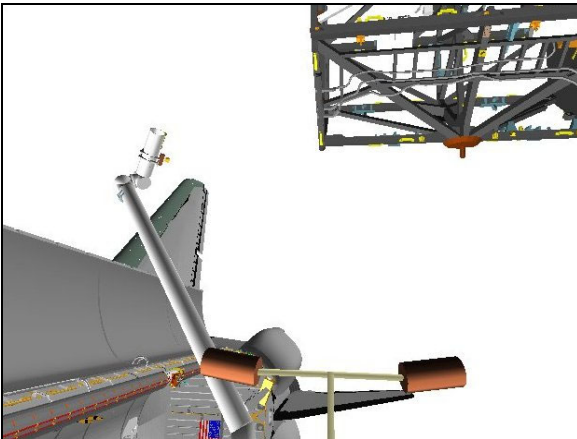
	SY	SP	EP	WP	WY	WR	
Approx back off	-56.0	+21.5	-14.0	-88.2	-74.0	+41.6	
1: WP +				+89.2			
2: SP –		+6.0					
3: WY +					-68.0		
4: WR +						+91.6	
5: EP –			-58.0				
1A/3A SAW Viewing	-56.0	+6.0	-58.0	+89.2	-68.0	+91.6	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-892	+334	-419	142	320	177	0

BRAKES – ON (tb-ON)

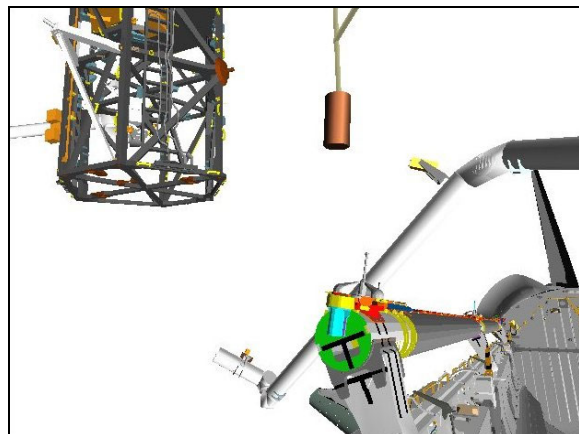
√MODE – not DIRECT

PARAM – PORT TEMP

JOINT – CRIT TEMP



US LAB (-5,-5)

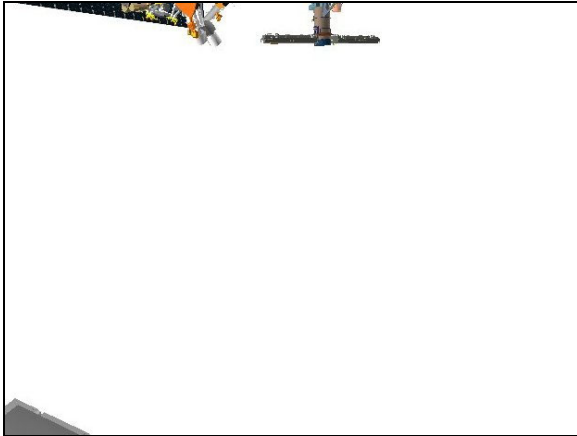


CCTV D (-30,15)

VIEWING
SUPPORT

NOTE

The following pictures indicate the required camera positions for viewing 1A and 3A SAW deployment



ELBOW (-40,25)



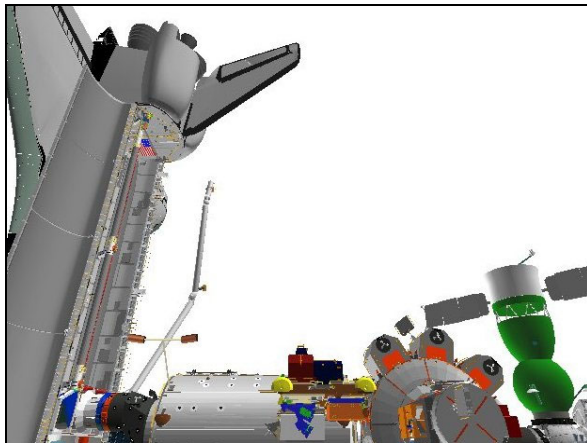
CCTV B (60,30)

- RHC 3. MNVR TO PRE-CRADLE
 RATE – as reqd (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – SINGLE, ENTER

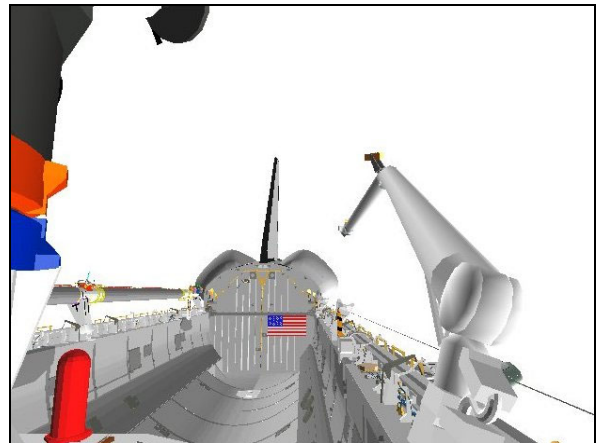
Mnvr to PRE-CRADLE posn:

	SY	SP	EP	WP	WY	WR	
1A/3A SAW Viewing	-56.0	+6.0	-58.0	+89.2	-68.0	+91.6	
1: EP +			-25.0				
2: SP +		+25.0					
3: SY +	0.0						
4: WP –				+5.0			
5: WY +					0.0		
6: WR –						0.0	
Pre-cradle	0.0	+25.0	-25.0	+5.0	0.0	0.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-1261	-146	-551	5	2	0	0

- BRAKES – ON (tb-ON)
 ✓MODE – not DIRECT
 PARAM – PORT TEMP
 JOINT – CRIT TEMP



S1 LOWER OUTBOARD (90,30)



CCTV A (0,10)

S3/S4 INSTALL VIEWING

1. SETUP

NOTE

Assumed starting posn is 1A/3A SAW Viewing posn.
 MT at WS 2 with SSRMS on PDGF 2 at Handoff posn
 (SR: -79.4, SY: +38.5, SP: -127.7, EP: -39.6, WP: -73.6,
 WY: -6.8, WR: -9.8)

A7U

CCTV – config as reqd

MON 1	C (US Lab)
MON 2	A
DNLK	D
DTV	B

SM 94 PDRS CONTROL

√PL ID, ITEM 3: 0

√INIT ID, ITEM 24: 0

2. MNVR TO S3/S4 INSTALL VIEWING

√RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – SINGLE, ENTER

Mnvr to S3/S4 INSTALL VIEWING posn (within 0.1°):

1A/3A SAW
Viewing
1: WY +
2: EP –
S3/S4 Install
Viewing

SY	SP	EP	WP	WY	WR	
-56.0	+6.0	-58.0	+89.2	-68.0	+91.6	
				-66.7		
		-61.4				
-56.0	+6.0	-61.4	+89.2	-66.7	+91.6	
X	Y	Z	PITCH	YAW	ROLL	PL ID
-887	+329	-405	141	318	179	0

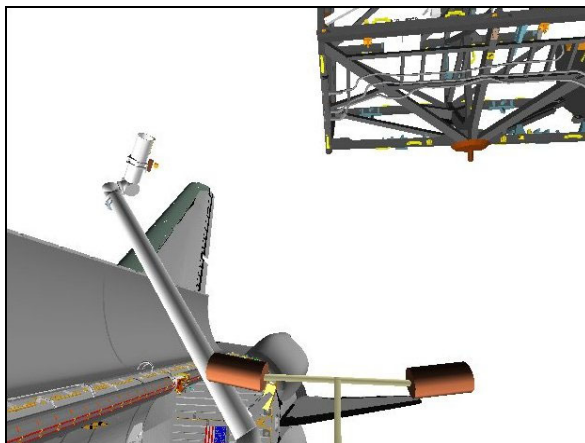
BRAKES – ON (tb-ON)

√MODE – not DIRECT

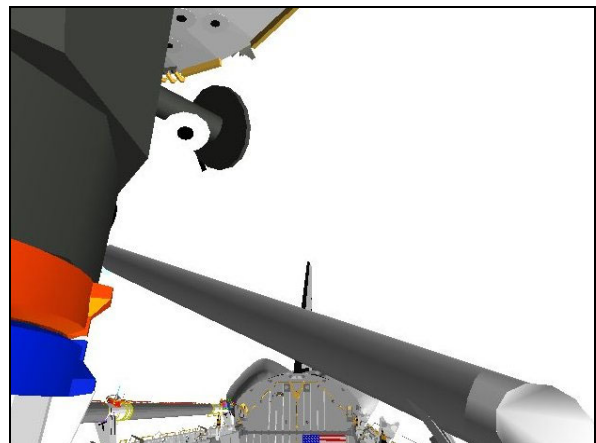
PARAM – PORT TEMP

JOINT – CRIT TEMP

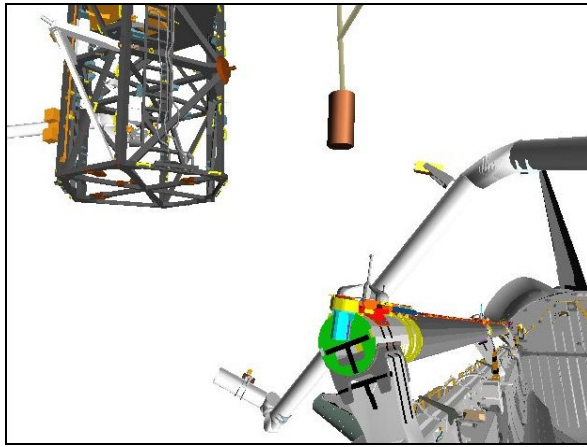
Notify SSRMS operator that SRMS is in S3/S4 Install Viewing posn with Brakes ON



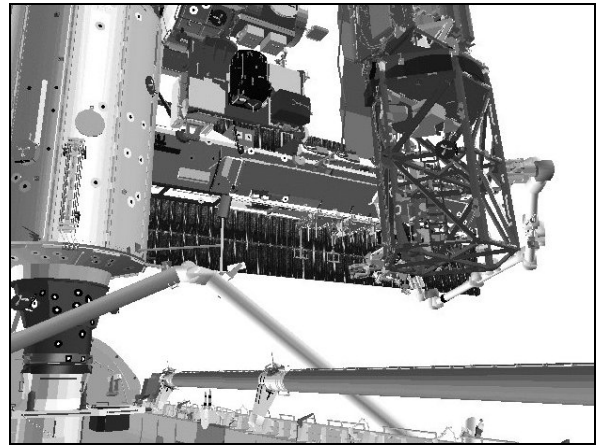
US LAB (-5,-5)



CCTV A (-5,25)



CCTV D (-30,15)



CCTV B (30,15)

A7U

3. SVS WRIST CAMERA FOCAL LENGTH SETUP

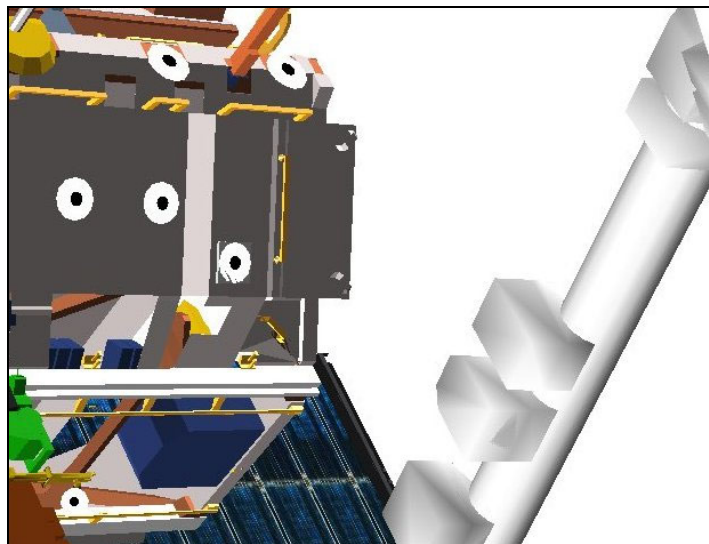
Route video (if required):

VID OUT	VID IN
MON 1	WRIST
DNLK	WRIST

Set up SRMS Wrist Camera:

Cam	HFOV	Focus	ALC	Color Bal	Shut	Gamma
EE	14.6	Far	AVG	Sun	OFF	OFF

Verify SRMS Wrist Camera view of S1 SVS targets



WRIST HFOV: 14.6

Notify AVU operator camera setup complete

4. WRIST CAMERA ZOOM ADJUSTMENT

Adjust camera zoom as required by AVU operator using small zoom increments

5. SAFE WRIST CAMERA SETUP

On notification from AVU operator, SRMS wrist camera focal length setup complete:

Install zoom/focus switch guards

Do not adjust SRMS Wrist camera zoom/focus

Do not switch to RMS Elbow camera for remainder of SVS operations

If RMS Wrist camera failed, on MCC GO:

A7U

6. SVS CAMERA B FOCAL LENGTH SETUP

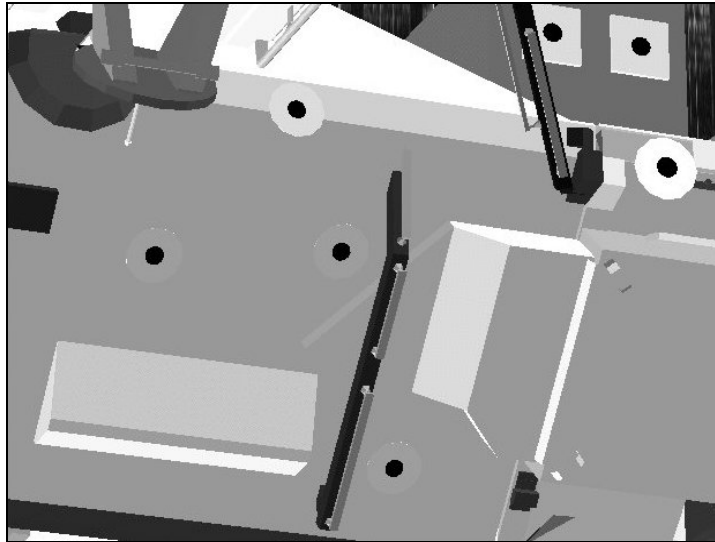
Route video (if required):

VID OUT	VID IN
MON 1	B
DNLK	B

Set up Cam B:

Cam	HFOV	Focus	ALC	Lt Level	Ap Cor	Gamma
B	8.5	Far	AVG	Day	OFF	OFF

Aim Cam B at S0/S1 SVS targets



CCTV B (21,21) HFOV: 8.5

Notify AVU operator Cam B aimed at S0/S1 SVS targets

7. CAMERA B ZOOM ADJUSTMENT

Adjust camera zoom as required by AVU operator using small zoom increments

8. SAFE CAMERA B ZOOM/FOCUS

On notification from AVU operator, camera B focal length setup complete:

Install zoom/focus switch guards

Do not adjust Camera B zoom/focus for remainder of SVS operations

9. S3 TRUSS INSTALL SVS SETUP

A7U

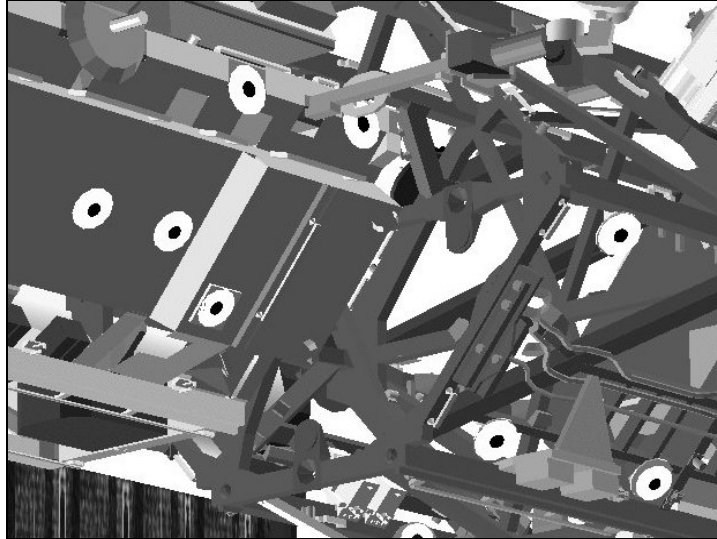
Route video (if required):

VID OUT	VID IN
MON 1	B
DNLK	B

Aim Cam B at S1 SVS targets on GO from AVU operator and when SSRMS has completed mnvr to pre-install posn

NOTE

View from CCTV B with SSRMS in Pre-Install posn



CCTV B (47,15) HFOV: 8.5

Notify AVU operator Cam B aimed at S1/S3 SVS targets

10. SAFE CAMERA B PAN/TILT

On notification from AVU operator, camera B focal length setup complete:

Install pan/tilt switch guards

Do not adjust Camera B pan/tilt/zoom/focus for remainder of SVS operations

11. MNVR TO 1A/3A SAW VIEWING

On SSRMS Operator GO to maneuver to the 1A/3A Viewing position

√RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – SINGLE, ENTER

Mnvr to 1A/3A SAW VIEWING posn:

S3/S4 Install
Viewing
1: EP +
2: WY –
1A/3A SAW
Viewing

SY	SP	EP	WP	WY	WR	
-56.0	+6.0	-61.4	+89.2	-66.7	+91.6	
		-58.0				
				-68.0		
-56.0	+6.0	-58.0	+89.2	-68.0	+91.6	
X	Y	Z	PITCH	YAW	ROLL	PL ID
-892	+334	-419	142	320	177	0

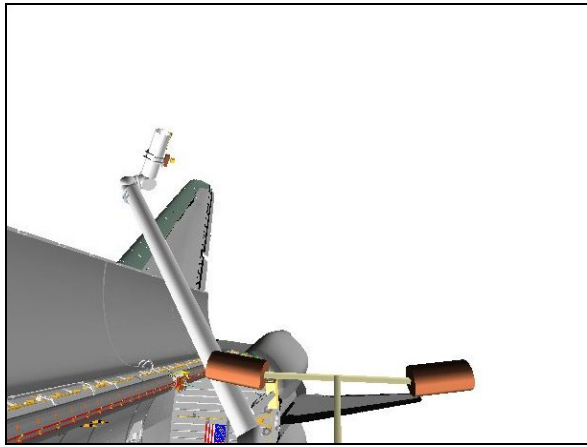
BRAKES – ON (tb-ON)

√MODE – not DIRECT

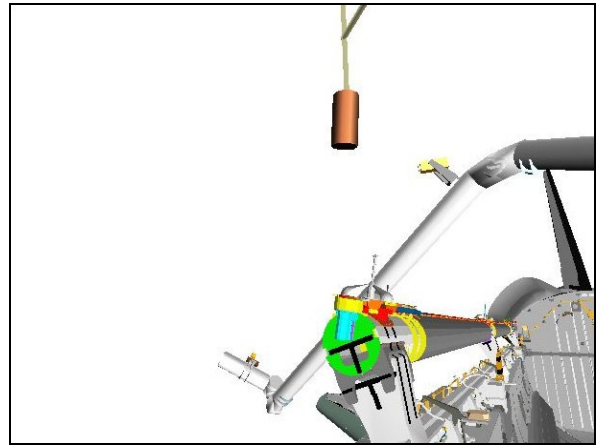
PARAM – PORT TEMP

JOINT – CRIT TEMP

Notify SSRMS operator that SRMS is in 1A/3A SAW Viewing posn with Brakes ON



US LAB (-5,-5)



CCTV D (-30,15)

SAW RETRACT VIEWING

1. SETUP

NOTE

Assumed starting posn is 1A/3A SAW Viewing posn.
 Verify MT at WS 2 with SSRMS on PDGF 2 at 3A
 Viewing posn (SR: -138.0, SY: +60.7, SP: -38.7,
 EP: -45.3, WP: -61.0, WY: -7.4, WR: +0.6)

A7U

CCTV – config as reqd

MON 1	P1LO
MON 2	B (D)
DNLK	Elbow
DTV	C

SM 94 PDRS CONTROL

√PL ID, ITEM 3: 0

√INIT ID, ITEM 24: 0

RHC

2. MNVR TO SAW RETRACT VIEWING POSITION

RATE – as reqd (VERN within 10 ft)

BRAKES – OFF (tb-OFF)

MODE – SINGLE, ENTER

Mnvr to SAW RETRACT VIEWING posn:

1A/3A SAW
Viewing

1: EP +

2: SP +

3: SY +

4: WP –

5: WY +

6: WR –

SAW Retract
Viewing

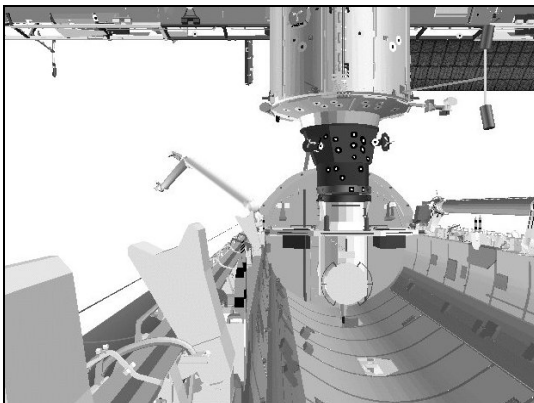
	SY	SP	EP	WP	WY	WR	
	-56.0	+6.0	-58.0	+89.2	-68.0	+91.6	
			-25.0				
		+25.0					
	+160.0						
				+5.0			
					0.0		
						0.0	
	+160.0	+25.0	-25.0	+5.0	0.0	0.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-133	-333	-485	182	21	142	0

BRAKES – ON (tb-ON)

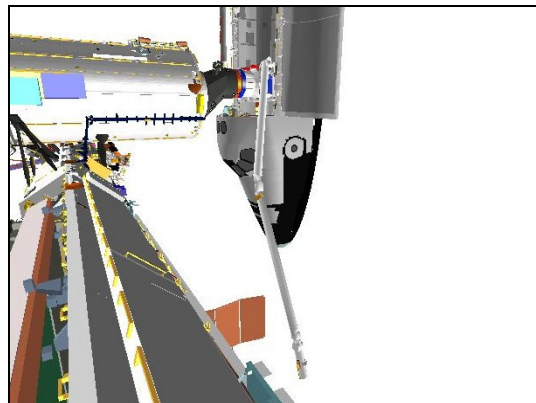
√MODE – not DIRECT

PARAM – PORT TEMP

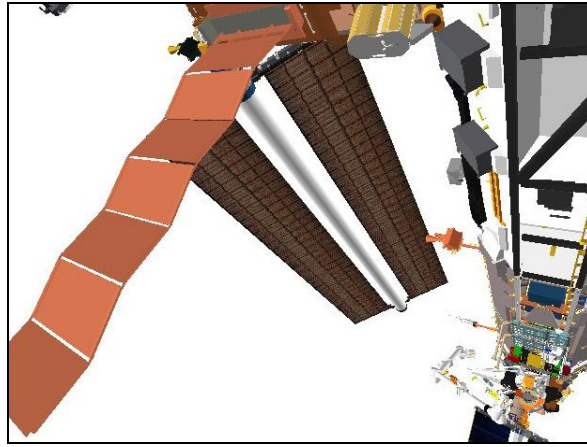
JOINT – CRIT TEMP



CCTV B (0,0)



P1 LOWER OUTBOARD (120,-15)



ELBOW (70,-40)

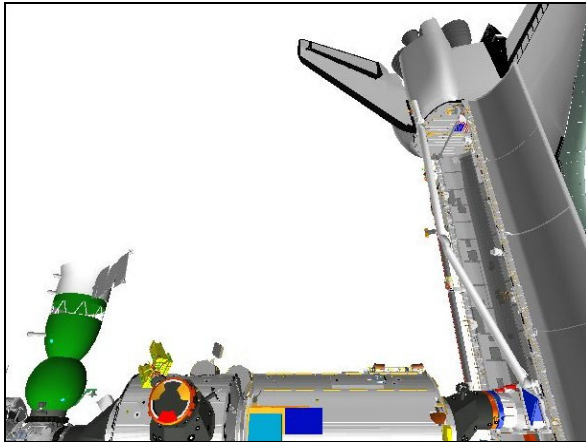
- RHC
3. MNVR TO PRE-CRADLE
 RATE – as reqd (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – SINGLE, ENTER

Drive SY- to 0.0°

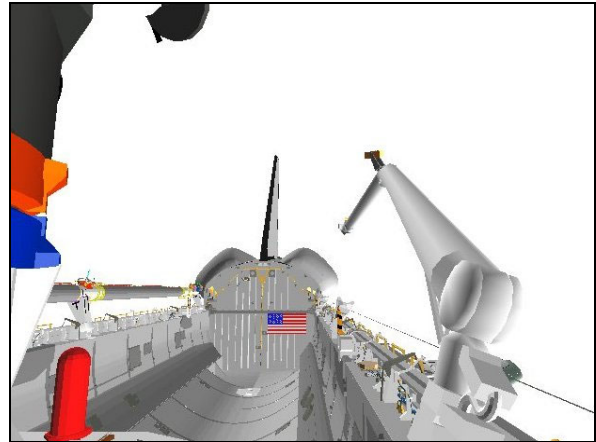
PRE-CRADLE posn:

√	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-1261	-146	-551	5	2	0	0
	SY	SP	EP	WP	WY	WR	
√	0.0	+25.0	-25.0	+5.0	0.0	0.0	

- BRAKES – ON (tb-ON)
 √MODE – not DIRCT
 PARAM – PORT TEMP
 JOINT – CRIT TEMP



P1 LOWER OUTBOARD (90,30)



CCTV A (0,10)

SAW RETRACT VIEWING W/OBSS

1. SETUP

NOTE

Assumed starting posn is OBSS Park. Verify MT at WS 3 with SSRMS on PDGF 3 at Focused Inspection
Viewing posn (SR: +41.6, SY: +61.1, SP: +46.3, EP: -61.3, WP: -121.8, WY: -39.1, WR: +115.0)

A7U CCTV – config as reqd

MON 1	P1LO
MON 2	A (B)
DNLK	Elbow
DTV	OBSS ITVC

SM 94 PDRS CONTROL

- √PL ID, ITEM 3: 2
- √INIT ID, ITEM 24: 2

RHC

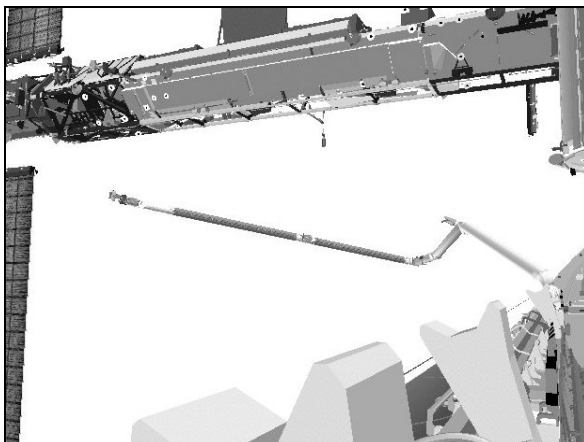
2. MNVR TO SAW RETRACT VIEWING W/OBSS POSITION

RATE – as reqd (VERN within 10 ft)
BRAKES – OFF (tb-OFF)
MODE – SINGLE, ENTER

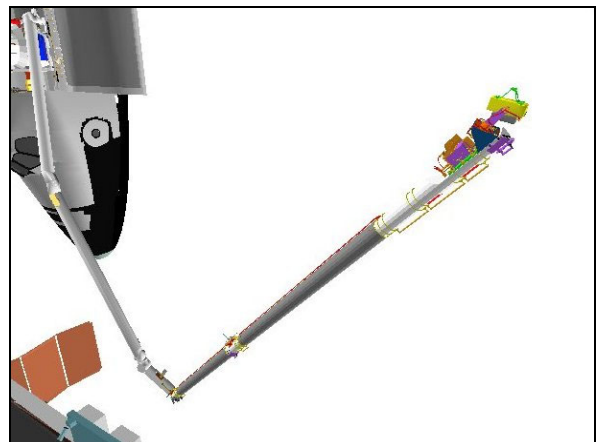
Mnvr to SAW RETRACT VIEWING w/OBSS posn:

	SY	SP	EP	WP	WY	WR	
OBSS Park	0.0	+25.0	-25.0	+5.0	0.0	0.0	
1: WR –						-45.0	
2: WY –					-30.0		
3: SY +	+160.0						
SAW Retract w/OBSS	+160.0	+25.0	-25.0	+5.0	-30.0	-45.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-577	-751	-577	13	42	272	2

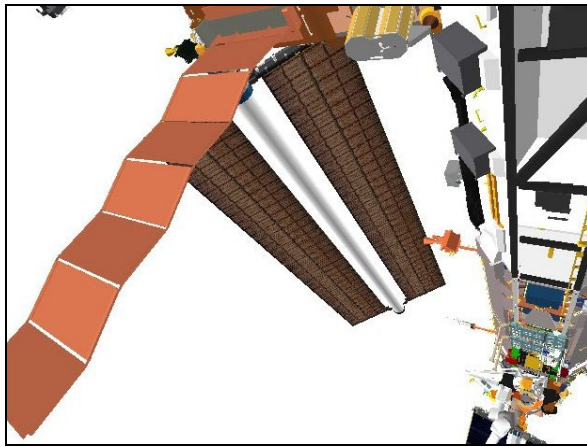
- BRAKES – ON (tb-ON)
- √MODE – not DIRECT
- PARAM – PORT TEMP
- JOINT – CRIT TEMP



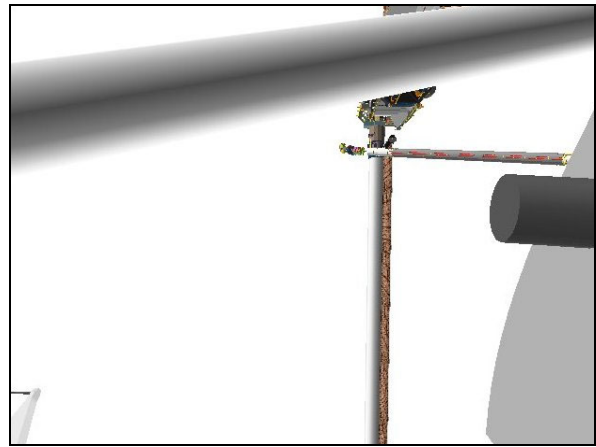
CCTV B (-25,5)



P1 LOWER OUTBOARD (-150,-20)



ELBOW (70,-40)



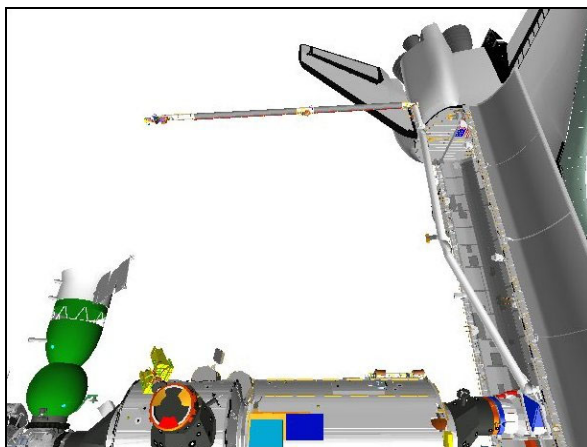
CCTV A (85,0)

- RHC
3. MNVR TO OBSS PARK
 RATE – as reqd (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – SINGLE, ENTER

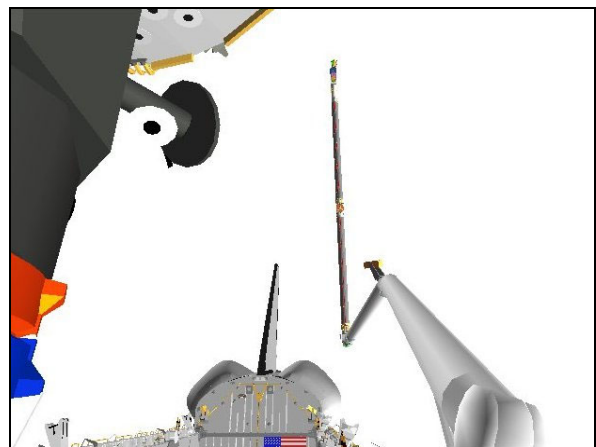
Mnvr to OBSS PARK posn:

	SY	SP	EP	WP	WY	WR	
SAW Retract w/OBSS	+160.0	+25.0	-25.0	+5.0	-30.0	-45.0	
1: SY –	0.0						
2: WY +					0.0		
3: WR +						0.0	
OBSS Park	0.0	+25.0	-25.0	+5.0	0.0	0.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-1216	-141	-1141	95	359	358	2

- BRAKES – ON (tb-ON)
 √MODE – not DIRECT
 PARAM – PORT TEMP
 JOINT – CRIT TEMP



P1 LOWER OUTBOARD (90,30)



CCTV A (0,25)

REFERENCE DATA

I

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REF DATA

JOINT ANGLES VERSUS POR COORDINATES

S3/S4 PRE-GRAPPLE

X	Y	Z	PITCH	YAW	ROLL	PL ID
-829	+95	-501	270	49	91	0
-1002	+43	-455	0	0	0	4
-724	+46	-520	0	0	0	5
SY	SP	EP	WP	WY	WR	
-60.3	+60.7	-108.8	-107.5	+27.4	+188.7	

S3/S4 GRAPPLE (Expected Values)

X	Y	Z	PITCH	YAW	ROLL	PL ID
-829	+50	-461	270	49	91	0
-1002	0	-414	0	0	0	4
-725	0	-480	0	0	0	5
SY	SP	EP	WP	WY	WR	
-54.1	+63.7	-121.1	-96.4	+33.0	+185.0	

S3/S4 INTERMEDIATE

X	Y	Z	PITCH	YAW	ROLL	PL ID
-829	+50	-481	270	49	91	0
-1002	0	-434	0	0	0	4
-725	0	-500	0	0	0	5
SY	SP	EP	WP	WY	WR	
-55.0	+66.8	-119.7	-101.1	+32.2	+185.4	

S3/S4 PORT

X	Y	Z	PITCH	YAW	ROLL	PL ID
-829	+48	-481	270	49	91	0
-1002	-2	-434	0	0	0	4
-725	-2	-500	0	0	0	5
SY	SP	EP	WP	WY	WR	
-54.7	+67.2	-120.1	-101.1	+32.4	+185.3	

S3/S4 LOW HOVER

X	Y	Z	PITCH	YAW	ROLL	PL ID
-829	+48	-522	270	49	91	0
-1002	-2	-475	0	0	0	4
-725	-2	-541	0	0	0	5
SY	SP	EP	WP	WY	WR	
-56.4	+72.4	-116.1	-110.7	+30.9	+186.1	

S3/S4 ROLL

X	Y	Z	PITCH	YAW	ROLL	PL ID
-829	+34	-534	270	34	91	0
-1002	-2	-475	0	0	15	4
-725	-19	-539	0	0	15	5
SY	SP	EP	WP	WY	WR	
-54.4	+80.8	-118.4	-99.9	+27.8	+176.8	

REF DATA

S3/S4 TILT

X	Y	Z	PITCH	YAW	ROLL	PL ID
-824	+34	-573	292	34	91	0
-1006	-2	-584	22	0	15	4
-725	-19	-539	22	0	15	5
SY	SP	EP	WP	WY	WR	
-60.2	+86.1	-116.0	-104.2	+41.2	+190.5	

S3/S4 HIGH HOVER

X	Y	Z	PITCH	YAW	ROLL	PL ID
-884	+34	-637	292	34	91	0
-1066	-2	-647	22	0	15	4
-785	-19	-603	22	0	15	5
SY	SP	EP	WP	WY	WR	
-52.3	+80.4	-95.9	-112.9	+46.4	+182.3	

S3/S4 HANDOFF

X	Y	Z	PITCH	YAW	ROLL	PL ID
-870	+334	-682	185	321	271	0
-800	+375	-850	95	0	190	4
-889	+387	-579	95	0	190	5
SY	SP	EP	WP	WY	WR	
-63.2	+23.3	-21.6	-61.7	-71.6	+63.8	

1A/3A SAW VIEWING

X	Y	Z	PITCH	YAW	ROLL	PL ID
-892	+334	-419	142	320	177	0
-885	+349	-426	55	3	110	1
-1234	+307	-901	55	3	140	2
SY	SP	EP	WP	WY	WR	
-56.0	+6.0	-58.0	+89.2	-68.0	+91.6	

S3/S4 INSTALL VIEWING

X	Y	Z	PITCH	YAW	ROLL	PL ID
-887	+329	-405	141	318	179	0
-753	+246	-506	143	48	137	4
-957	+423	-413	143	48	137	5
SY	SP	EP	WP	WY	WR	
-56.0	+6.0	-61.4	+89.2	-66.7	+91.6	

SAW RETRACT VIEWING

X	Y	Z	PITCH	YAW	ROLL	PL ID
-133	-333	-485	182	21	142	0
-115	-336	-488	76	36	176	1
-244	-681	-949	76	36	206	2
SY	SP	EP	WP	WY	WR	
+160.0	+25.0	-25.0	+5.0	0.0	0.0	

SAW RETRACT VIEWING W/OBSS

X	Y	Z	PITCH	YAW	ROLL	PL ID
-149	-355	-477	196	48	88	0
-137	-369	-478	13	42	242	1
-577	-751	-577	13	42	272	2
SY	SP	EP	WP	WY	WR	
+160.0	+25.0	-25.0	+5.0	-30.0	-45.0	

OBSS PRE-GRAPPLE AT HANDOFF

X	Y	Z	PITCH	YAW	ROLL	PL ID
-966	-1	-625	285	0	271	0
-975	-1	-610	45	270	0	1
-967	+590	-628	15	270	0	2
SY	SP	EP	WP	WY	WR	
-33.3	+80.0	-90.0	-77.3	+23.8	-39.8	

*
*

* display singularity

OBSS HANDOFF (Expected Values)

X	Y	Z	PITCH	YAW	ROLL	PL ID
-984	-1	-558	285	0	271	0
-993	-1	-543	45	270	0	1
-986	+590	-561	15	270	0	2
SY	SP	EP	WP	WY	WR	
-28.4	+75.5	-98.1	-62.5	+23.6	-45.1	

*
*

*display singularity

OBSS PARK

X	Y	Z	PITCH	YAW	ROLL	PL ID
-1261	-146	-551	5	2	0	0
-1279	-151	-553	95	359	328	1
-1216	-141	-1141	95	359	358	2
SY	SP	EP	WP	WY	WR	
0.0	+25.0	-25.0	+5.0	0.0	0.0	

OBSS UNDOCK

X	Y	Z	PITCH	YAW	ROLL	PL ID
-1032	-362	-618	284	0	270	0
-1041	-362	-602	314	270	270	1
-1029	+229	-614	14	270	0	2
SY	SP	EP	WP	WY	WR	
+25.8	+66.3	-49.0	-85.9	+10.7	-100.7	

*
*

*display singularity

OBSS HOVER

X	Y	Z	PITCH	YAW	ROLL	PL ID
-680	+128	-514	270	350	1	0
-680	+126	-496	0	0	341	1
-1271	+127	-511	0	0	11	2
SY	SP	EP	WP	WY	WR	
-90.0	+79.8	-123.1	-55.7	0.0	-250.0	

S3/S4 AUTOSEQUENCES

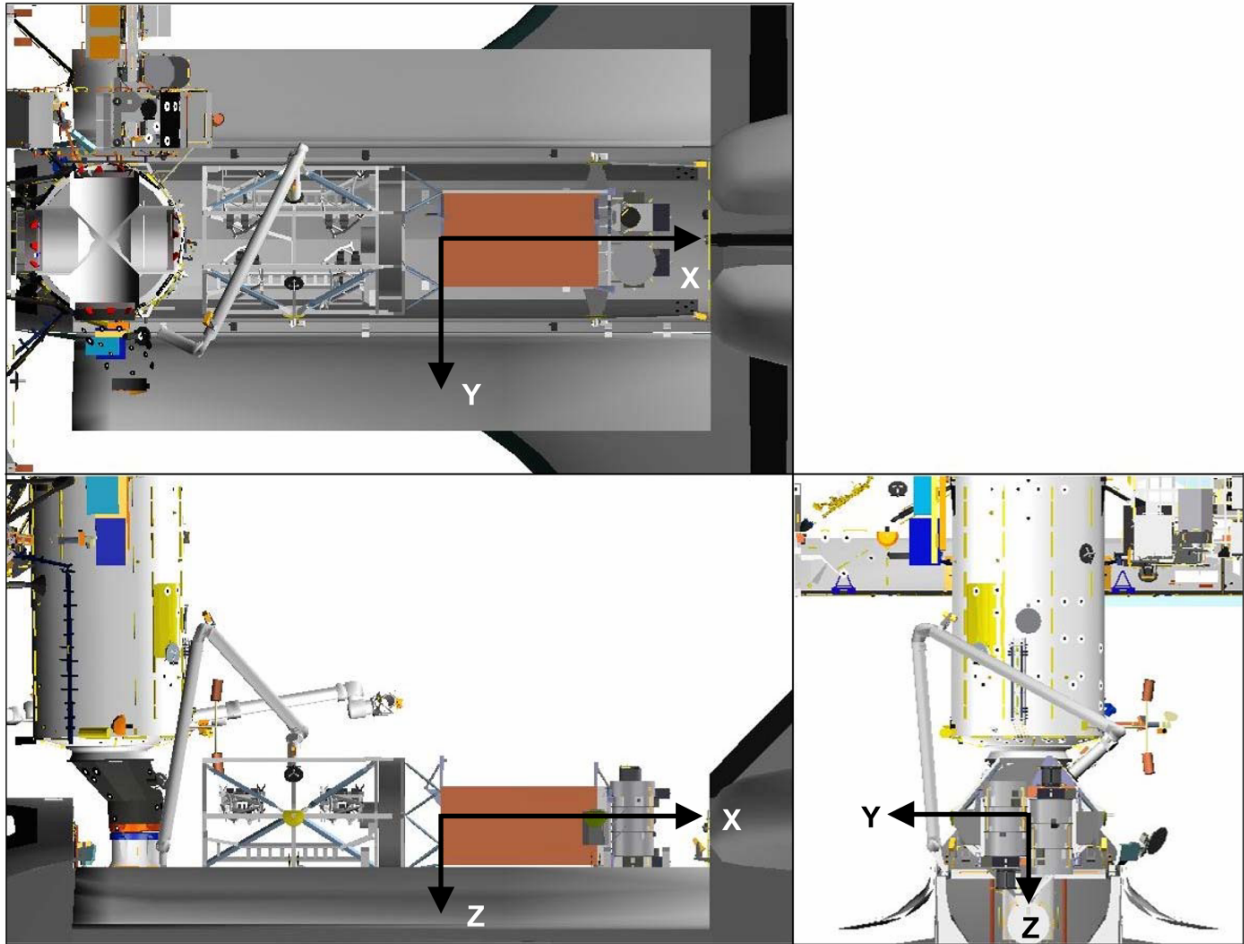
Maneuver to Handoff (PL ID 4)

Auto Seq ID	Auto posn	X/ SY	Y/ SP	Z/ EP	PITCH/ WP	YAW/ WY	ROLL/ WR	Pause
7	148	-1066	-2	-647	22	0	15	P
		-52.3	+80.4	-95.9	-112.9	+46.4	+182.3	
7	149	-1090	+90	-670	30	330	45	
		-42.2	+88.9	-96.3	-70.7	+37.1	+113.4	
7	150	-1130	+120	-750	45	325	55	
		-37.8	+79.0	-77.3	-61.8	+32.3	+94.5	
7	151	-1150	+230	-795	80	330	80	
		-37.7	+56.1	-61.5	-27.9	+15.0	+78.4	
7	152	-1130	+275	-795	90	350	90	
		-41.7	+41.5	-55.8	-4.7	+4.2	+88.4	
7	153	-1050	+355	-790	98	355	115	
		-47.2	+30.3	-43.7	-6.4	-16.1	+86.6	
7	154	-939	+331	-834	90	359	177	
		-49.2	+23.3	-21.6	-61.7	-71.6	+63.8	
7	155	-800	+375	-850	95	0	190	P
		-63.2	+23.3	-21.6	-61.7	-71.6	+63.8	

Maneuver to High Hover (PL ID 4)

Auto Seq ID	Auto posn	X/ SY	Y/ SP	Z/ EP	PITCH/ WP	YAW/ WY	ROLL/ WR	Pause
8	156	-800	+375	-850	95	0	190	P
		-63.2	+23.3	-21.6	-61.7	-71.6	+63.8	
8	157	-939	+331	-834	90	359	177	
		-49.2	+23.3	-21.6	-61.7	-71.6	+63.8	
8	158	-1050	+355	-790	98	355	115	
		-47.2	+30.3	-43.7	-6.4	-16.1	+86.6	
8	159	-1130	+275	-795	90	350	90	
		-41.7	+41.5	-55.8	-4.7	+4.2	+88.4	
8	160	-1150	+230	-795	80	330	80	
		-37.7	+56.1	-61.5	-27.9	+15.0	+78.4	
8	161	-1130	+120	-750	45	325	55	
		-37.8	+79.0	-77.3	-61.8	+32.3	+94.5	
8	162	-1090	+90	-670	30	330	45	
		-42.2	+88.9	-96.3	-70.7	+37.1	+113.4	
8	163	-1066	-2	-647	22	0	15	P
		-52.3	+80.4	-95.9	-112.9	+46.4	+182.3	

S3/S4 COORDINATE SYSTEM – PL ID 4



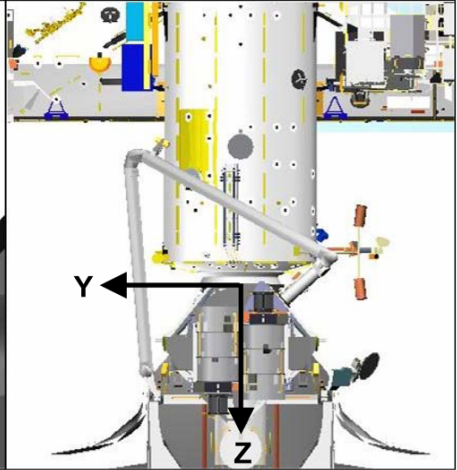
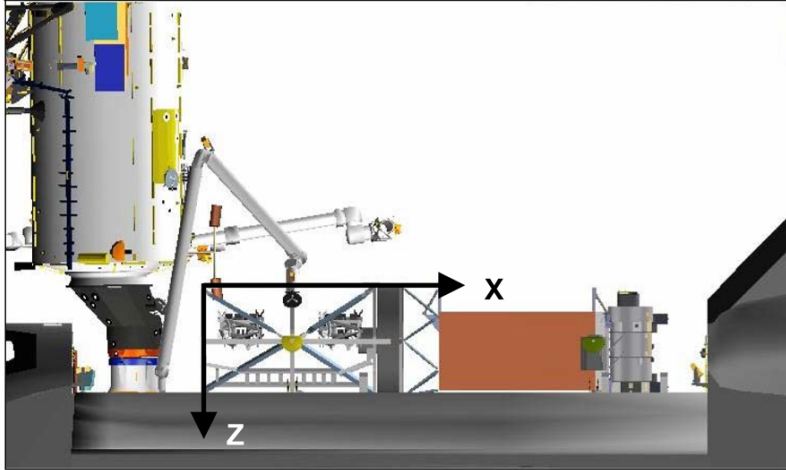
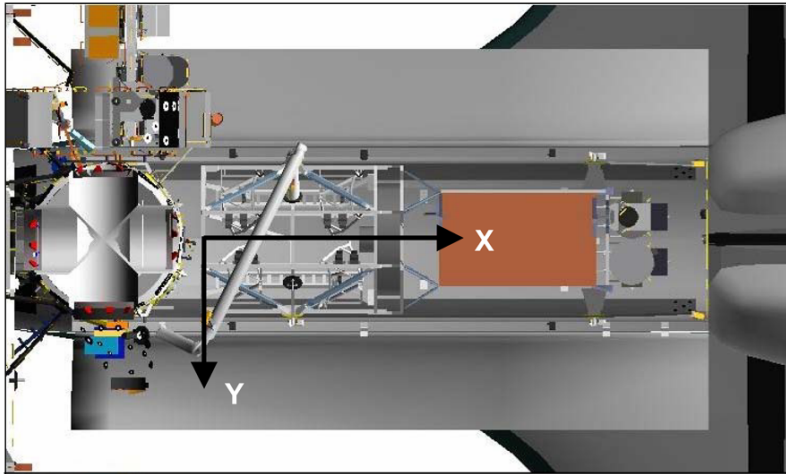
POR: POR at midpoint between forward and aft trunnions at trunnion level

PURPOSE: S3/S4 unberthing and maneuvering

RATES:	<u>COARSE</u>	<u>VERN</u>
TRANS LIM ft/sec	0.10	0.05
ROT LIM deg/sec	0.47	0.16

JOINT RATES:	<u>COARSE</u>	<u>VERN</u>
SHOULDER LIM deg/sec	0.23	0.10
ELBOW LIM deg/sec	0.32	0.11
WRIST LIM deg/sec	0.47	0.16

S3/S4 COORDINATE SYSTEM – PL ID 5



POR:

POR at top of S3 forward interface

PURPOSE:

S3/S4 maneuvering

RATES:

TRANS LIM ft/sec

COARSE

0.10

VERN

0.05

ROT LIM deg/sec

0.47

0.16

JOINT RATES:

SHOULDER LIM deg/sec

COARSE

0.23

VERN

0.10

ELBOW LIM deg/sec

0.32

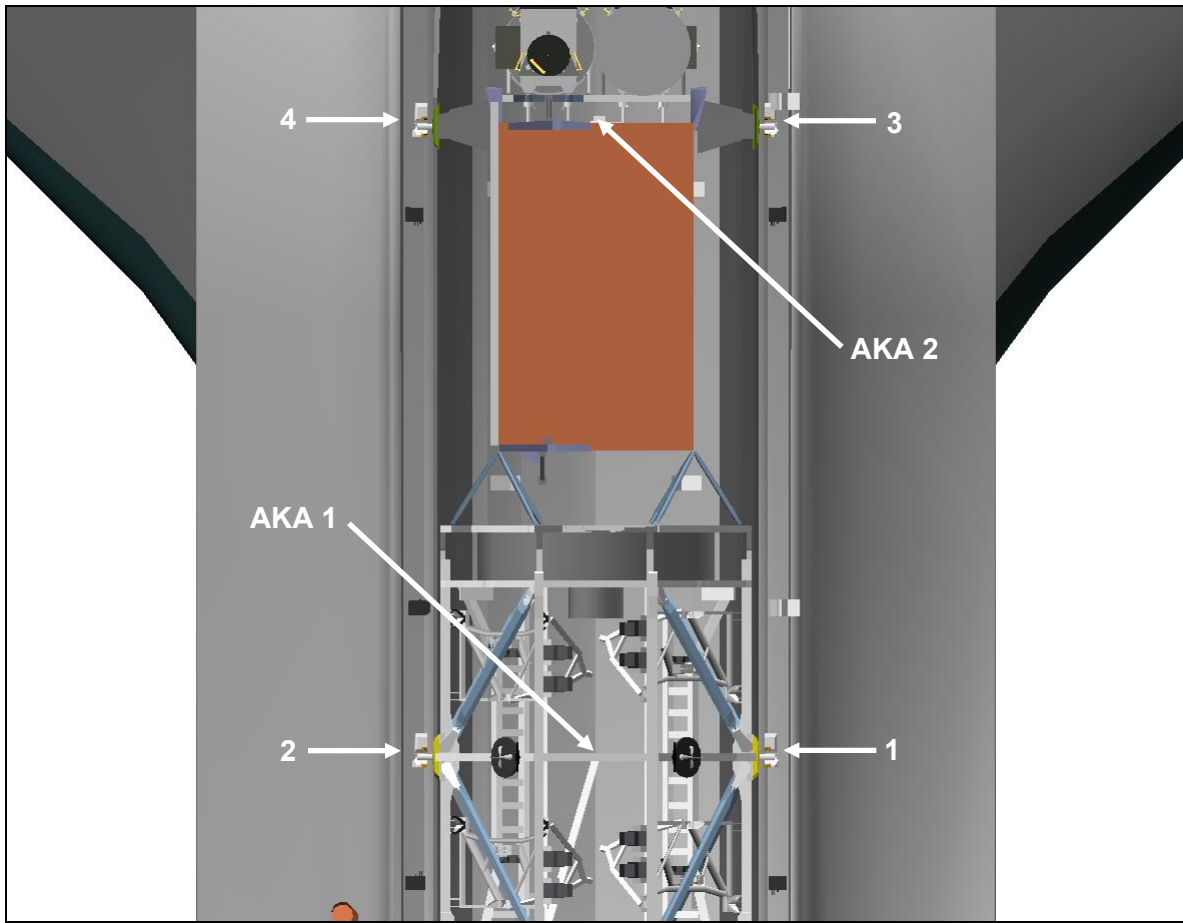
0.11

WRIST LIM deg/sec

0.47

0.16

S3/S4 PRLA CONFIGURATION



LAT/REL SEQUENCE	PL SEL	LAT/REL
AKA	2	1,2
PRLA	1	1,2 (FORWARDS)
PRLA	1	3,4 (AFTS)

CUE CARD CONFIGURATION

S3/S4 SJ GRAPPLE WRIST CCTV OVERLAY..... FS CC 6-2
UNGRAPPLE WRIST CCTV OVERLAY FS CC 6-3

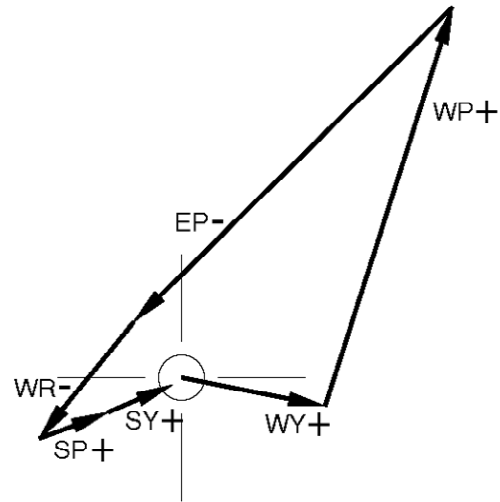
CUE CARD
CONFIG

Fabricate as transparency

ZOOM 34.0 HFOV
FOCUS 5.0 FT
EYEPOINT APPROX 18 IN



WR-



S3/S4 SJ GRAPPLE WRIST CCTV OVERLAY

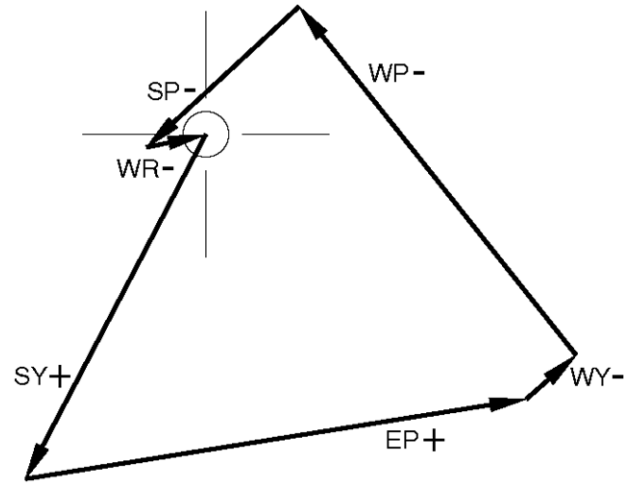
PDRS-7a/117/O/A

(reduced copy)

FS CC 6-2

PDRS/117/FIN

Fabricate as transparency



S3/S4 SJ UNGRAPPLE WRIST CCTV OVERLAY

PDRS-8a/117/O/A

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FS CC 6-3

PDRS/117/FIN

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PDRS OPS C/L

**STS
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