

PDRS Operations Checklist

STS-118 Flight Supplement

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

**Final
April 20, 2007**

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas




MISSION OPERATIONS DIRECTORATE

**PDRS OPERATIONS CHECKLIST
STS-118 FLIGHT SUPPLEMENT**

FINAL
April 20, 2007

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Incorporates the following:		
482#:	PDRS FS-0006	PDRS FS-0011
	PDRS FS-0007	PDRS FS-0012
	PDRS FS-0008	PDRS FS-0013
	PDRS FS-0009	PDRS FS-0014
	PDRS FS-0010	PDRS FS-0015

AREAS OF TECHNICAL RESPONSIBILITY

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281-483-7529

PDRS OPERATIONS CHECKLIST
 STS-118 FLIGHT SUPPLEMENT

LIST OF EFFECTIVE PAGES

FINAL 04/20/07

Sign Off	*	118/FIN	FS 3-9	118/FIN
FS ii	*	118/FIN	FS 3-10	118/FIN
FS iii	*	118/FIN	FS 3-11	118/FIN
FS iv	*	118/FIN	FS 3-12	118/FIN
FS v		118/FIN	FS 3-13	118/FIN
FS vi		118/FIN	FS 3-14	118/FIN
FS 1-1		118/FIN	FS 3-15	118/FIN
FS 1-2		118/FIN	FS 3-16	118/FIN
FS 1-3		118/FIN	FS 3-17	118/FIN
FS 1-4		118/FIN	FS 3-18	118/FIN
FS 1-5		118/FIN	FS 3-19	118/FIN
FS 1-6		118/FIN	FS 3-20	118/FIN
FS 1-7		118/FIN	FS 3-21	118/FIN
FS 1-8		118/FIN	FS 3-22	118/FIN
FS 1-9		118/FIN	FS 3-23	118/FIN
FS 1-10		118/FIN	FS 3-24	118/FIN
FS 1-11		118/FIN	FS 3-25	118/FIN
FS 1-12		118/FIN	FS 3-26	118/FIN
FS 1-13		118/FIN	FS 3-27	118/FIN
FS 1-14		118/FIN	FS 3-28	118/FIN
FS 1-15		118/FIN	FS 4-1	118/FIN
FS 1-16		118/FIN	FS 4-2	118/FIN
FS 2-1		118/FIN	FS 4-3	118/FIN
FS 2-2		118/FIN	FS 4-4	118/FIN
FS 2-3		118/FIN	FS 4-5	118/FIN
FS 2-4		118/FIN	FS 4-6	118/FIN
FS 2-5		118/FIN	FS 4-7	118/FIN
FS 2-6		118/FIN	FS 4-8	118/FIN
FS 2-7		118/FIN	FS 4-9	118/FIN
FS 2-8		118/FIN	FS 4-10	118/FIN
FS 2-9		118/FIN	FS 4-11	118/FIN
FS 2-10		118/FIN	FS 4-12	118/FIN
FS 2-11		118/FIN	FS 4-13	118/FIN
FS 2-12		118/FIN	FS 4-14	118/FIN
FS 2-13		118/FIN	FS 4-15	118/FIN
FS 2-14		118/FIN	FS 4-16	118/FIN
FS 2-15		118/FIN	FS 4-17	118/FIN
FS 2-16		118/FIN	FS 4-18	118/FIN
FS 3-1		118/FIN	FS 4-19	118/FIN
FS 3-2		118/FIN	FS 4-20	118/FIN
FS 3-3		118/FIN	FS 4-21	118/FIN
FS 3-4		118/FIN	FS 4-22	118/FIN
FS 3-5		118/FIN	FS 4-23	118/FIN
FS 3-6		118/FIN	FS 4-24	118/FIN
FS 3-7		118/FIN	FS 4-25	118/FIN
FS 3-8		118/FIN	FS 4-26	118/FIN

* – Omit from flight book

FS 4-27	118/FIN	FS 6-1	118/FIN
FS 4-28	118/FIN	FS 6-2	118/FIN
FS 5-1	118/FIN	FS 6-3	118/FIN
FS 5-2	118/FIN	FS 6-4	118/FIN
FS 5-3	118/FIN	FS 6-5	118/FIN
FS 5-4	118/FIN	FS 6-6	118/FIN
FS 5-5	118/FIN	FS 6-7	118/FIN
FS 5-6	118/FIN	FS 6-8	118/FIN
FS 5-7	118/FIN	FS 6-9	118/FIN
FS 5-8	118/FIN	FS 6-10	118/FIN
FS 5-9	118/FIN	FS 7-1	118/FIN
FS 5-10	118/FIN	FS 7-2	118/FIN
FS 5-11	118/FIN	FS 7-3	118/FIN
FS 5-12	118/FIN	FS 7-4	118/FIN
FS 5-13	118/FIN	FS 7-5	118/FIN
FS 5-14	118/FIN	FS 7-6	118/FIN
FS 5-15	118/FIN	FS 8-1	118/FIN
FS 5-16	118/FIN	FS 8-2	118/FIN
FS 5-17	118/FIN	FS 8-3	118/FIN
FS 5-18	118/FIN	FS 8-4	118/FIN
FS 5-19	118/FIN	FS 8-5	118/FIN
FS 5-20	118/FIN	FS 8-6	118/FIN
FS 5-21	118/FIN	FS 9-1	* 118/FIN
FS 5-22	118/FIN	FS CC 9-2	* 118/FIN
FS 5-23	118/FIN	FS CC 9-3	* 118/FIN
FS 5-24	118/FIN	FS CC 9-4	* 118/FIN
FS 5-25	118/FIN	FS CC 9-5	* 118/FIN
FS 5-26	118/FIN	FS CC 9-6	* 118/FIN
FS 5-27	118/FIN	FS CC 9-7	* 118/FIN
FS 5-28	118/FIN	FS 9-8	* 118/FIN
FS 5-29	118/FIN		
FS 5-30	118/FIN		

PDRS CUE CARDS

<u>Title</u>	<u>Ref. Page</u>	<u>Card No.</u>
S5 SJ GRAPPLE WRIST CCTV OVERLAY	FS CC 9-2	PDRS-9a/118/O/B
UNGRAPPLE WRIST CCTV OVERLAY	FS CC 9-3	PDRS-10a/118/O/B
ESP-3 SJ GRAPPLE WRIST CCTV OVERLAY	FS CC 9-4	PDRS-11a/118/O/B
UNGRAPPLE WRIST CCTV OVERLAY	FS CC 9-5	PDRS-12a/118/O/A
OBSS SJ GRAPPLE AT HANDOFF WRIST CCTV OVERLAY	FS CC 9-6	PDRS-13a/118/O/B
OBSS SJ UNGRAPPLE AT HANDOFF WRIST CCTV OVERLAY	FS CC 9-7	PDRS-14a/118/O/B

* – Omit from flight book

<u>CONTENTS</u>	<u>PAGE</u>
<u>NOMINAL S5 OPS</u>	FS 1-1
S5 GRAPPLE.....	FS 1-2
UNBERTH.....	FS 1-5
HANDOFF.....	FS 1-9
UNGRAPPLE.....	FS 1-13
 <u>NOMINAL ESP-3 OPS</u>	 FS 2-1
ESP-3 GRAPPLE.....	FS 2-2
UNBERTH.....	FS 2-5
HANDOFF.....	FS 2-9
UNGRAPPLE.....	FS 2-13
 <u>OFF-NOMINAL S5 OPS</u>	 FS 3-1
S5 SJ GRAPPLE.....	FS 3-2
UNBERTH.....	FS 3-9
HANDOFF.....	FS 3-11
UNGRAPPLE.....	FS 3-17
CONTINGENCY REBERTH.....	FS 3-23
 <u>OFF-NOMINAL ESP-3 OPS</u>	 FS 4-1
ESP-3 SJ GRAPPLE.....	FS 4-2
UNBERTH.....	FS 4-9
HANDOFF.....	FS 4-11
UNGRAPPLE.....	FS 4-17
CONTINGENCY REBERTH.....	FS 4-23
 <u>OBSS OPERATIONS</u>	 FS 5-1
OBSS HANDOFF FROM SSRMS (WS4) TO SRMS.....	FS 5-2
SRMS TO SSRMS (WS4).....	FS 5-7
SJ HANDOFF FROM SSRMS (WS4) TO SRMS.....	FS 5-13
SRMS TO SSRMS (WS4).....	FS 5-23
 <u>VIEWING SUPPORT</u>	 FS 6-1
EVA 1 – P6 PVR CINCH VIEWING.....	FS 6-2
EVA 2 – CMG R&R VIEWING.....	FS 6-7
EVA 3 – P6 SASA RELOCATE VIEWING.....	FS 6-9
 <u>S5 REFERENCE DATA</u>	 FS 7-1
JOINT ANGLES VS POR COORDINATES.....	FS 7-2
S5 COORDINATE SYSTEM – PL ID 4.....	FS 7-3
PRLA CONFIGURATION.....	FS 7-4
S5 INSTALL CAMERA MATRIX.....	FS 7-5
 <u>ESP-3 REFERENCE DATA</u>	 FS 8-1
JOINT ANGLES VS POR COORDINATES.....	FS 8-2
ESP-3 COORDINATE SYSTEM – PL ID 5.....	FS 8-3
PRLA CONFIGURATION.....	FS 8-4
ESP-3 INSTALL CAMERA MATRIX.....	FS 8-5
 <u>CUE CARD CONFIGURATION</u>	 FS 9-1

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NOMINAL S5 OPS

S5 GRAPPLE.....	FS 1-2
UNBERTH	FS 1-5
HANDOFF	FS 1-9
UNGRAPPLE	FS 1-13

**NOMINAL
S5 OPS**

S5 GRAPPLE

NOMINAL
S5 OPS

1. S5 PRE-GRAPPLE

SM 94 PDRS CONTROL

√PL ID, ITEM 3: 0

√INIT ID, ITEM 24: 0

Mon 1	S1 LOOB
DwnInk	Elbow (EE)
Mon 2	C
DTV	A (D)

RATE – as required (VERN within 10 ft)

BRAKES – OFF (tb-OFF)

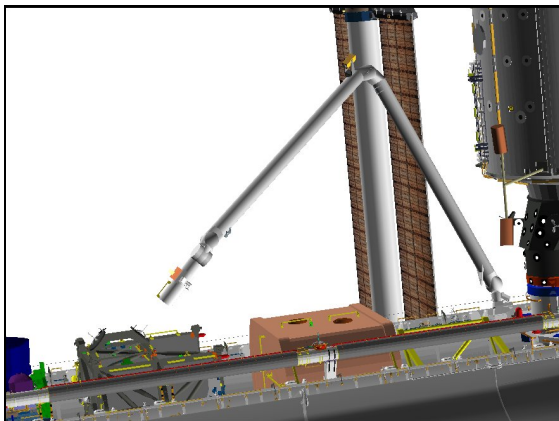
MODE – ORB UNL, ENTER

Mnvr to S5 PRE-GRAPPLE posn:

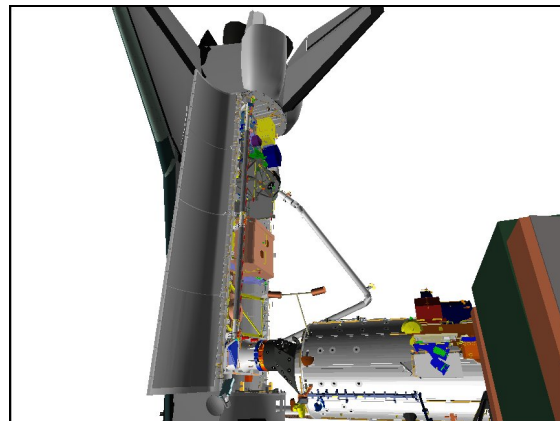
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1040	0	-492	315	0	331	0
SY	SP	EP	WP	WY	WR	
-22.1	+64.9	-102.7	-11.9	+29.0	-6.8	

BRAKES – ON (tb-ON)

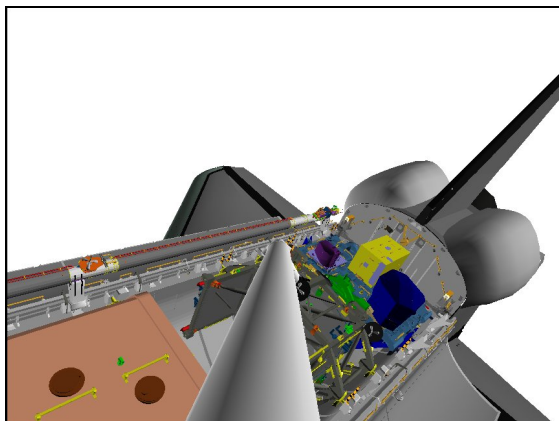
√MODE – not DIRECT



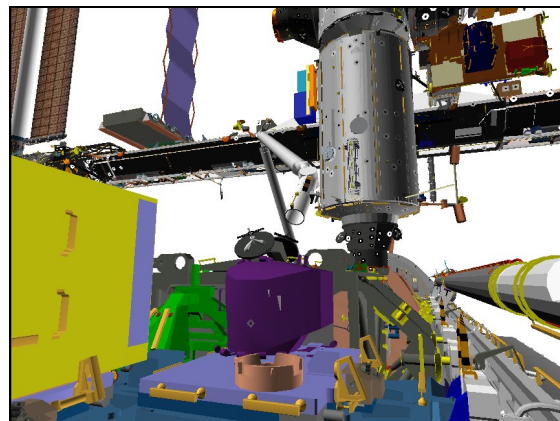
BIRD'S EYE



S1 LOOB (70,25)



ELBOW (0,0)



CCTV C (-20,10)

A7U

2. S5 GRAPPLE

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	S1 LOOB
DwnInk	EE
Mon 2	C
DTV	D

RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – END EFF, ENTER

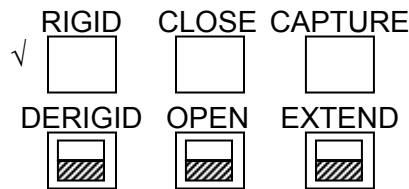
Mnvr to grapple envelope

<u>CAUTION</u> Monitor EE tb timing to prevent EE motor burnout
--

SM 169 PDRS STATUS

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) *

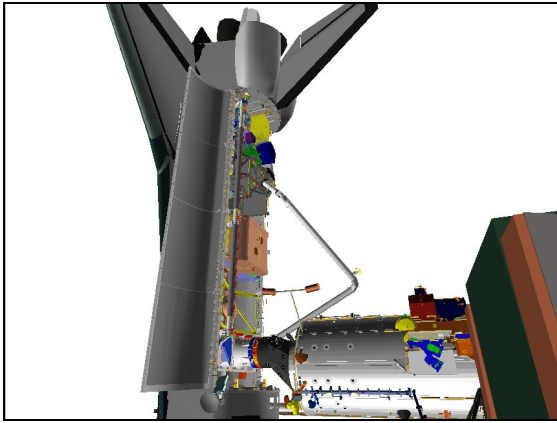
EE MODE – OFF

BRAKES – ON (tb-ON)

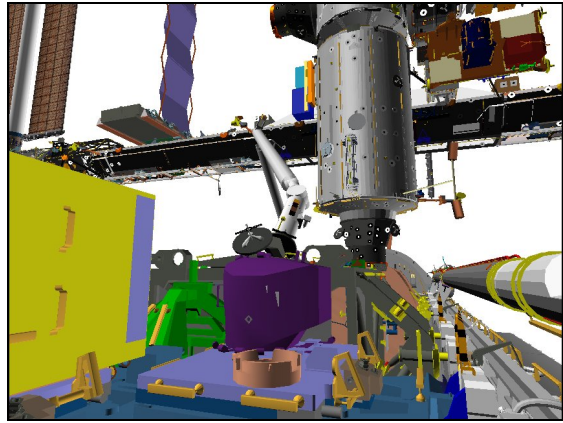
SM 94 PDRS CONTROL

PL ID – ITEM 3 +4 EXEC

INIT ID – ITEM 24 +4 EXEC



S1 LOOB (70,25)



CCTV C (-20,10)

Record POS/ATT and Joint Angles:

	X	Y	Z	PITCH	YAW	ROLL	PL ID
							4
Expected	-1089	0	-414	180	0	180	4
	SY	SP	EP	WP	WY	WR	
Expected	-19.4	+57.8	-97.8	-8.6	+27.2	-9.1	

Record POS/ATT and Joint Angles in S5 CONTINGENCY REBERTH
(OFF-NOM S5 HANDOFF)

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

S5 UNBERTH

- A7U 1. SETUP
CCTV – config for unberth

Mon 1	Lab (P1 LOOB)
DwnInk	Elbow (A)
Mon 2	Mux B & C
DTV	D

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 *

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 (two) – ON
A6U RETEN LOGIC PWR SYS 1,2 (two) – ON

SM 97 PL RETENTION

- √PL SEL 1 RDY-FOR-LAT 1,2,3,4,5 (ten) – 1
- √LAT 1,2,3,4,5 (ten) – 1

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

3. AKA RELEASE

- PL RETEN PL SEL – 1
- √LAT 5 tb – LAT
- √RDY 5 tb – gray

Note single motor times (> 30 sec)
PL RETEN LAT 5 – REL (tb-REL), 60 sec max
– OFF

4. PRLA RELEASE

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

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

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

6. MNVR TO S5 LOW HOVER POSN

CAUTION

Monitor clearances between STBD trunnions and OBSS during unberth. Minimum clearance of approximately 4 inches expected

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

Mnvr S5 up until Z = -610

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

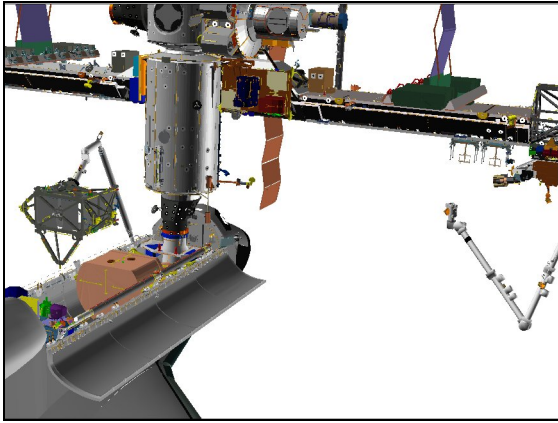
Mnvr to S5 LOW HOVER posn

X	Y	Z	PITCH	YAW	ROLL	PL ID
-1089	0	-610	180	0	180	4
SY	SP	EP	WP	WY	WR	
-28.4	+66.5	-69.3	-49.9	+32.9	-1.1	

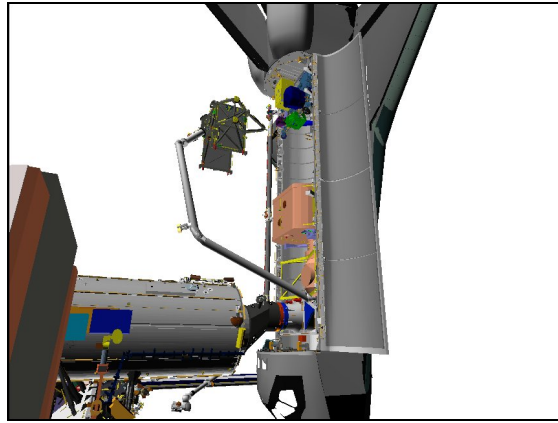
BRAKES – ON (tb-ON)

- * If using shuttle attitude control, verify rate < 0.20; *
- * then DAP: AUTO *

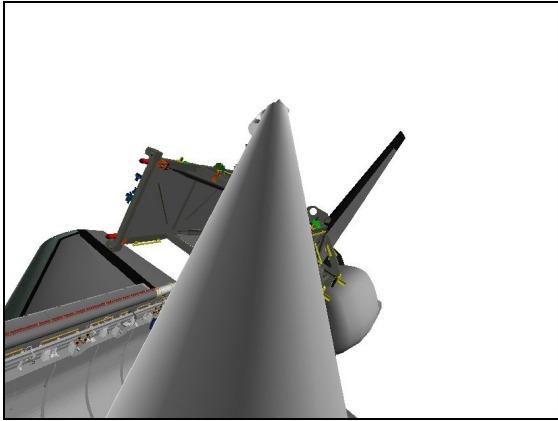
Notify SSRMS Operator SRMS at S5 Low Hover position, GO for maneuver to Pre-Grapple



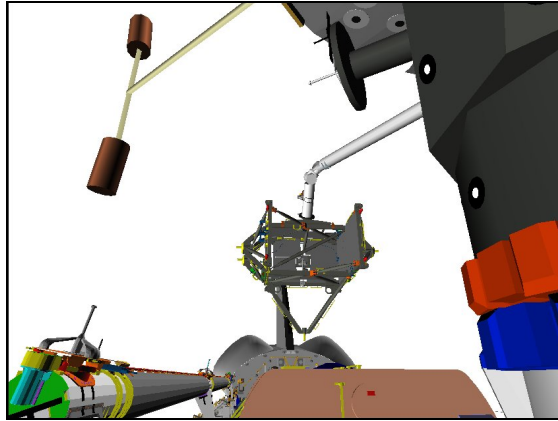
BIRD'S EYE



P1 LOOB (115,20)



ELBOW (0,-20)



CCTV D (5,25)

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S5 HANDOFF

1. MNVR TO S5 STBD POSN

On SSRMS Operator GO for maneuver to S5 Stbd position SSRMS at S5 Pre-Grapple position

- * If using shuttle attitude control: *
- * DAP: FREE *

Mon 1	P1 LOOB
DwnInk	Elbow
Mon 2	D
DTV	B (C)

RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – SINGLE, ENTER

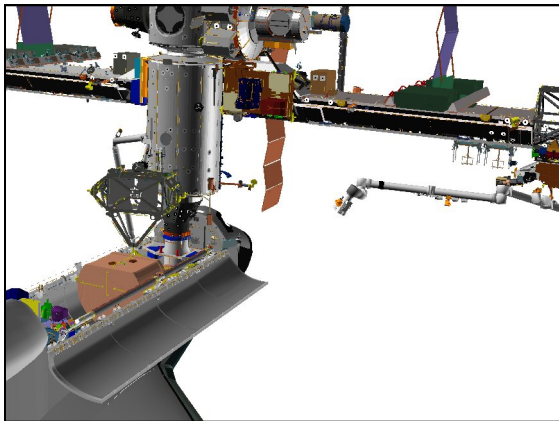
Drive SY negative to -47.0

S5 STBD posn:

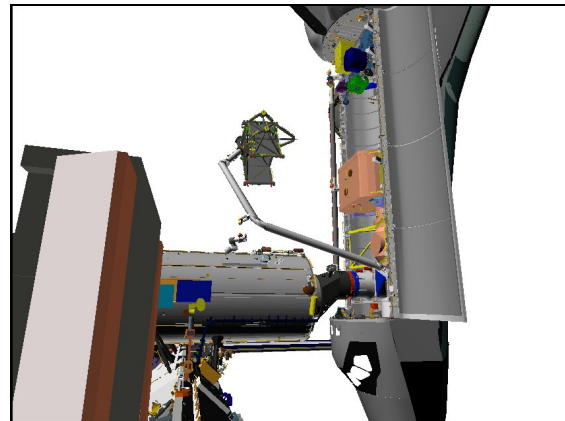
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1018	+116	-651	186	18	179	4
SY	SP	EP	WP	WY	WR	
-47.0	+66.5	-69.3	-49.9	+32.9	-1.1	

BRAKES – ON (tb-ON)

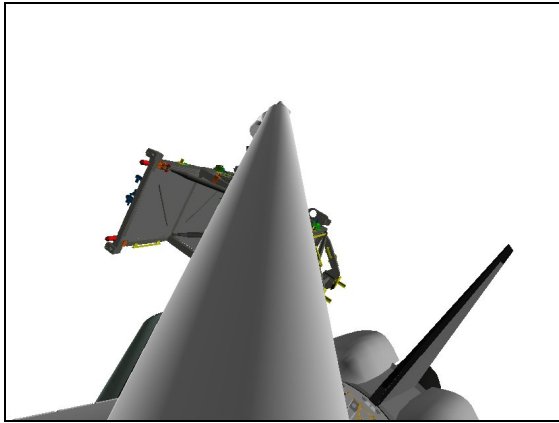
- * If using shuttle attitude control, verify rate < 0.20; *
- * then DAP: AUTO *



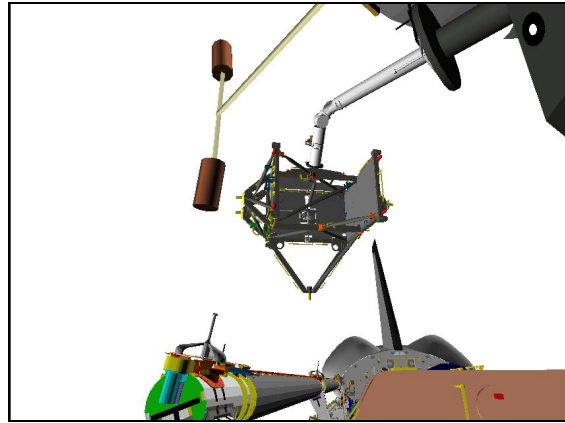
BIRD'S EYE



P1 LOOB (105,15)



ELBOW (0,-20)



CCTV D (-10,25)

2. MNVR TO S5 HANDOFF

- * If using shuttle attitude control: *
- * DAP: FREE *

Mon 1	P1 LOOB
DwnInk	Elbow
Mon 2	D
DTV	B (C)

NOTE

Expect 35 inches from SRMS Lower Boom and 26 inches from Elbow camera to UHF at Handoff posn

SM 94 PDRS CONTROL

AUTO 1 – ITEM 13 +0 7 EXEC

RATE – as required (VERN within 10 ft)

BRAKES – OFF (tb-OFF)

MODE – AUTO 1, ENTER

√START PT, ITEM 17: 148

√READY It – ON

AUTO SEQ – PROCEED (IN PROG It on)

(5:15)

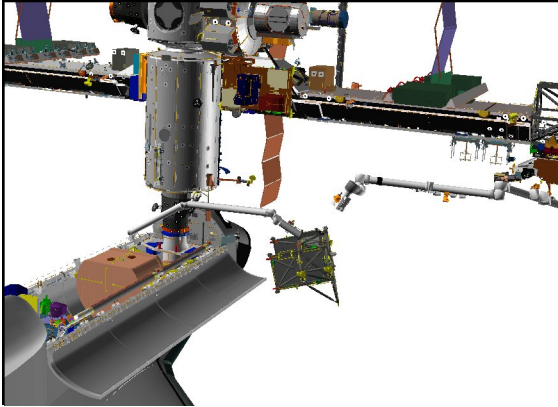
Auto Pos #	X/ SY	Y/ SP	Z/ EP	PITCH/ WP	YAW/ WY	ROLL/ WR	PL ID
148	-1018	+116	-651	186	18	179	4
	-47.0	+66.5	-69.3	-49.9	+32.9	-1.1	
149	-892	+363	-511	239	81	118	4
	-63.4	+34.5	-60.0	-33.5	-12.9	-27.5	
150	-850	+441	-517	323	66	34	4
	-67.9	+10.6	-21.0	-49.4	-29.9	-40.0	

BRAKES – ON (tb-ON)

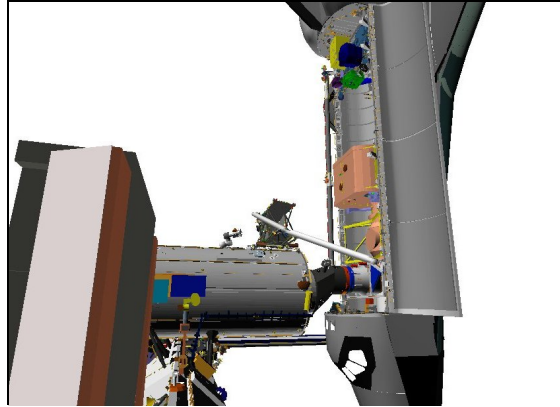
√MODE – not DIRECT

- * If using shuttle attitude control, verify rate < 0.20; *
- * then DAP: AUTO *

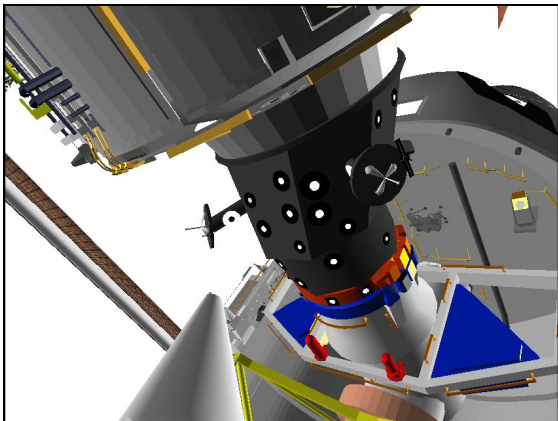
Notify SSRMS Operator, SRMS is in S5 Handoff posn with Brakes on. GO for S5 Grapple Maneuver



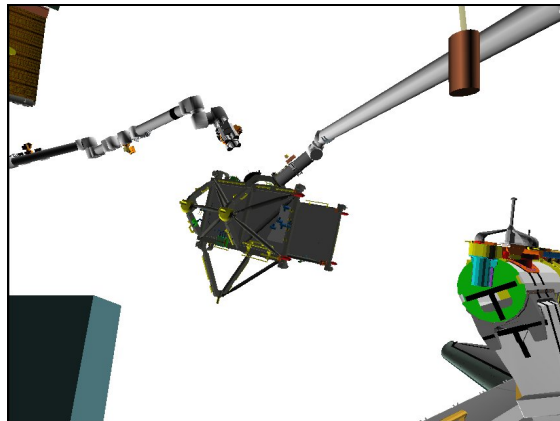
BIRD'S EYE



P1 LOOB (105,15)



ELBOW (-155,-5)



CCTV D (-50,10)

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S5 UNGRAPPLE

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

Mon 1	P1 LOOB
DwnInk	EE
Mon 2	D
DTV	C

NOTE

Do not backoff more than 36 inches after ungrapple. Monitor SRMS clearance to Lab using P1 LOOB

SM 94 PDRS CONTROL

PL ID – ITEM 3 +0 EXEC
INIT ID – ITEM 24 +0 EXEC

2. S5 UNGRAPPLE
On SSRMS Operator GO for Ungrapple, S5 Grapple complete and brakes on

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

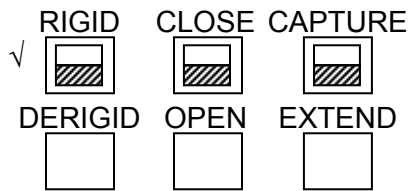
CAUTION

Monitor EE tb timing to prevent EE motor burnout

SM 169 PDRS STATUS

EE MODE – AUTO
RELEASE sw – depress (mom)

Mnvr clear of grapple pin



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

EE MODE – OFF

- * If manual release required: *
- * 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) *
- * MODE – OFF *

BRAKES – ON (tb-ON)

- * If using shuttle attitude control, verify rate < 0.20; *
- * then DAP: AUTO *

3. MNVR TO S5 INSTALL VIEWING POSN

Mon 1	P1 LOOB
DwnInk	Elbow
Mon 2	D
DTV	C

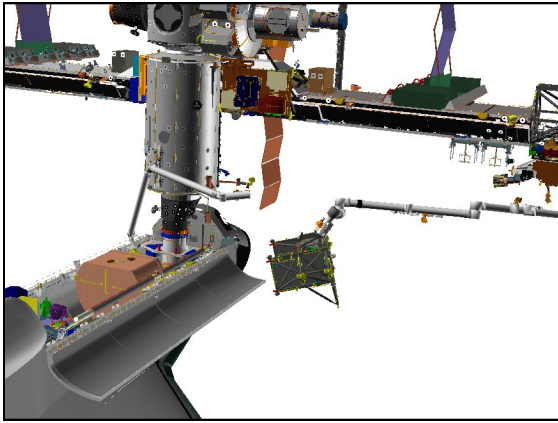
RATE – VERN (RATE MIN tb-ON)
 BRAKES – OFF (tb-OFF)
 MODE – SINGLE, ENTER

Mnv r to S5 INSTALL VIEWING posn:

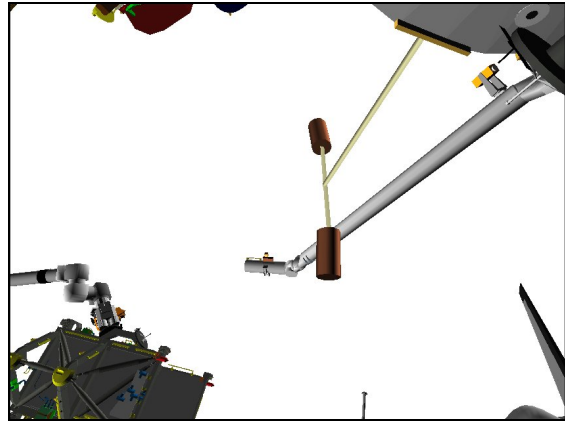
	SY	SP	EP	WP	WY	WR	
Backed Off	-66.0	+21.2	-35.3	-46.8	-30.6	-41.7	
1: SY +	-58.5						
2: SP +		+36.4					
3: EP –			-53.9				
4: WP +				+0.9			
5: WY –					-51.7		
6: WR –						-45.1	
S5 Install Viewing	-58.5	+36.4	-53.9	+0.9	-51.7	-45.1	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-915	+317	-649	159	293	102	0

BRAKES – ON (tb-ON)
 PARAM – PORT TEMP
 JOINT – CRIT TEMP

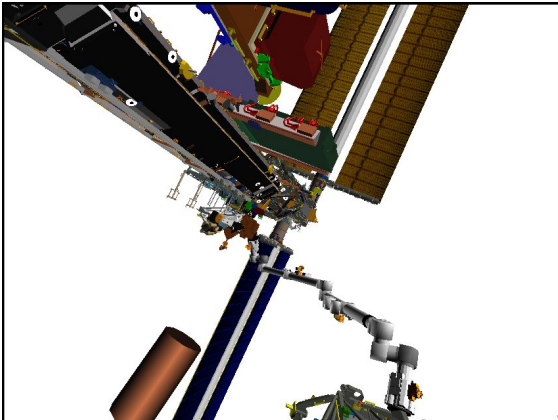
Notify SSRMS Operator, SRMS at S5 Install Viewing position



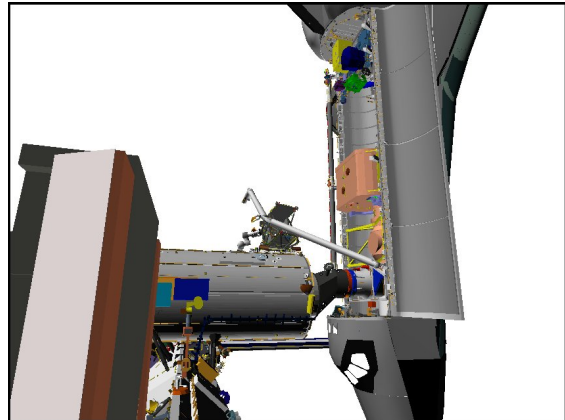
BIRD'S EYE



CCTV D (-30,35)



ELBOW (-40,30)



P1 LOOB (105,15)

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NOMINAL ESP-3 OPS

ESP-3 GRAPPLE.....	FS 2-2
UNBERTH	FS 2-5
HANDOFF	FS 2-9
UNGRAPPLE	FS 2-13

**NOMINAL
ESP-3 OPS**

ESP-3 GRAPPLE

1. MNVR TO ESP-3 PRE-GRAPPLE POSN
Verify SSRMS at ESP-3 Pre-Grapple position

SM 94 PDRS CONTROL

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

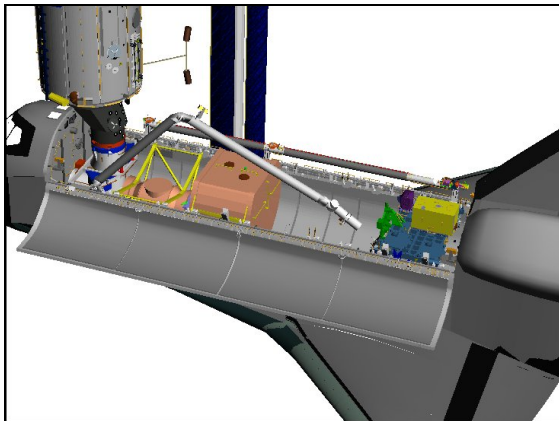
Mon 1	A
Dwnlnk	Elbow (EE)
Mon 2	S1 LOOB 03 (P1 LOOB 09)
DTV	B (C)

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

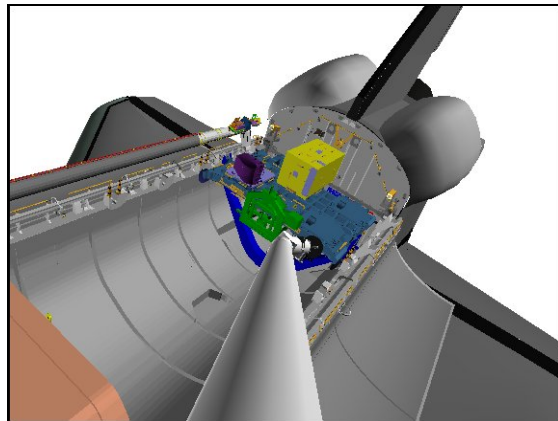
Mnvr to ESP-3 PRE-GRAPPLE posn:

X	Y	Z	PITCH	YAW	ROLL	PL ID
-1132	-60	-435	328	0	181	0
SY	SP	EP	WP	WY	WR	
-7.3	+47.8	-86.7	+7.5	+16.4	-172.9	

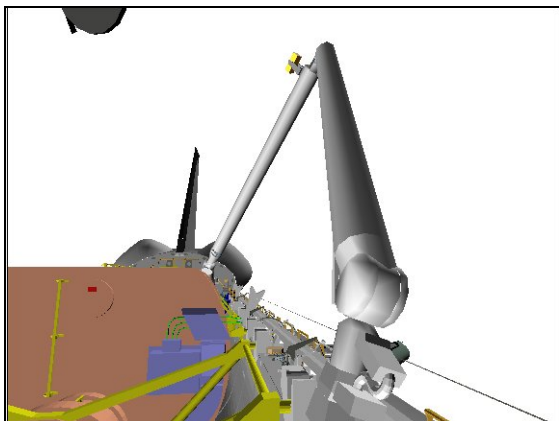
BRAKES – ON (tb-ON)



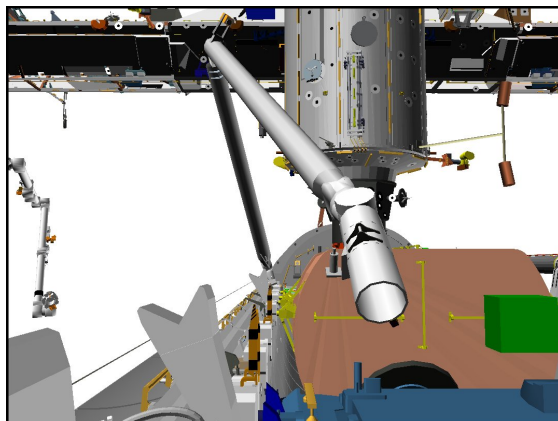
BIRD'S EYE



ELBOW (0,0)



CCTV A (10,10)



CCTV B (0,5)

NOMINAL
ESP-3 OPS

A7U

2. ESP-3 GRAPPLE

CCTV – config for grapple

- RMS WRIST, zoom 34.0 HFOV
- focus 5 ft

Maintain eyepoint ~18 in when using grapple overlay

Mon 1	A
DwnInk	EE (Elbow)
Mon 2	S1 LOOB 03 (P1 LOOB 09)
DTV	B

RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – END EFF, ENTER

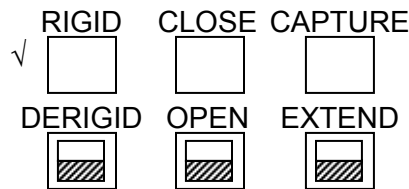
Mnvr to grapple envelope

CAUTION
Monitor EE tb timing to prevent EE motor burnout

SM 169 PDRS STATUS

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) *

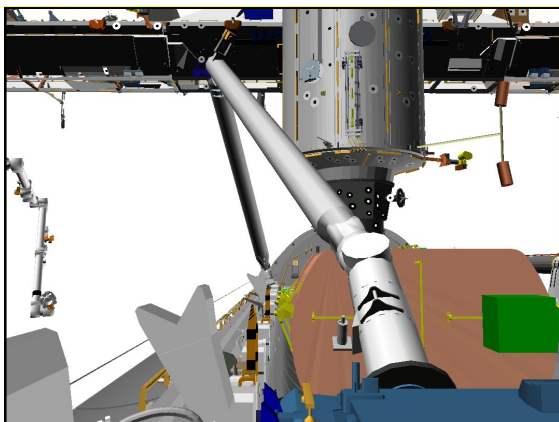
EE MODE – OFF

BRAKES – ON (tb-ON)

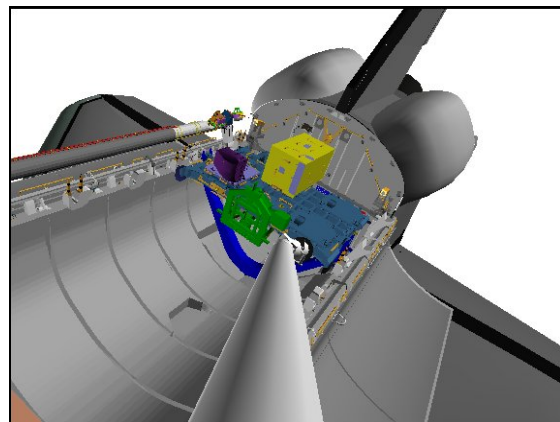
SM 94 PDRS CONTROL

PL ID – ITEM 3 +5 EXEC

INIT ID – ITEM 24 +5 EXEC



CCTV B (0,5)



ELBOW (0,0)

Record POS/ATT and Joint Angles:

	X	Y	Z	PITCH	YAW	ROLL	PL ID
							5
Expected	-1222	0	-414	180	0	180	5
	SY	SP	EP	WP	WY	WR	
Expected	-6.0	+39.8	-76.6	+5.7	+15.3	-173.6	

Record POS/ATT and Joint Angles in ESP-3 CONTINGENCY REBERTH
(OFF-NOM ESP-3 HANDOFF)

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

ESP-3 UNBERTH

1. SETUP

A7U CCTV – config for unberth

Mon 1	C
DwnInk	MUX D/A (A)
Mon 2	Lab 13 (P1 LOOB 09)
DTV	B (Elbow)

SM 94 PDRS CONTROL

√PL ID, ITEM 3: 5

√INIT ID, ITEM 24: 5

√BRAKES – ON (tb-ON)

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

Verify 'Desat Request:' – Inh

* If using shuttle attitude control: *
* DAP: FREE *

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 (four) – OFF
PL SEL – 3
LOGIC PWR 1,2 (two) – ON

R13L PL BAY MECH PWR SYS 1,2 (two) – ON

SM 97 PL RETENTION

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

√LAT 1,2,3,4 (eight): 1

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

3. PRLA RELEASE

Note single motor times (> 30 sec)

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

4. DEACTIVATING LATCHES

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

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

5. MNVR TO ESP-3 LOW HOVER POSN

CAUTION

Monitor clearances between STBD trunnions and OBSS during unberth. Minimum clearance of approximately 3 inches expected at Z= -454

Gradually apply 3-inch -Y bias starting at Z= -435 and complete by Z= -445

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

Mnvr ESP-3 up until Z = -520

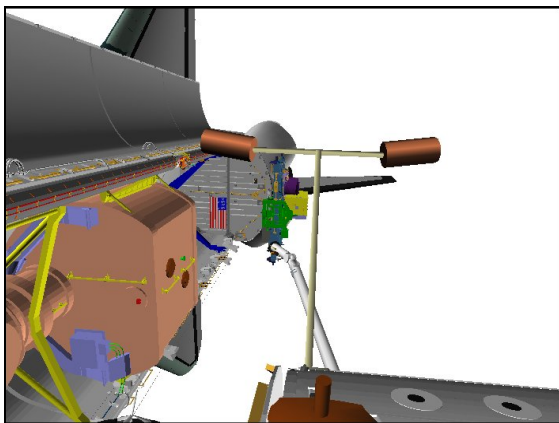
√PL RETEN RDY 1,2,3,4 tb (four) – bp

Mnvr to ESP-3 LOW HOVER posn: apply 3-inch -Y bias by Z= -445

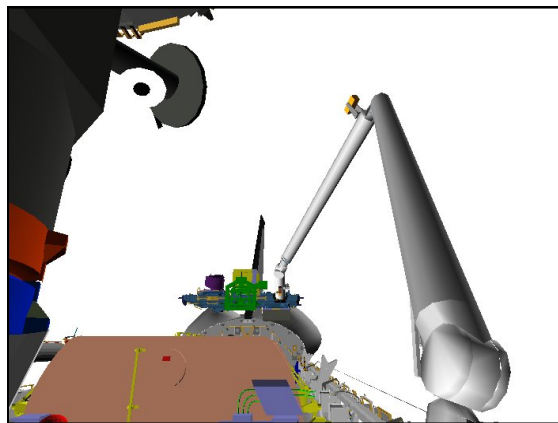
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1222	-3	-520	180	0	180	5
SY	SP	EP	WP	WY	WR	
-10.2	+50.2	-71.1	-10.9	+18.9	-171.3	

BRAKES – ON (tb-ON)

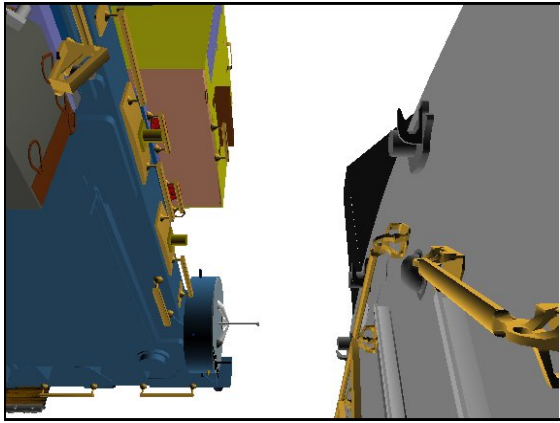
- * If using shuttle attitude control, verify rate < 0.20; *
- * then DAP: AUTO *



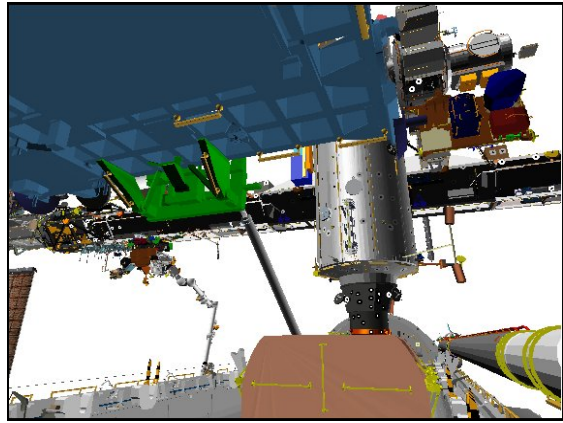
LAB (-5,-35)



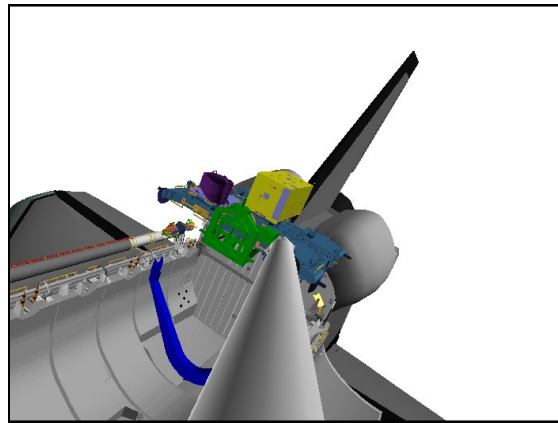
CCTV A (0,20)



CCTV B (90,40)



CCTV C (-20,20)



ELBOW (0,0)

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ESP-3 HANDOFF

1. MNVR TO ESP-3 PORT POSN

- * If using shuttle attitude control: *
- * DAP: FREE *

NOTE

Coarse rates allowed when Y= -210 (Rel Y = 112)

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

Mnvr ESP-3 Forward and Port until X = -1068
 Y = -322

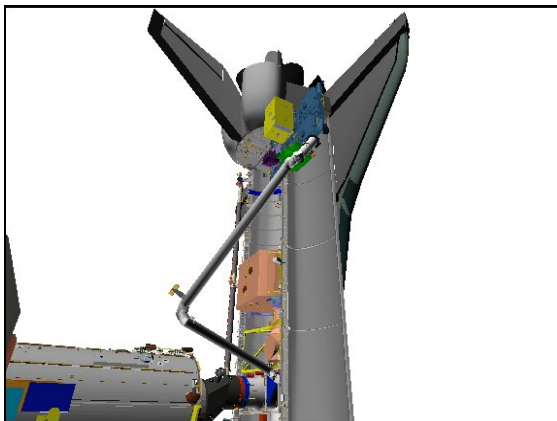
Mon 1	Elbow
Dwnlnk	A
Mon 2	P1 LOOB 09
DTV	C (B)

Mnvr to ESP-3 PORT posn (within 2"/1°):

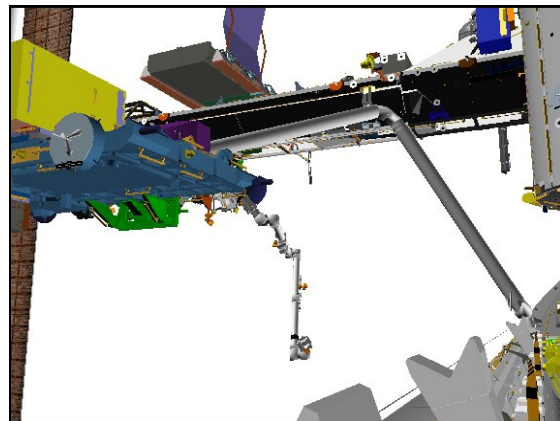
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1068	-322	-520	180	0	180	5
SY	SP	EP	WP	WY	WR	
+38.4	+75.5	-85.0	-23.4	-22.8	-196.7	

BRAKES – ON (tb-ON)

- * If using shuttle attitude control, verify rate < 0.20; *
- * then DAP: AUTO *



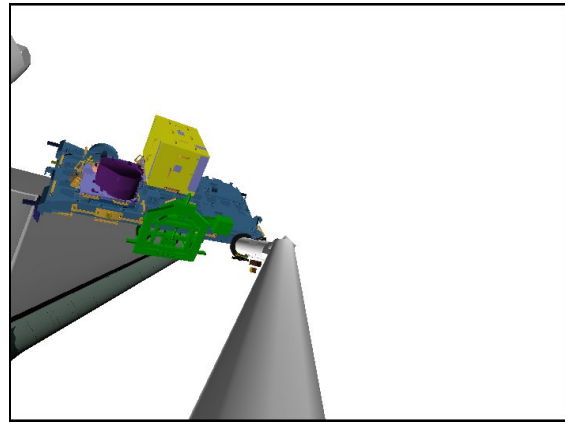
P1 LOOB (120,30)



CCTV B (-25,10)



CCTV C (-50,20)



ELBOW (0,0)

2. MNVR TO ESP-3 INTERMEDIATE POSN

- * If using shuttle attitude control: *
- * DAP: FREE *

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

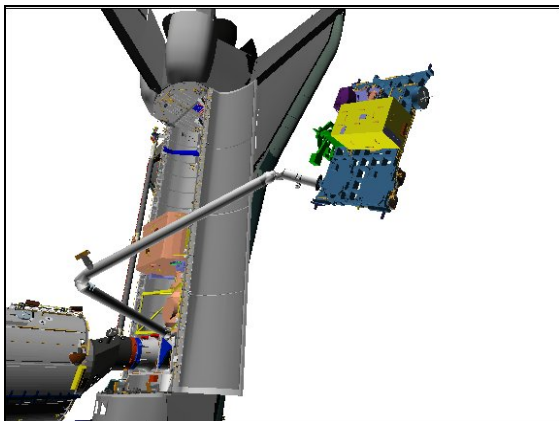
Mon 1	Elbow
DwnInk	A
Mon 2	P1 LOOB 09
DTV	B (C)

Mnvr to ESP-3 INTERMEDIATE posn:

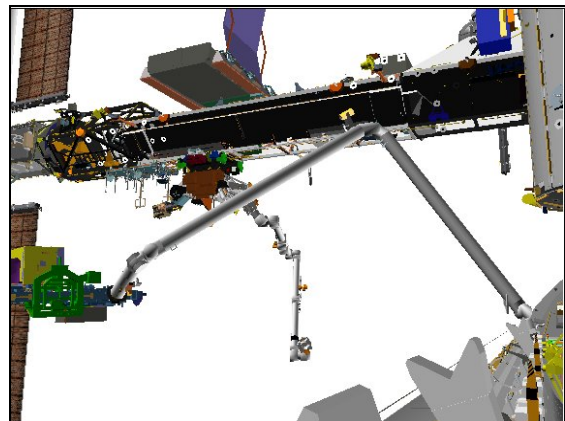
X	Y	Z	PITCH	YAW	ROLL	PL ID
-870	-575	-460	0	295	2	5
SY	SP	EP	WP	WY	WR	
+59.5	+74.3	-90.5	-6.8	+51.0	-135.4	

BRAKES – ON (tb-ON)

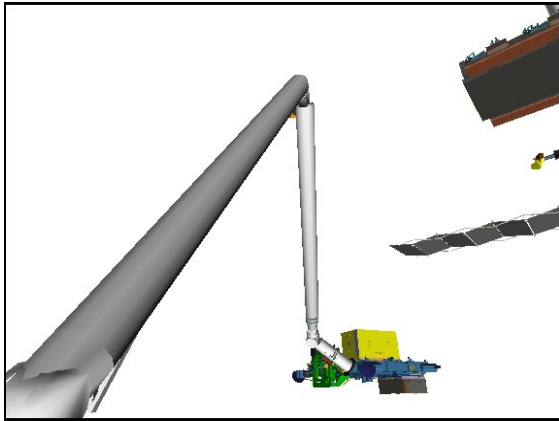
- * If using shuttle attitude control, verify rate < 0.20; *
- * then DAP: AUTO *



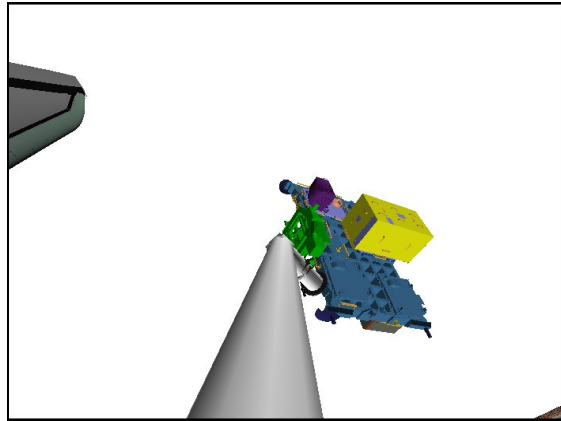
P1 LOOB (135,25)



CCTV B (-25,10)



CCTV A (50,25)



ELBOW (0,0)

3. MNVR TO ESP-3 HANDOFF POSN

- * If using shuttle attitude control: *
- * DAP: FREE *

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

Mon 1	Elbow
DwnInk	A
Mon 2	P1 LOOB 09 (Mast 37)
DTV	B

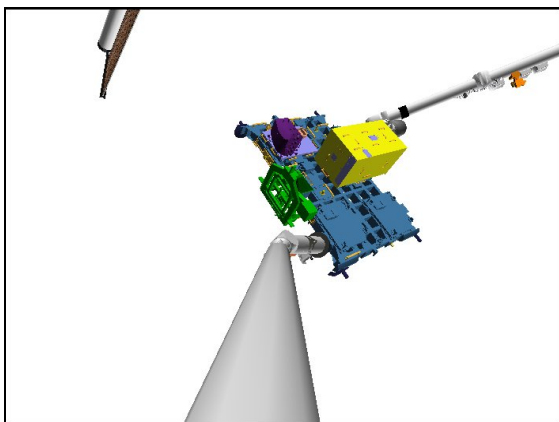
Mnvr to ESP-3 HANDOFF posn:

X	Y	Z	PITCH	YAW	ROLL	PL ID
-353	-435	-385	352	336	19	5
SY	SP	EP	WP	WY	WR	
+135.8	+68.7	-106.7	+19.1	+24.5	-155.9	

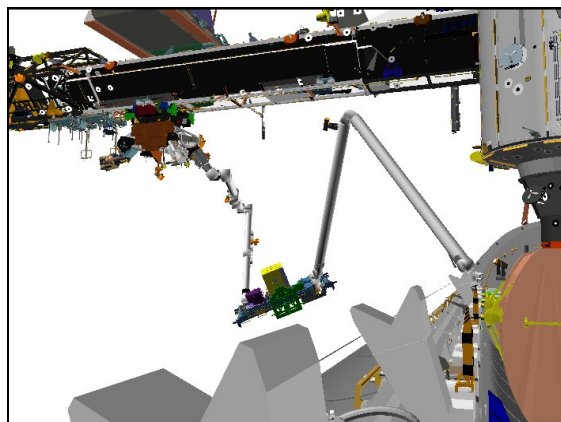
BRAKES – ON (tb-ON)

- * If using shuttle attitude control, verify rate < 0.20; *
- * then DAP: AUTO *

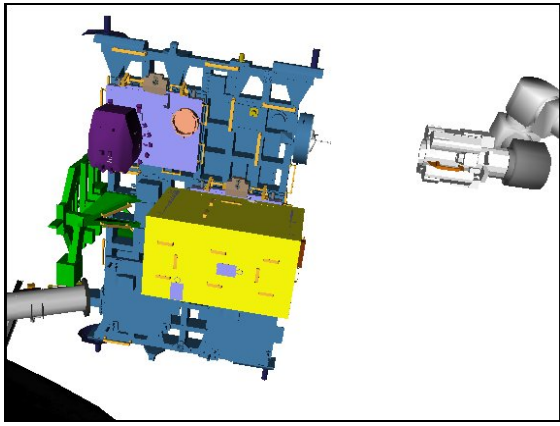
Notify SSRMS Operator, SRMS is in ESP-3 Handoff position with Brakes on.
 GO for ESP-3 Grapple



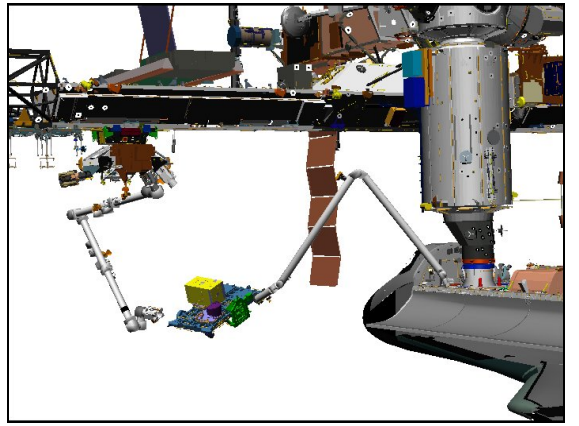
ELBOW (0,0)



CCTV B (-20,5)



MBS MAST (-150,45)



BIRD'S EYE

ESP-3 UNGRAPPLE

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

Mon 1	A
DwnInk	EE
Mon 2	Mast 37 (P1 LOOB 09)
DTV	B

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

2. ESP-3 UNGRAPPLE
On SSRMS Operator GO for ESP-3 release, SSRMS Capture complete

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 (*)

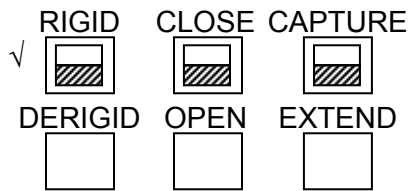
RATE – VERN (RATE MIN tb-ON)
BRAKES – OFF (tb-OFF)
MODE – END EFF, ENTER

CAUTION

Monitor EE tb timing to prevent EE motor burnout

SM 169 PDRS STATUS
EE MODE – AUTO
RELEASE sw – depress (mom)

Mnvr clear of grapple pin



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

EE MODE – OFF

- * If manual release required: *
- * 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) *
- * MODE – OFF *

BRAKES – ON (tb-ON)

- * If using shuttle attitude control, verify rate < 0.20; *
- * then DAP: AUTO *

3. MNVR TO ESP-3 INSTALL VIEWING POSN

Mon 1	Elbow
DwnInk	A
Mon 2	P1 LOOB 09
DTV	B

RHC

RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)
 MODE – ORB UNL, ENTER

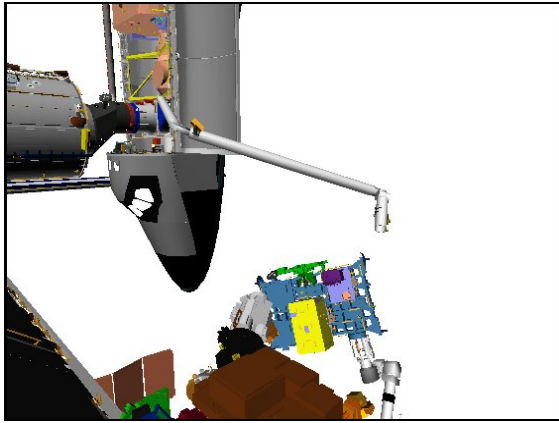
Mnv r to ESP-3 INSTALL VIEWING posn:

X	Y	Z	PITCH	YAW	ROLL	PL ID
-506	-552	-399	116	33	21	0
SY	SP	EP	WP	WY	WR	
+110.0	+41.9	-69.8	+95.3	+14.8	-194.8	

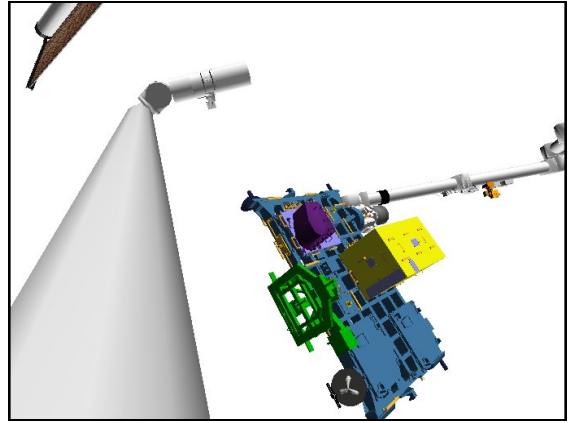
BRAKES – ON (tb-ON)

- √MODE – not DIRECT
- PARAM – PORT TEMP
- JOINT – CRIT TEMP

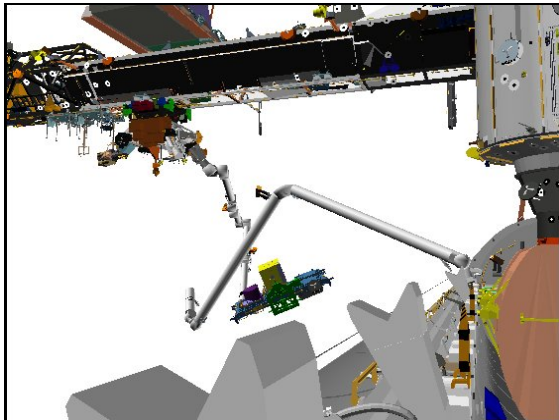
Notify SSRMS Operator, SRMS is in ESP-3 Install Viewing position. GO for ESP-3 Install



P1 LOOB (136,-10)



ELBOW (20,-20)



CCTV B (-20,5)



CCTV A (80,0)

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OFF-NOMINAL S5 OPS

S5 SJ GRAPPLE	FS 3-2
UNBERTH	FS 3-9
HANDOFF	FS 3-11
UNGRAPPLE	FS 3-17
CONTINGENCY REBERTH.....	FS 3-23

OFF-NOMINAL
S5 OPS

S5 SJ GRAPPLE

- A7U 1. SJ MNVR TO PRE-GRAPPLE
 CCTV – perform PAN/TILT RESET
 – fully zoom out for SJ pictures

SM 94 PDRS CONTROL

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

Mon 1	S1 LOOB
Dwnlnk	Elbow (EE)
Mon 2	C
DTV	A (D)

- RATE – as required (VERN within 10 ft)
- BRAKES – OFF (tb-OFF)
- MODE – best available

Mnvr to PRE-GRAPPLE posn (reference pictures as reqd):

	SY	SP	EP	WP	WY	WR	
Pre-cradle	0.0	+25.0	-25.0	+5.0	0.0	0.0	
1: SP +		+64.9					
2: WP –				-11.9			
3: WY +					+29.0		
4: WR –						-6.8	
5: SY –	-22.1						
6: EP –			-102.7				
S5 Pre-grapple	-22.1	+64.9	-102.7	-11.9	+29.0	-6.8	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-1040	0	-492	315	0	331	0

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

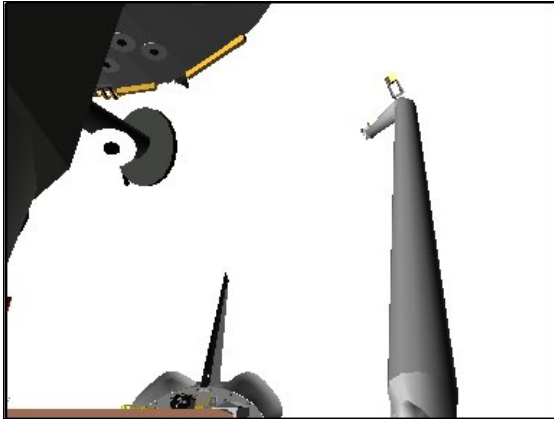
OFF-NOMINAL
S5 OPS

Step 1:

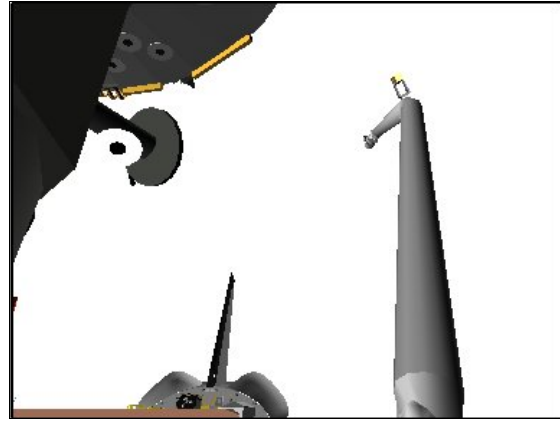
Drive SP+ (for 39.9°)
From +25.0 to +64.9

Step 2:

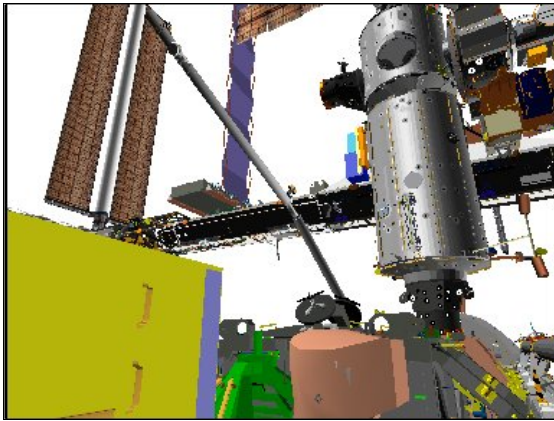
Drive WP- (for 16.9°)
From +5.0 to -11.9



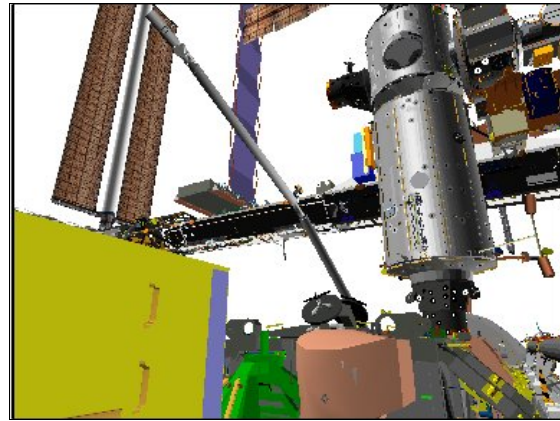
CCTV A (5,30)



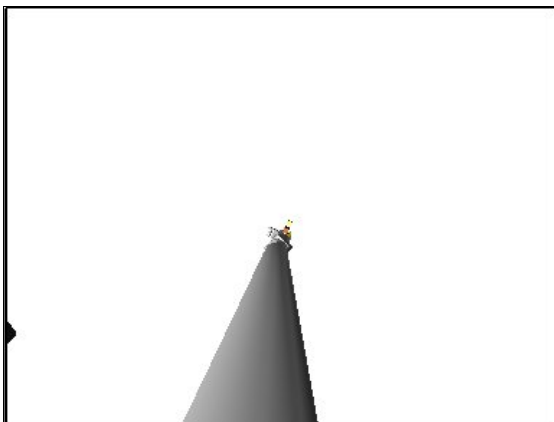
CCTV A (5,30)



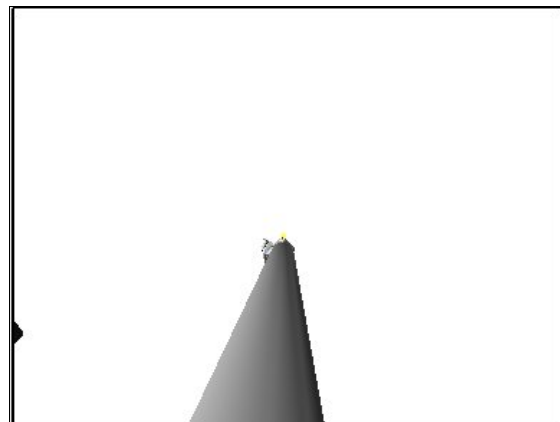
CCTV C (-30,20)



CCTV C (-30,20)



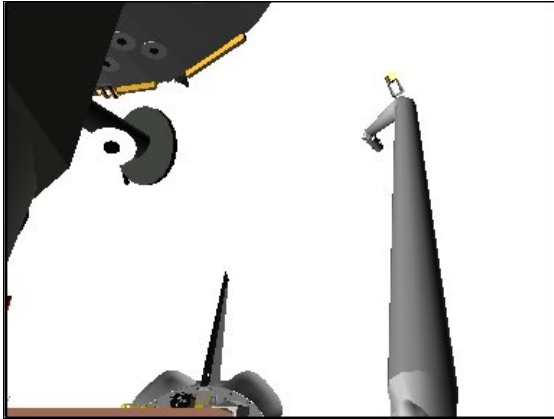
ELBOW (0,0)



ELBOW (0,0)

Step 3:

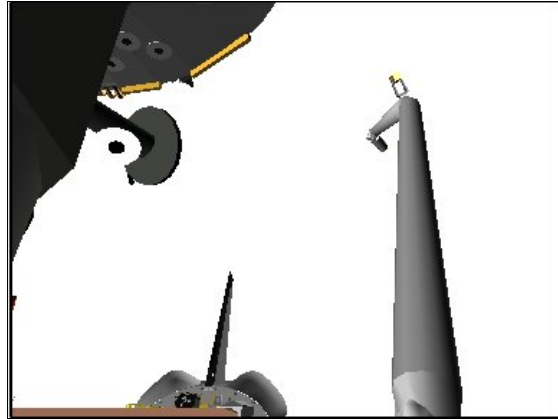
Drive WY+ (for 29.0°)
From 0.0 to +29.0



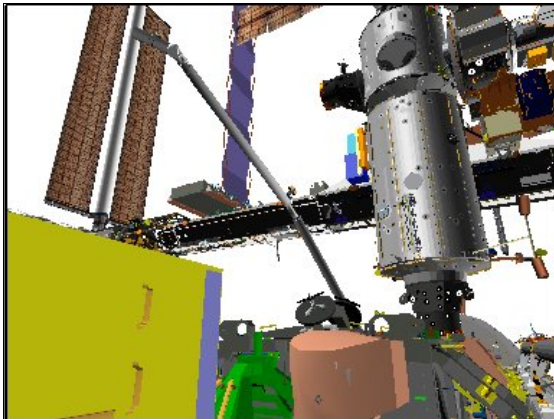
CCTV A (5,30)

Step 4:

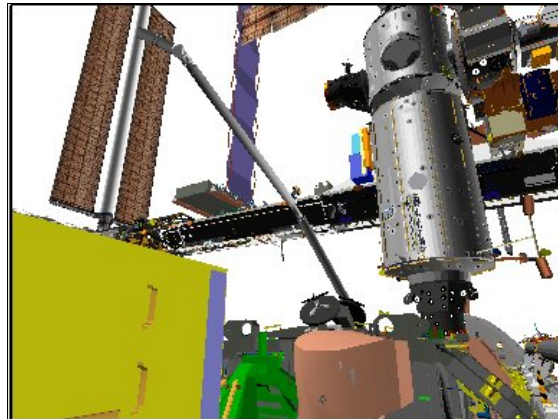
Drive WR- (for 6.8°)
From 0.0 to -6.8



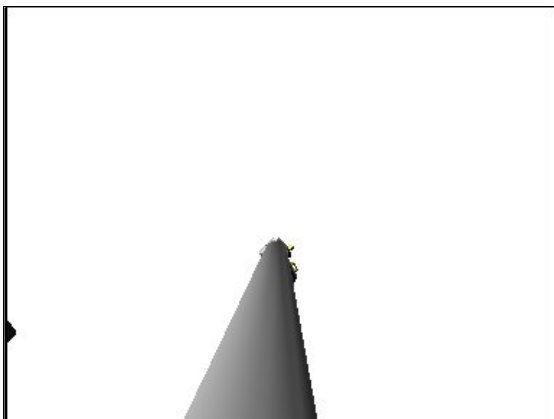
CCTV A (5,30)



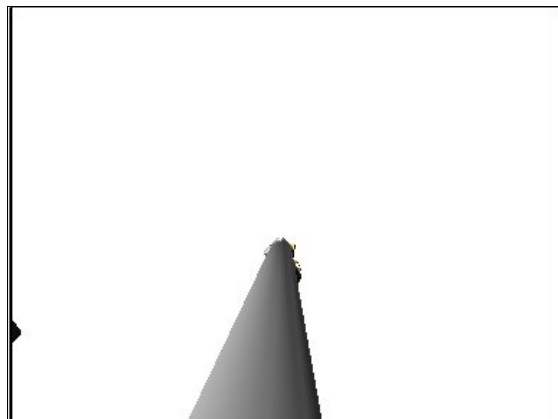
CCTV C (-30,20)



CCTV C (-30,20)



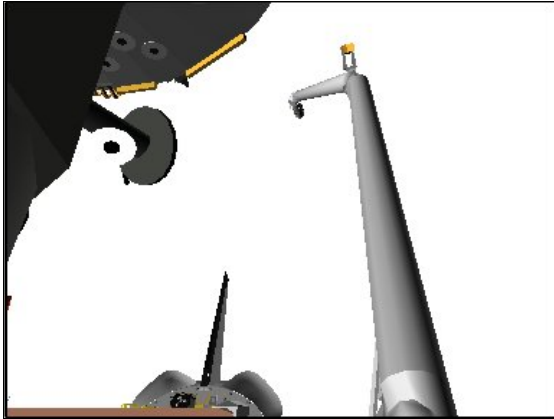
ELBOW (0,0)



ELBOW (0,0)

Step 5:

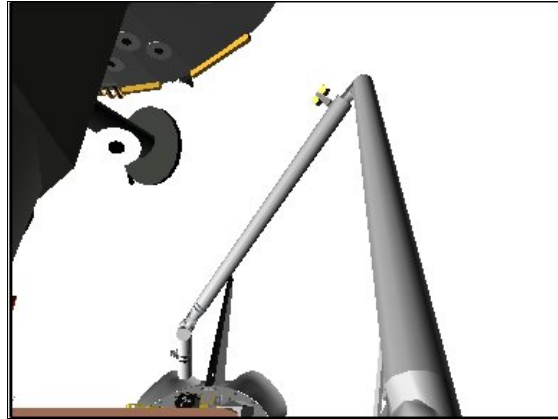
Drive SY- (for 22.1°)
From 0.0 to -22.1



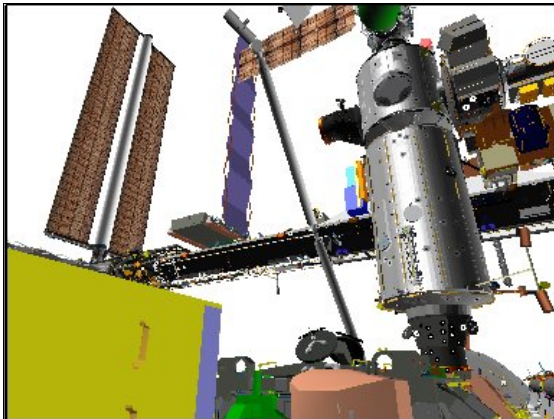
CCTV A (5,30)

Step 6:

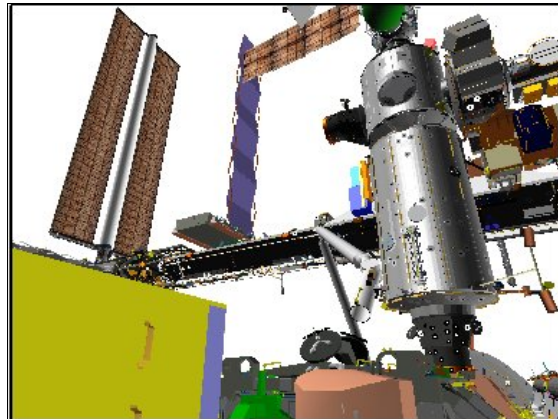
Drive EP- (for 77.7°)
From -25.0 to -102.7



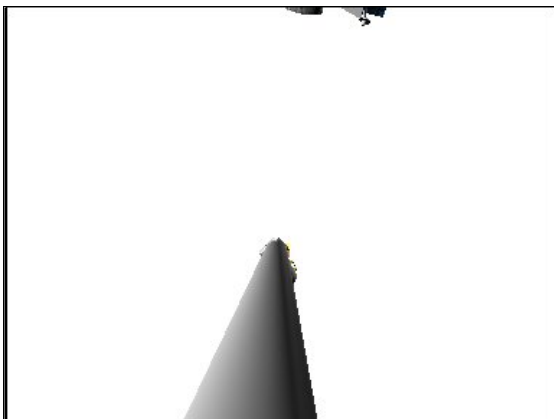
CCTV A (5,30)



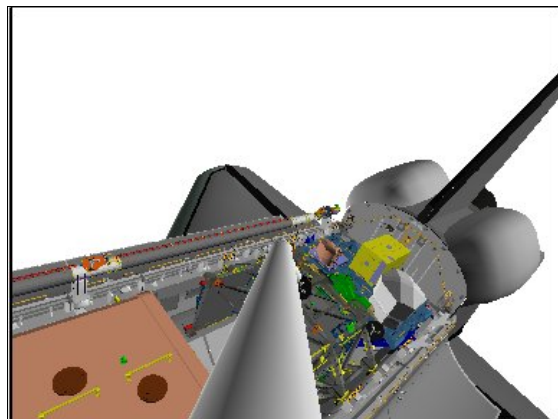
CCTV C (-30,25)



CCTV C (-30,25)



ELBOW (0,0)



ELBOW (0,0)

A7U

2. SJ MNVR TO S5 GRAPPLE

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	S1 LOOB
DwnInk	EE
Mon 2	C
DTV	D

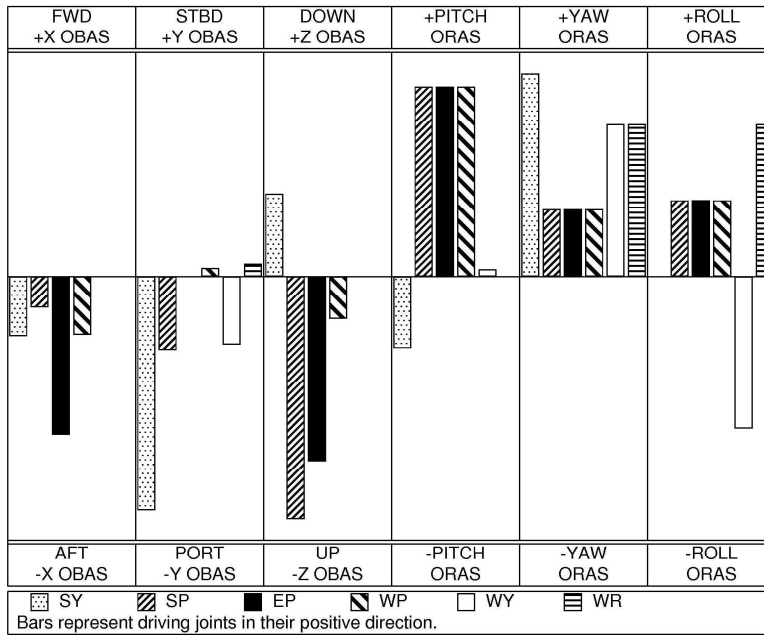
RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – best available

Drive joints per S5 SJ GRAPPLE WRIST CCTV OVERLAY and diagram until EE within grapple envelope

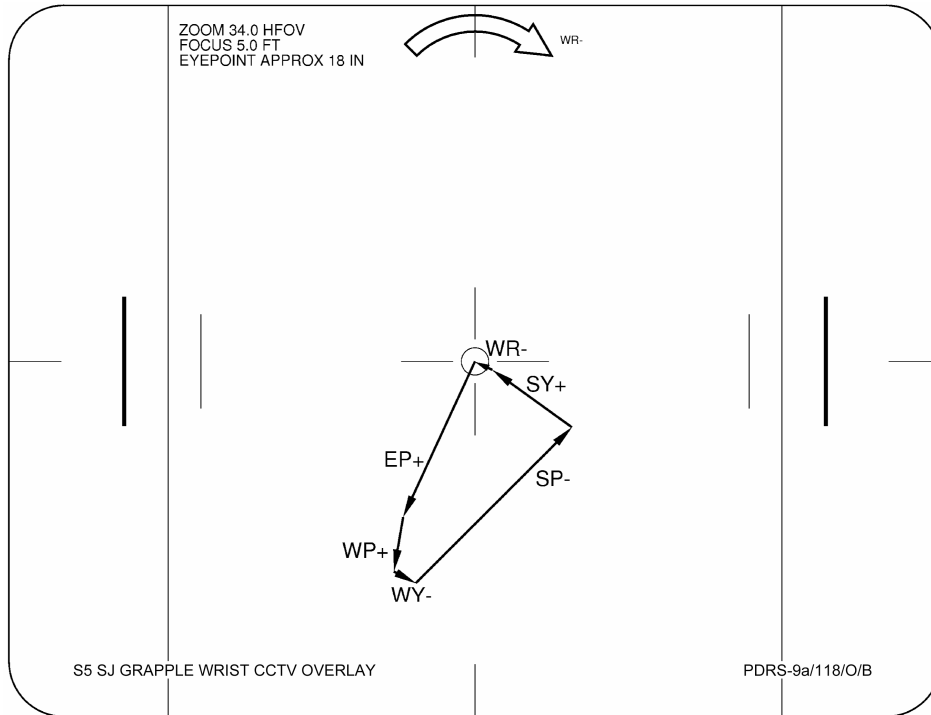
S5 SJ GRAPPLE



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

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

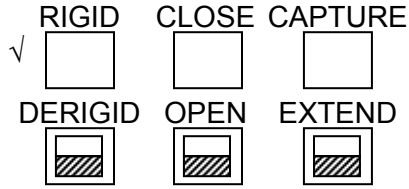
ΔSY	ΔSP	ΔEP	ΔWP	ΔWY	ΔWR
+2.7	-7.1	+4.9	+3.3	-1.8	-2.3



3. S5 GRAPPLE

CAUTION
Monitor EE tb timing to prevent EE motor burnout

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

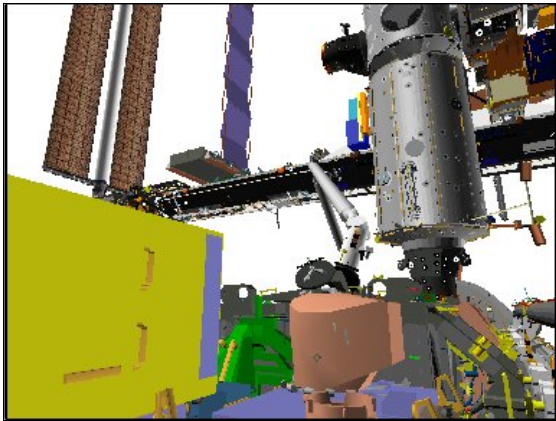


CRITICAL TIMES (28 sec total):
CAPTURE tb – gray, then
CLOSE tb – gray, 3 sec max, then
RIGID tb – gray, 25 sec max

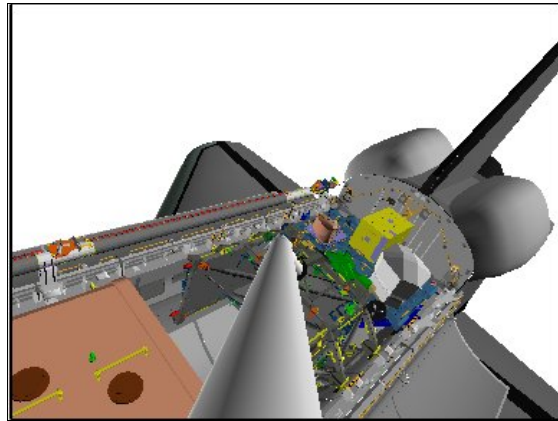
- * If manual grapple reqd: *
- * EE MODE – MAN *
- * CAPTURE sw – depress (hold until CLOSE tb-gray, 3 sec max) *
- * MAN CONTR – RIGID (hold until RIGID tb-gray, 25 sec max) *

EE MODE – OFF

BRAKES – ON (tb-ON)
MODE – not DIRECT



CCTV C (-30,15)



ELBOW (0,0)

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
	SY	SP	EP	WP	WY	WR	
Expected	-19.4	+57.8	-97.8	-8.6	+27.2	-9.1	

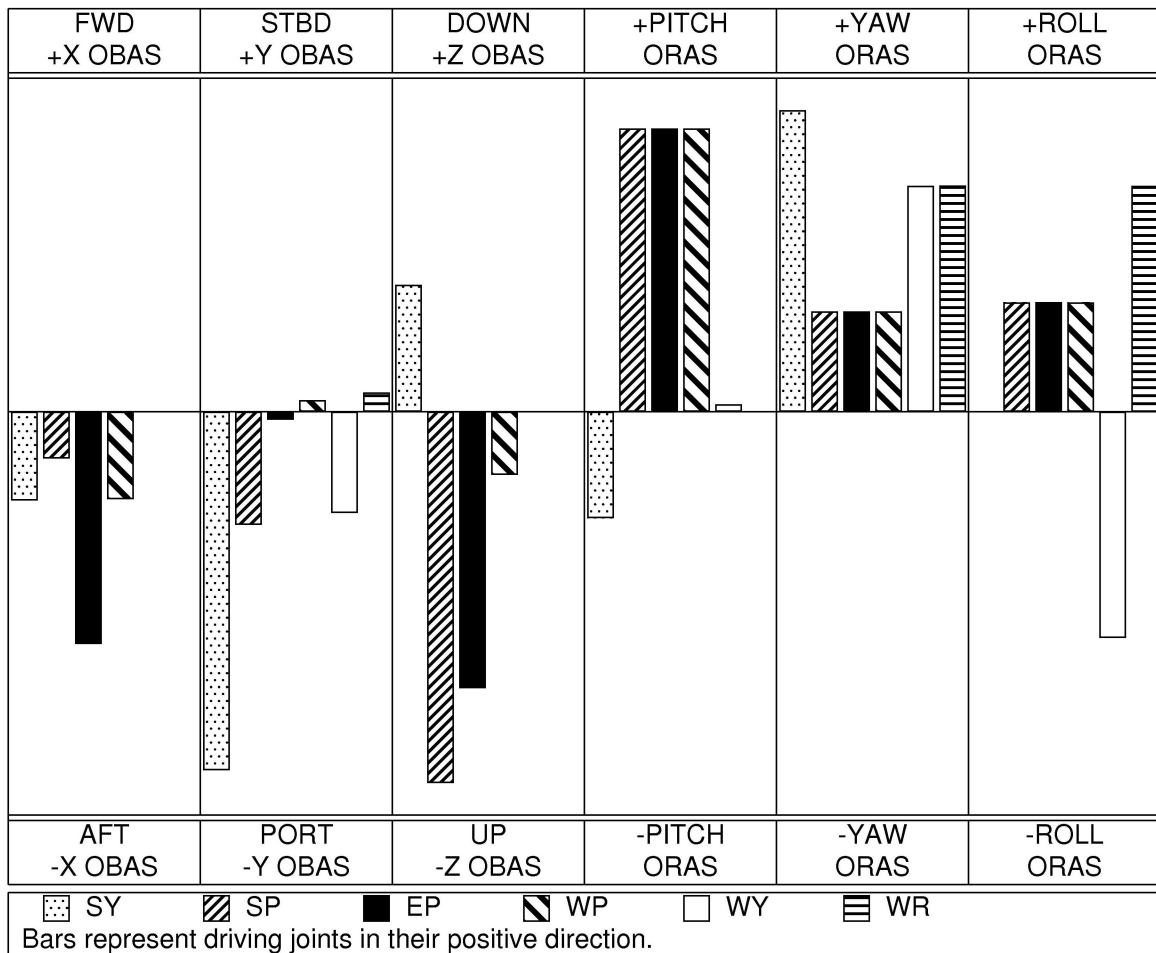
Record POS/ATT and Joint Angles in S5 CONTINGENCY REBERTH
Load REL, if desired
Review GENERIC END EFFECTOR CUE CARD – ISS/SHUTTLE DOCKED OPS

S5 SJ UNBERTH

1. SETUP
Perform S5 UNBERTH, steps 1-5 (NOMINAL S5 OPS)
2. SJ MNVR TO CLEAR OF V-GUIDES
RATE – as required (VERN within 10 ft)
BRAKES – OFF (tb-OFF)
MODE – best available

Drive joints per S5 SJ TOP OF V-GUIDES histogram until S5 trunnions at top of V-guides (Z = -438)

S5 SJ TOP OF V-GUIDES



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

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

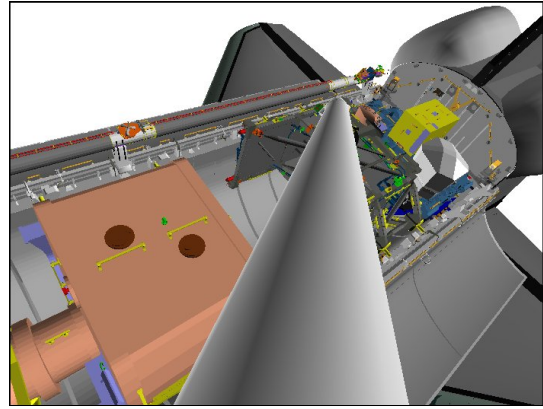
ΔSY	ΔSP	ΔEP	ΔWP	ΔWY	ΔWR
-1.2	+2.6	+1.7	-4.8	+0.8	+0.9

SUGGESTED JOINT ORDER

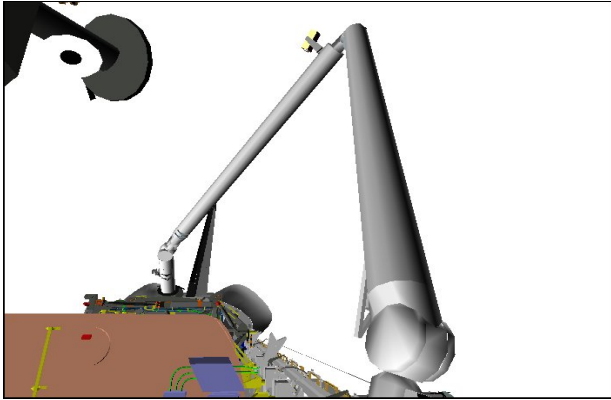
SP+, SY-, WY+, WP-, EP+, WR+ as reqd



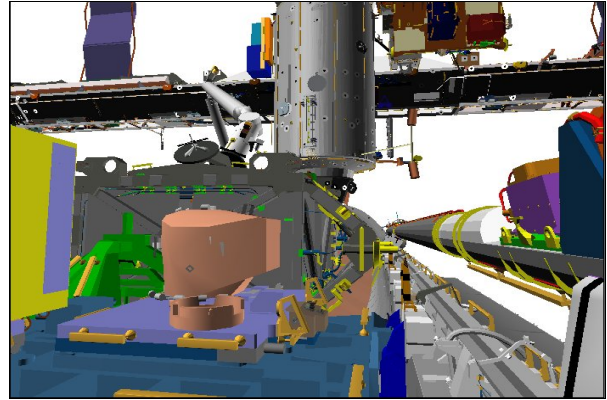
P1 LOOB (115,25)



ELBOW (-10,-20)



CCTV A (10,20)



CCTV C (-10,5)

S5 SJ HANDOFF

1. SJ MNVR TO S5 HANDOFF POSN

Mon 1	P1 LOOB
DwnInk	Elbow
Mon 2	D
DTV	B (C)

NOTE

In line 3, minimum clearance from S5 keel to CMG on ESP-3 is 20 inches. Monitor with P1 LOOB

RATE – as reqd (VERN within 10 ft)

BRAKES – OFF (tb-OFF)

MODE – best available

Mnvr to S5 HANDOFF posn (reference pictures as reqd):

	SY	SP	EP	WP	WY	WR	
S5 Top of V-Guides	-20.6	+60.4	-96.1	-13.4	+28.0	-8.2	
1: SP +		+69.0					
2: WP –				-33.0			
3: EP +			-21.0				
4: SP –		+40.0					
5: WR –						-40.0	
6: WY –					-29.9		
7: SY –	-55.0						
8: SP –		+10.6					
9: WP –				-49.4			
10: SY –	-67.9						
S5 Handoff	-67.9	+10.6	-21.0	-49.4	-29.9	-40.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-850	+441	-517	323	66	34	4

BRAKES – ON (tb-ON)

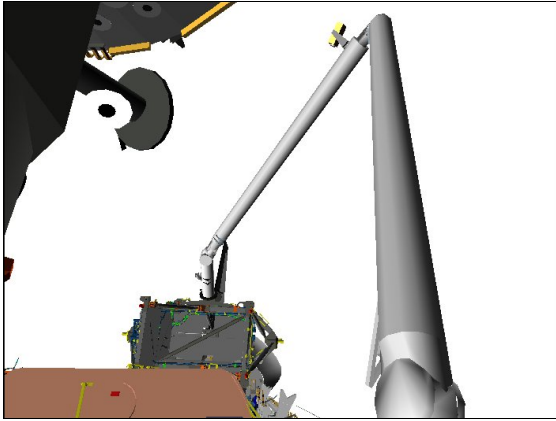
√MODE – not DIRECT

Notify SSRMS Operator, SRMS is in S5 Handoff position with brakes on.

GO for S5 Grapple maneuver

Step 1:

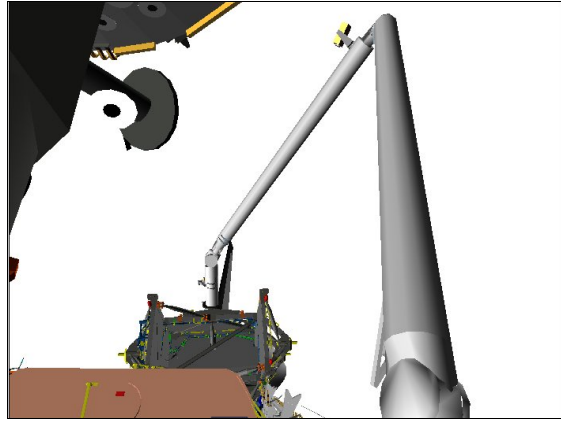
Drive SP+ (for 8.6°)
From +60.4 to +69.0



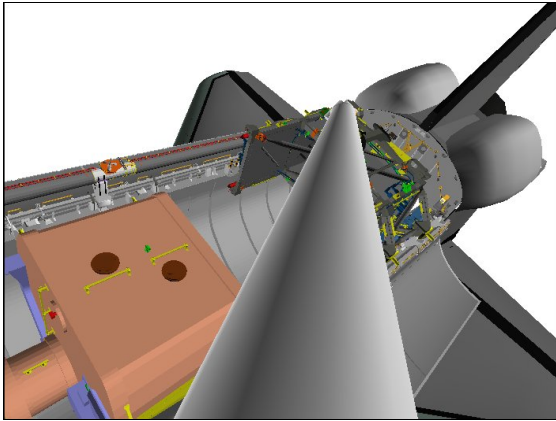
CCTV A (5,25)

Step 2:

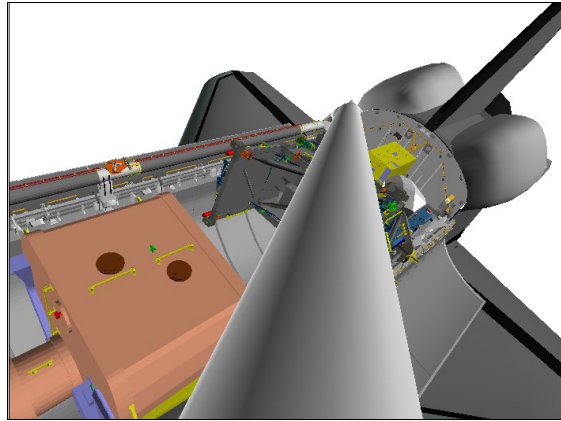
Drive WP- (for 19.6°)
From -13.4 to -33.0



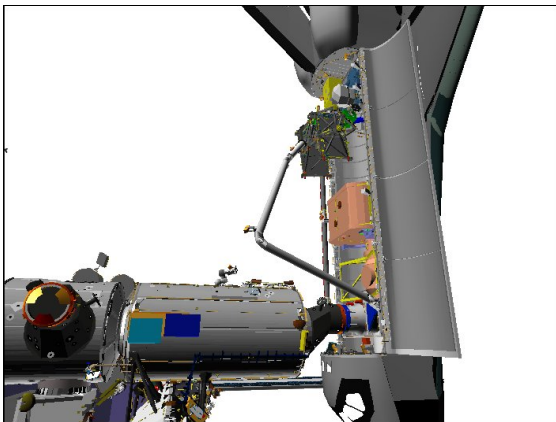
CCTV A (5,25)



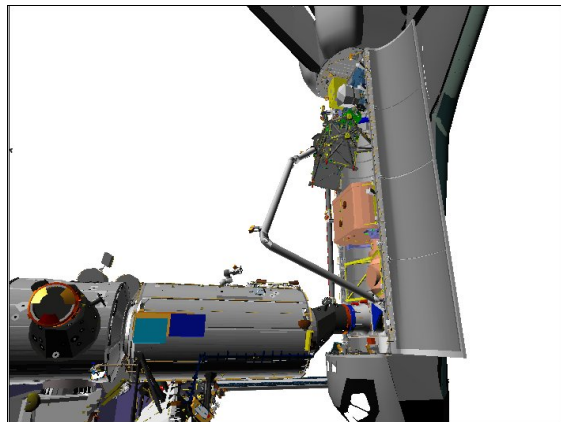
ELBOW (-10,-20)



ELBOW (-10,-20)



P1 LOOB (105,20)



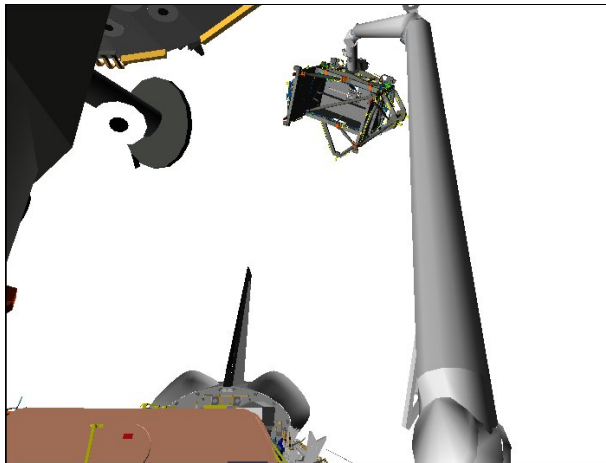
P1 LOOB (105,20)

Step 3:

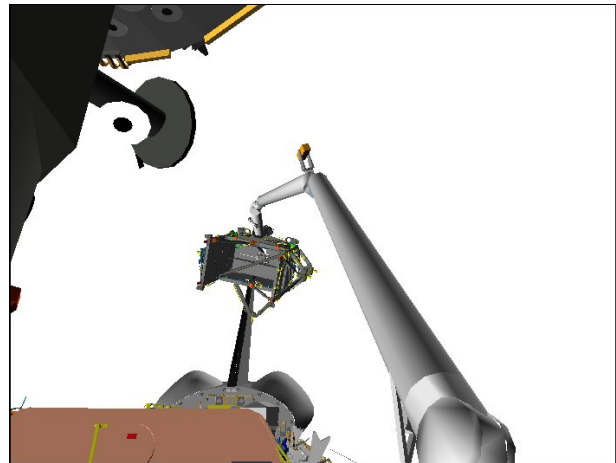
Drive EP+ (for 75.1°)
From -96.1 to -21.0

Step 4:

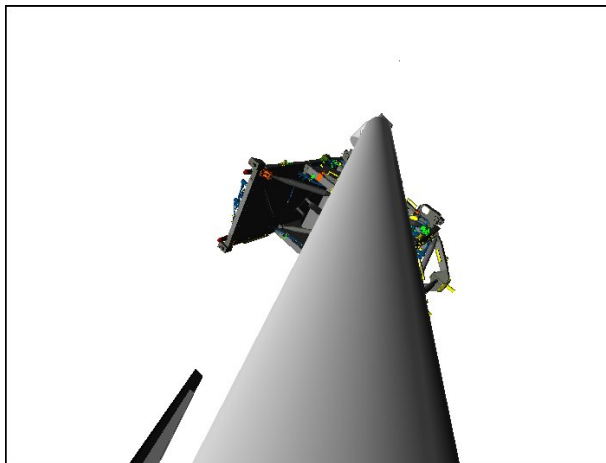
Drive SP- (for 29°)
From +69.0 to +40.0



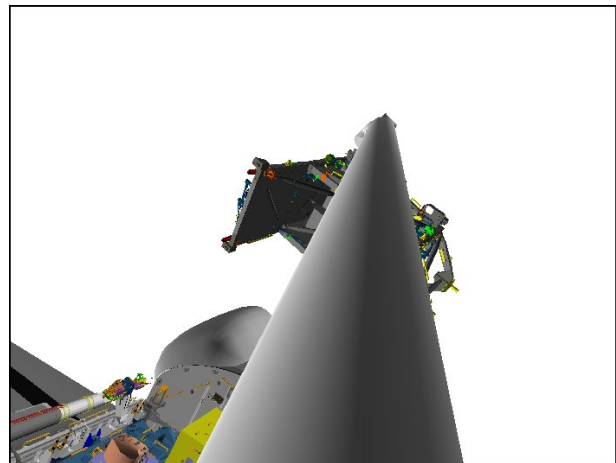
CCTV A (5,25)



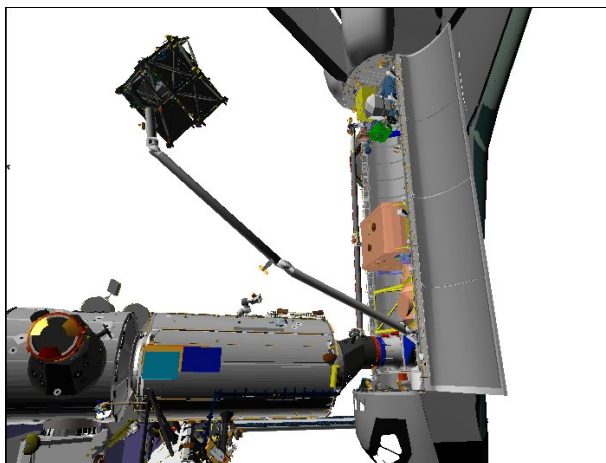
CCTV A (5,25)



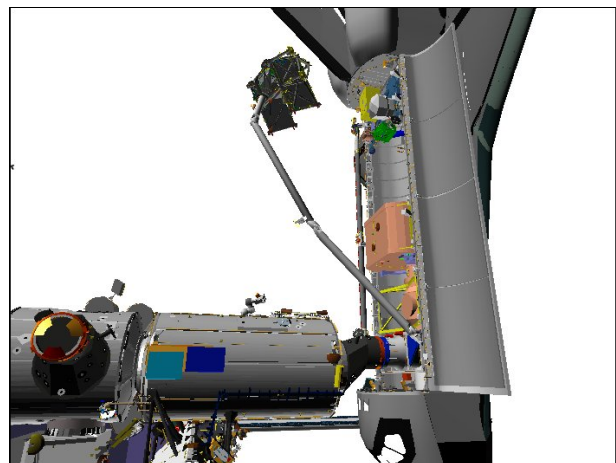
ELBOW (-10,-20)



ELBOW (-10,-20)



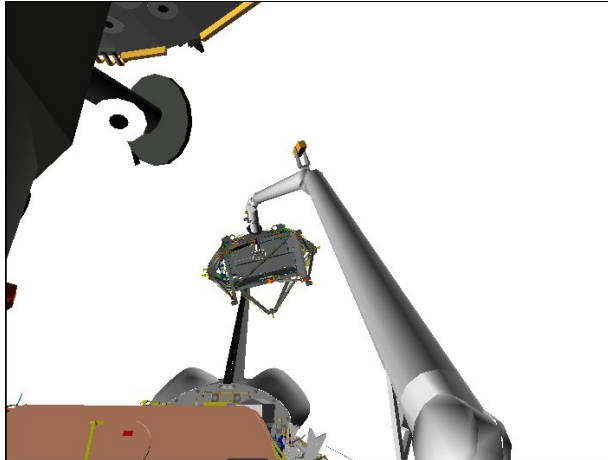
P1 LOOB (105,20)



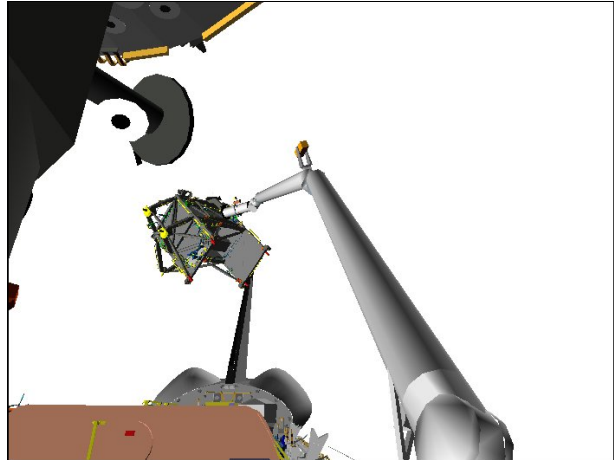
P1 LOOB (105,20)

Step 5:
Drive WR- (for 31.8°)
From -8.2 to -40.0

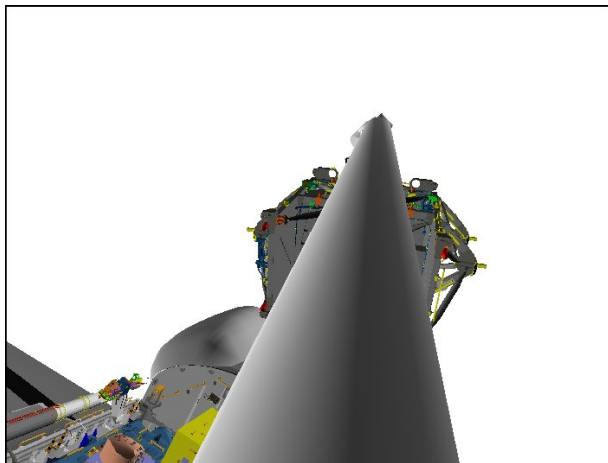
Step 6:
Drive WY- (for 57.9°)
From +28.0 to -29.9



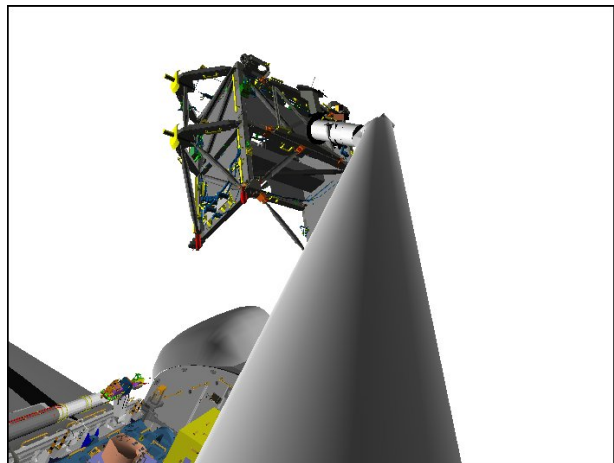
CCTV A (5,25)



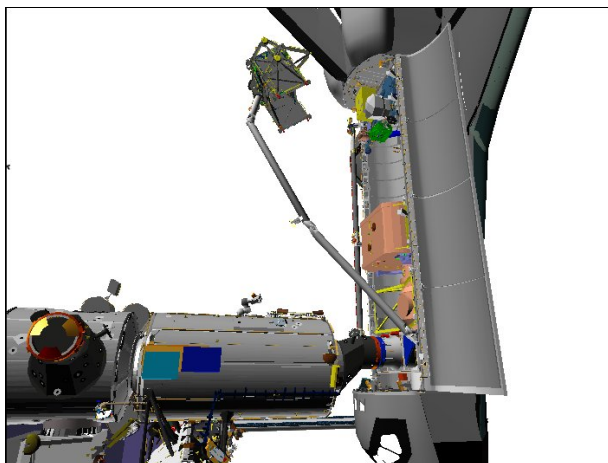
CCTV A (5,25)



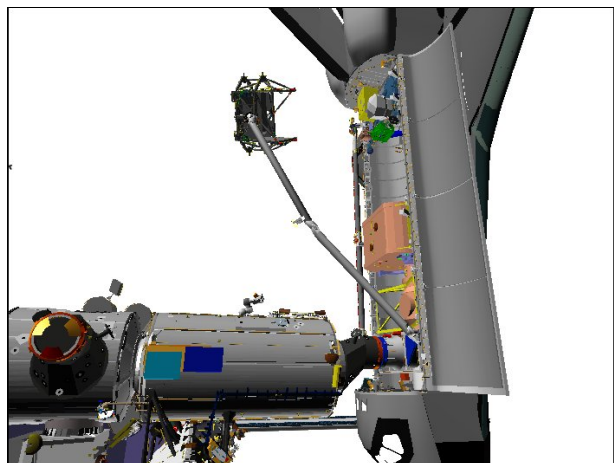
ELBOW (-10,-20)



ELBOW (-10,-20)



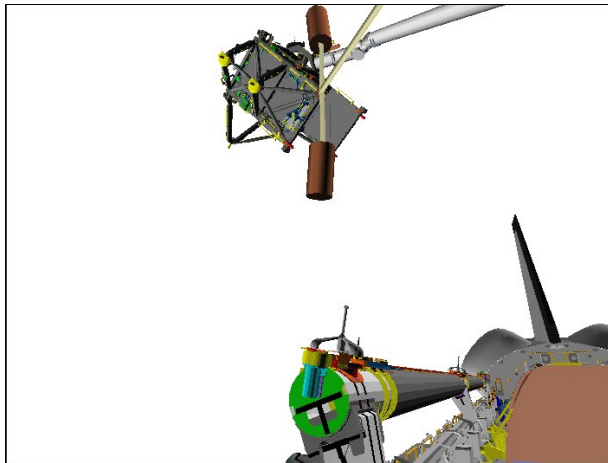
P1 LOOB (105,20)



P1 LOOB (105,20)

Step 7:

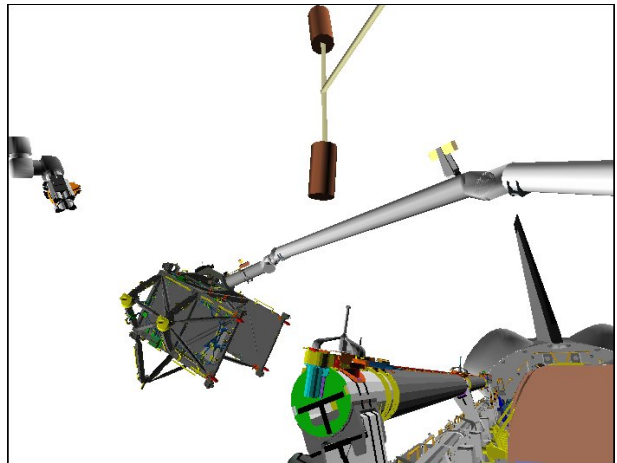
Drive SY- (for 34.4°)
From -20.6 to -55.0



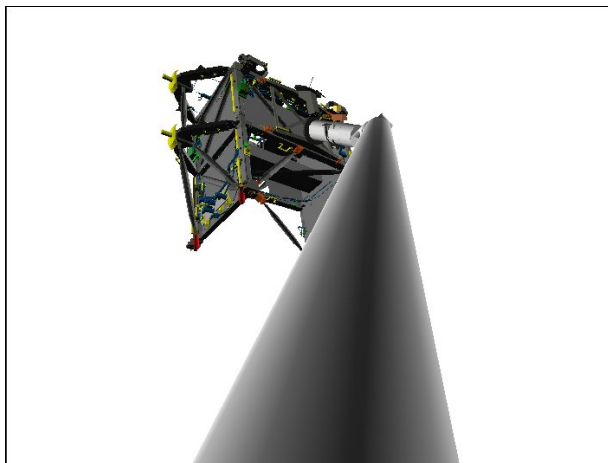
CCTV D (-25,20)

Step 8:

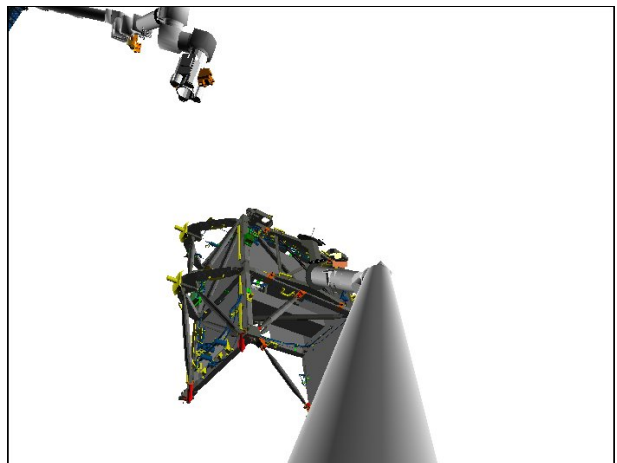
Drive SP- (for 29.4°)
From +40.0 to +10.6



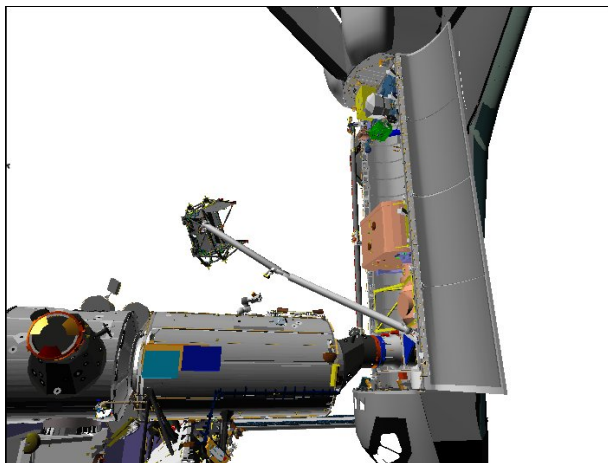
CCTV D (-25,20)



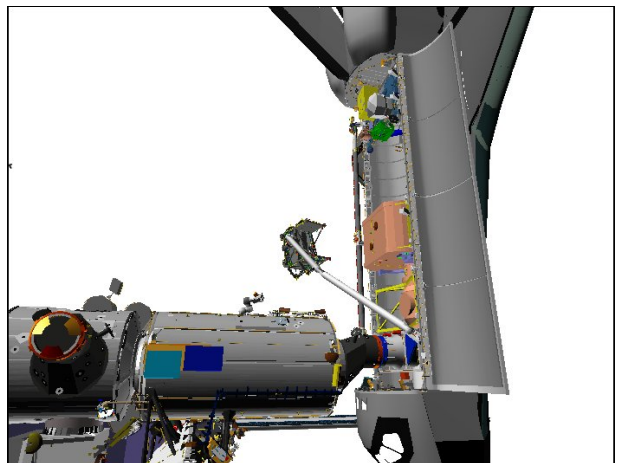
ELBOW (-10,-20)



ELBOW (-10,0)



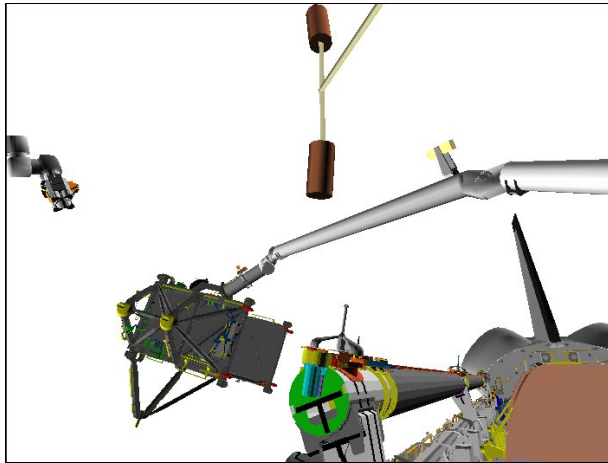
P1 LOOB (105,20)



P1 LOOB (105,20)

Step 9:

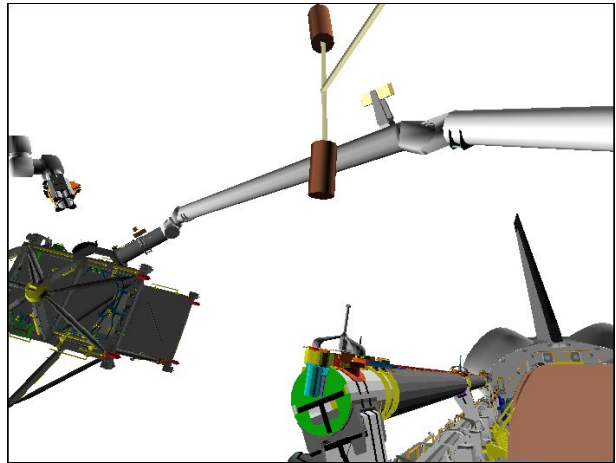
Drive WP- (for 16.4°)
From -33.0 to -49.4



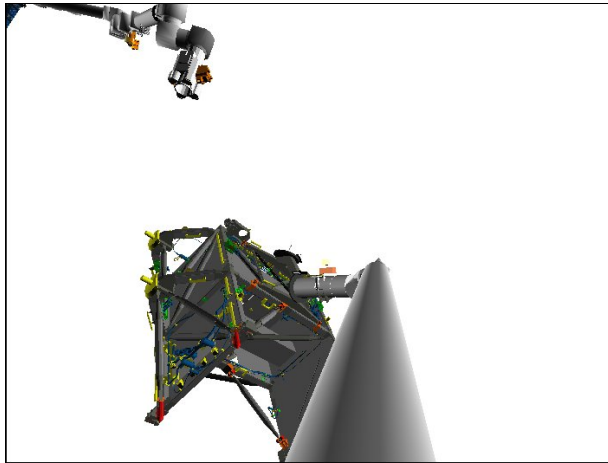
CCTV D (-25,20)

Step 10:

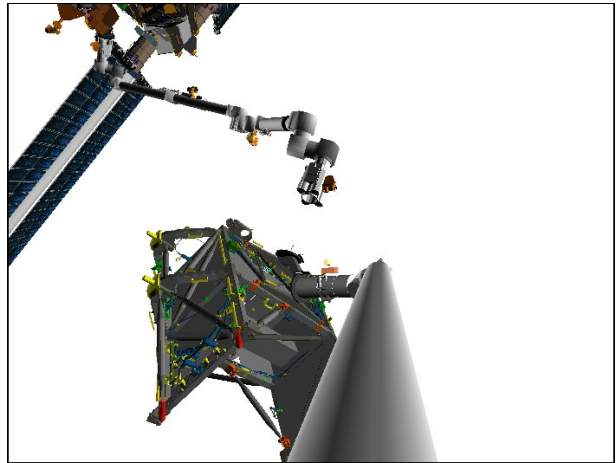
Drive SY- (for 12.9°)
From -55.0 to -67.9



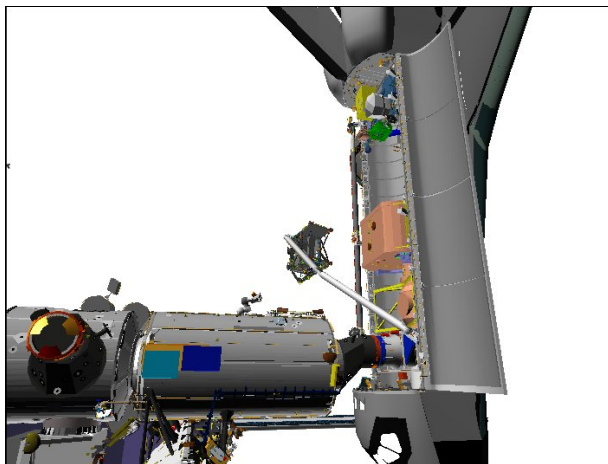
CCTV D (-25,20)



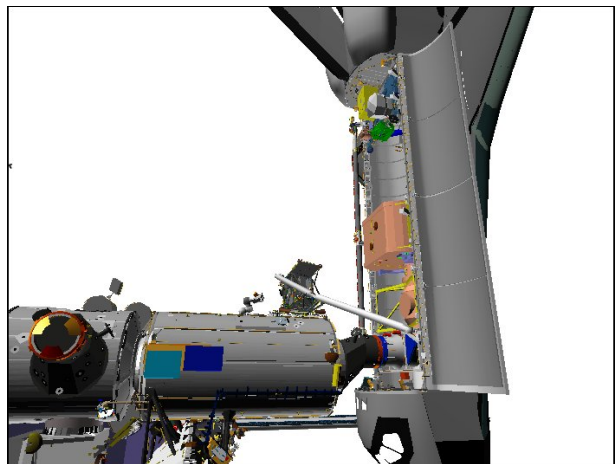
ELBOW (-10,0)



ELBOW (-10,0)



P1 LOOB (105,20)



P1 LOOB (105,20)

S5 SJ UNGRAPPLE

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

Mon 1	P1 LOOB
DwnInk	EE
Mon 2	D
DTV	C

2. S5 UNGRAPPLE
 On SSRMS Operator GO for Ungrapple, S5 Grapple complete and brakes on

If SINGLE MODE available:

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 (*)

PL ID – ITEM 3 +0 EXEC

INIT ID – ITEM 24 +0 EXEC

RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – best available

CAUTION

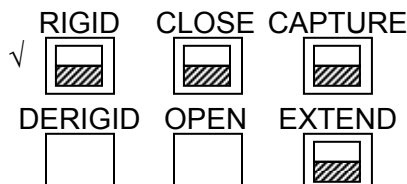
Monitor EE tb timing to prevent EE motor burnout

SM 169 PDRS STATUS

EE MODE – MAN

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

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



CRITICAL TIMES (8 sec total):

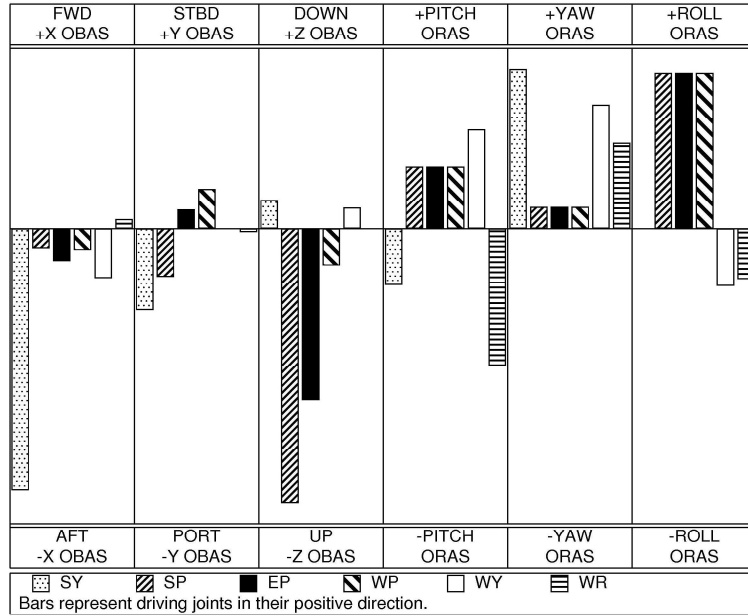
DERIGID tb – gray, 5 sec max, then

OPEN tb – gray, 3 sec max

3. MNVR ARM CLEAR OF S5

Drive joints per S5 SJ UNGRAPPLE WRIST CCTV OVERLAY until EE clear of grapple fixture

S5 SJ UNGRAPPLE



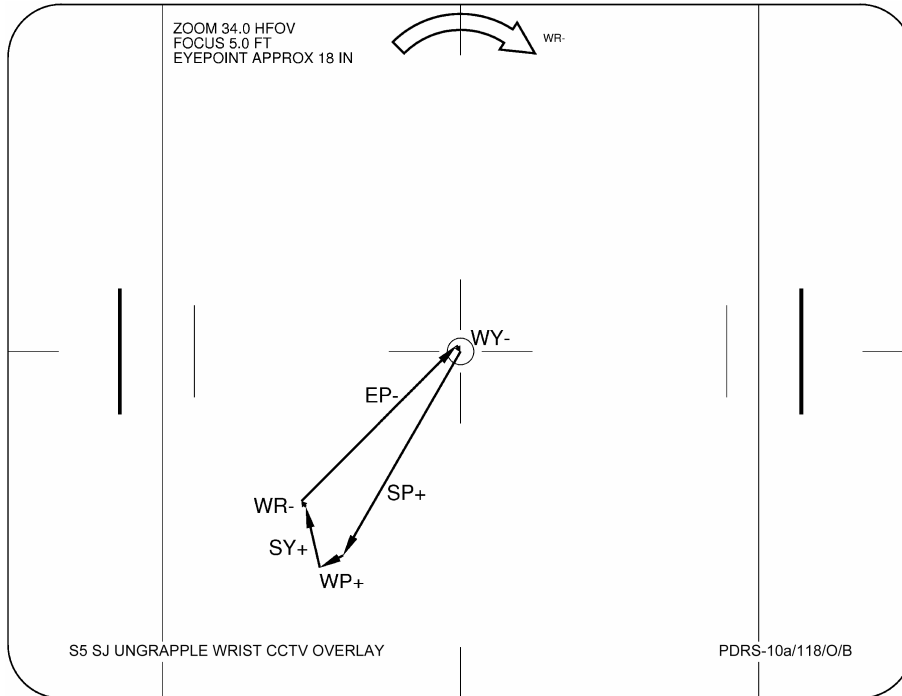
To get:	Drive:
+X (fwd)	-SY
+Y (stbd)	-SY, +WP
+Z (down)	-SP, -EP

To get:	Drive:
+PITCH	-WR, +WY
+YAW	+SY, +WY
+ROLL	+WP, +EP

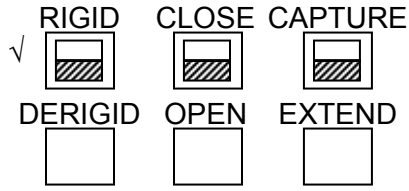
Driving:	Results In:
+SY	-X (aft), +YAW
+SP	-Z (up), +ROLL
+EP	-Z (up), +ROLL

Driving:	Results In:
+WP	+Y (stbd), +ROLL
+WY	-X (aft), +YAW
+WR	+X (fwd), -PITCH

ΔSY	ΔSP	ΔEP	ΔWP	ΔWY	ΔWR
+2.0	+10.6	-14.3	+2.7	-1.0	-2.0



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

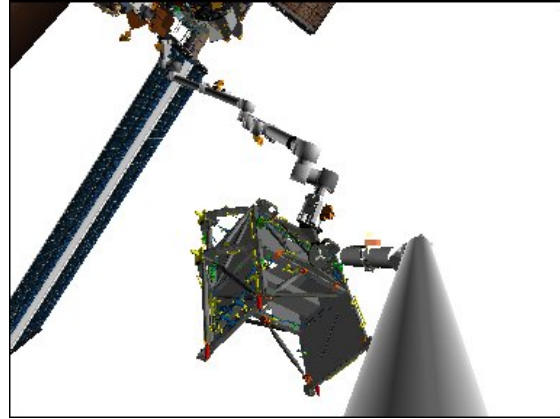


CRITICAL TIMES (20 sec total):
 EXTEND tb – gray, 20 sec max

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



CCTV D (-35,20)



ELBOW (-20,0)

4. SRMS MNVR TO S5 INSTALL VIEWING

Mon 1	P1 LOOB
DwnInk	Elbow
Mon 2	D
DTV	C

RATE – as required (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – best available

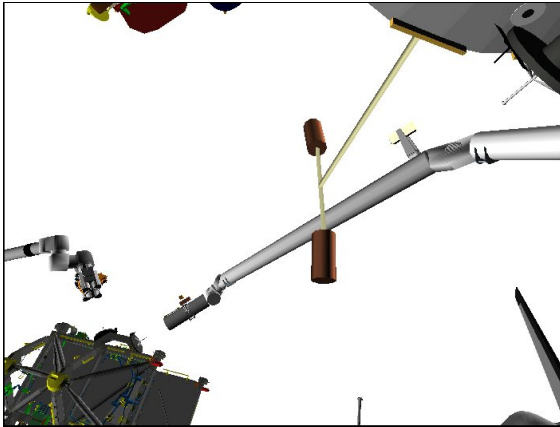
Mnvr to S5 INSTALL VIEWING posn (reference pictures as reqd):

	SY	SP	EP	WP	WY	WR	
Ungrapple Backoff	-66.0	+21.2	-35.3	-46.8	-30.6	-41.7	
1: SY +	-58.5						
2: SP +		+36.4					
3: EP -			-53.9				
4: WP +				+0.9			
5: WY -					-51.7		
6: WR -						-45.1	
S5 Install Viewing	-58.5	+36.4	-53.9	+0.9	-51.7	-45.1	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-915	+317	-649	159	293	102	0

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

Step 1:

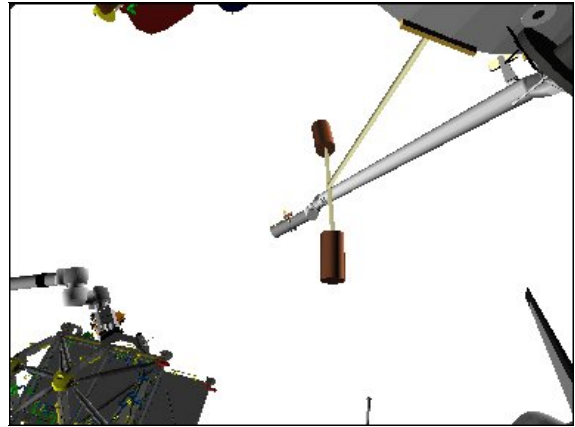
Drive SY+ (for 7.5°)
From -66.0 to -58.5



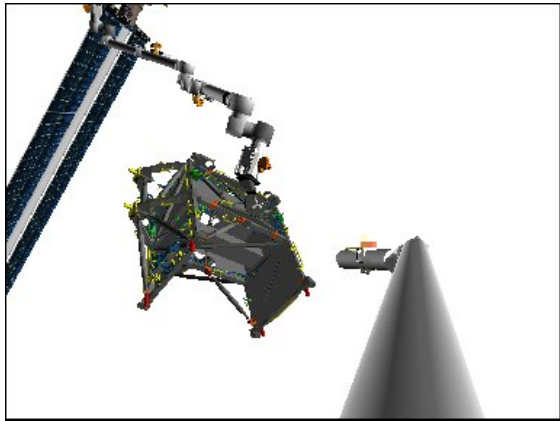
CCTV D (-30,35)

Step 2:

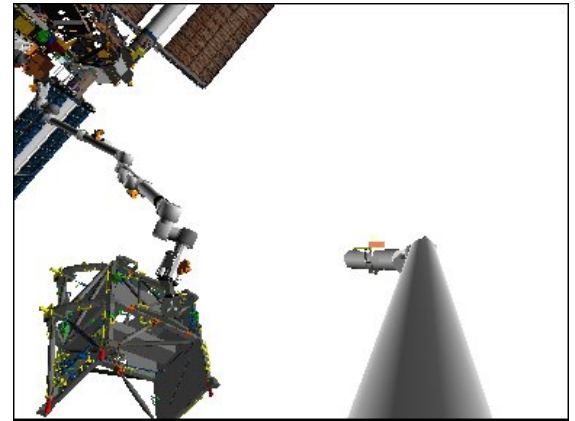
Drive SP+ (for 15.2°)
From +21.2 to +36.4



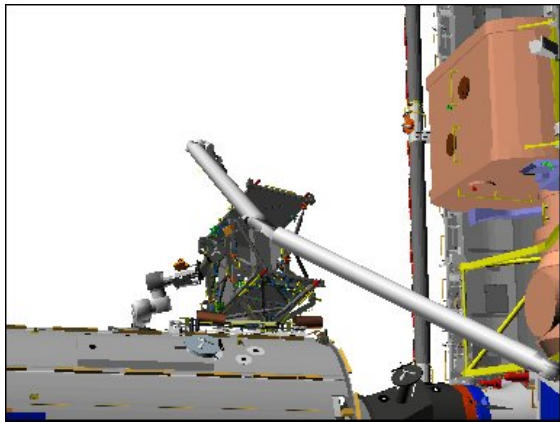
CCTV D (-30,35)



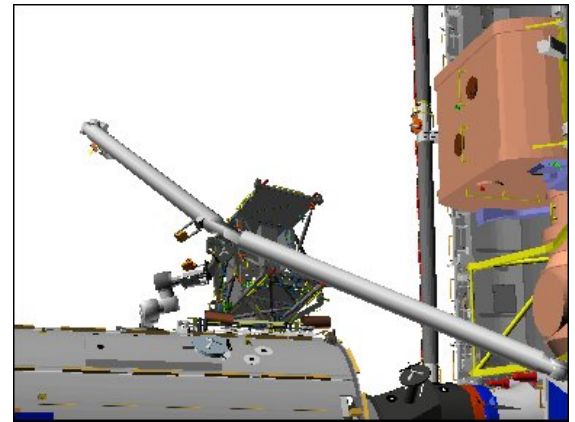
ELBOW (-20,0)



ELBOW (-20,0)



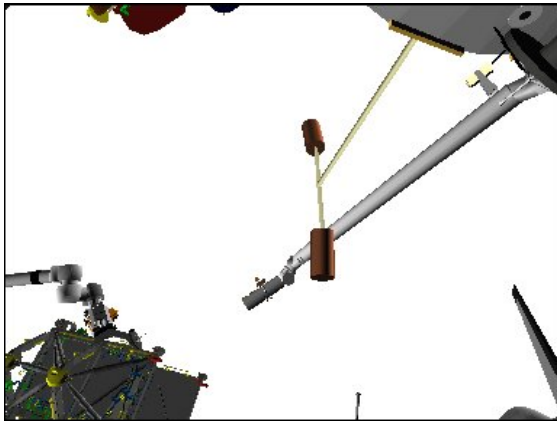
P1 LOOB (105,15)



P1 LOOB (105,15)

Step 3:

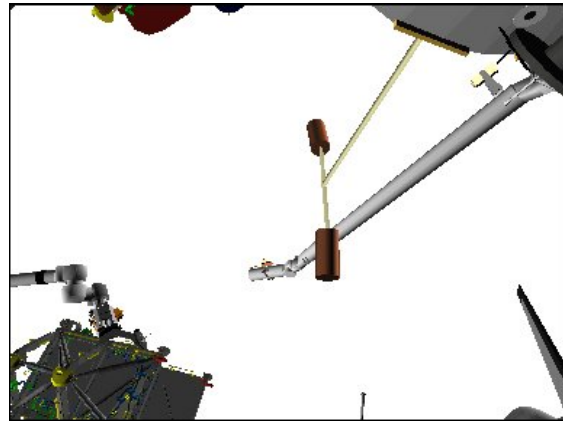
Drive EP- (for 18.6°)
From -35.3 to -53.9



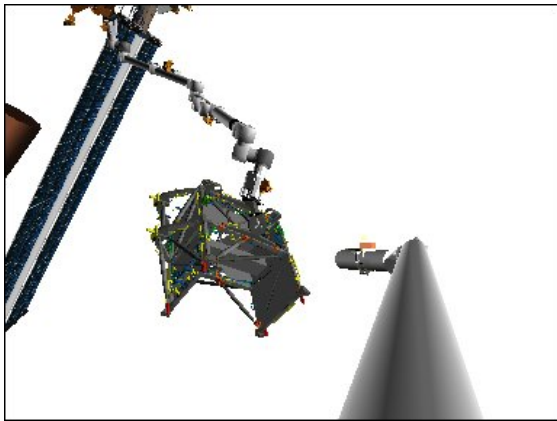
CCTV D (-30,35)

Step 4:

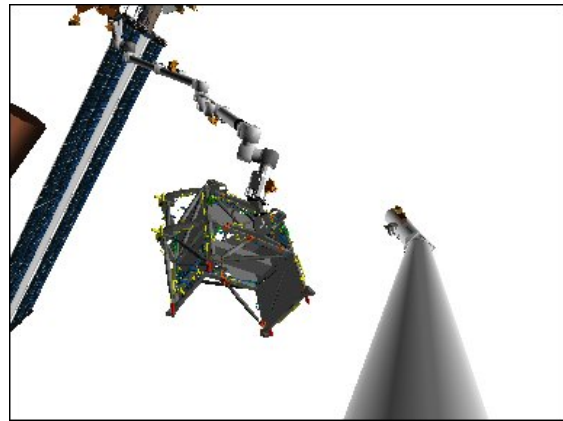
Drive WP+ (for 45.9°)
From -46.8 to +0.9



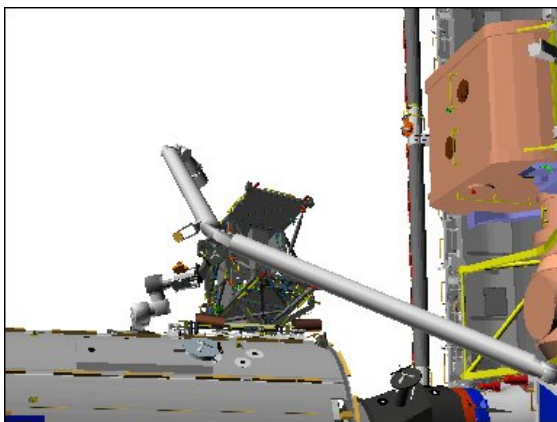
CCTV D (-30,35)



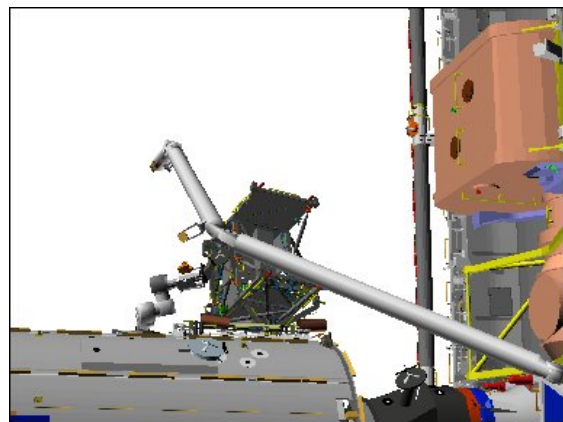
ELBOW (-20,0)



ELBOW (-20,0)



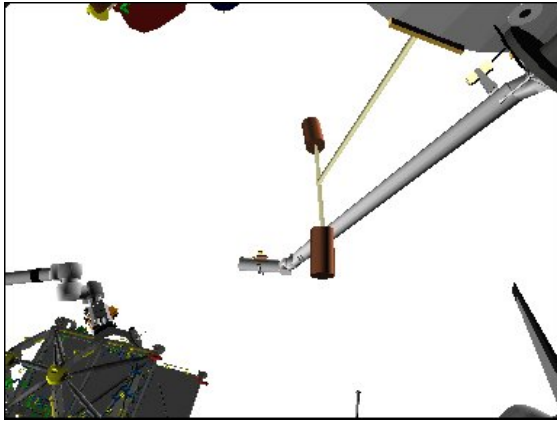
P1 LOOB (105,15)



P1 LOOB (105,15)

Step 5:

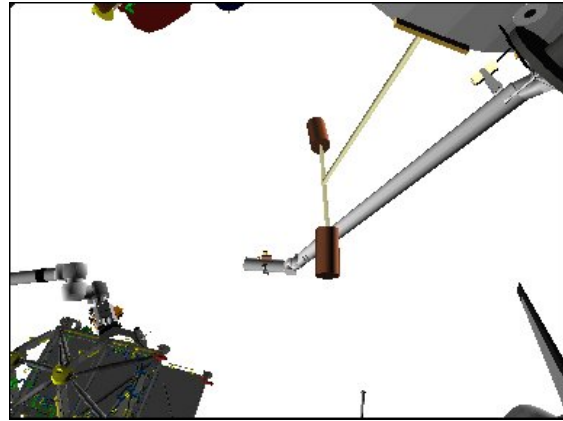
Drive WY- (for 21.1°)
From -30.6 to -51.7



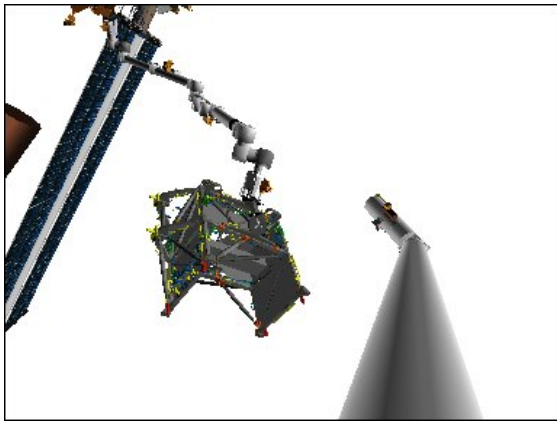
CCTV D (-30,35)

Step 6:

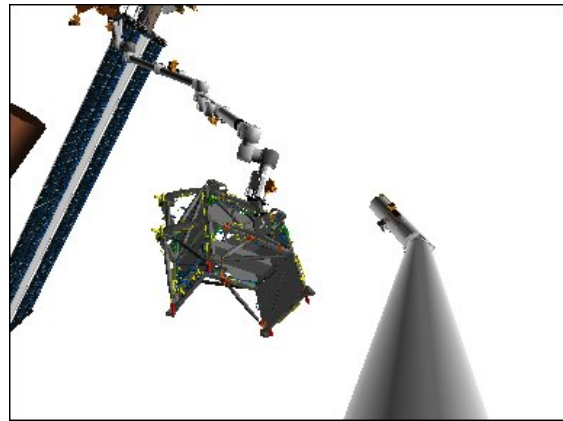
Drive WR- (for 3.4°)
From -41.7 to -45.1



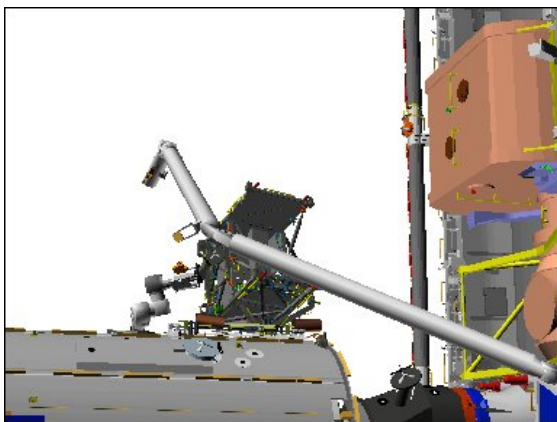
CCTV D (-30,35)



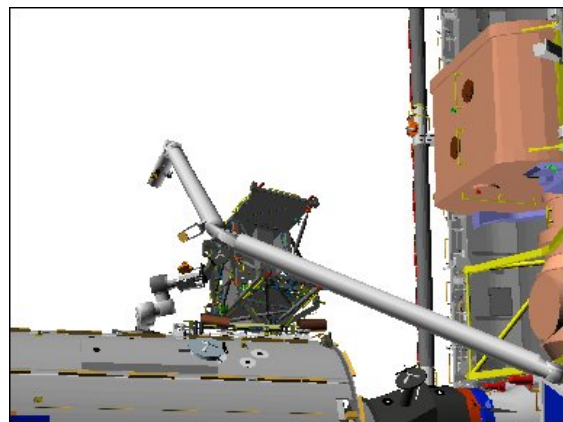
ELBOW (-20,0)



ELBOW (-20,0)



P1 LOOB (105,15)



P1 LOOB (105,15)

S5 CONTINGENCY REBERTH

1. SRMS MNVR TO S5 STBD POSN

Mon 1	P1 LOOB
DwnInk	Elbow
Mon 2	D
DTV	B (C)

SM 94 PDRS CONTROL

√PL ID, ITEM 3: 4

√INIT ID, ITEM 24: 4

RATE – as required (VERN within 10 ft)

BRAKES – OFF (tb-OFF)

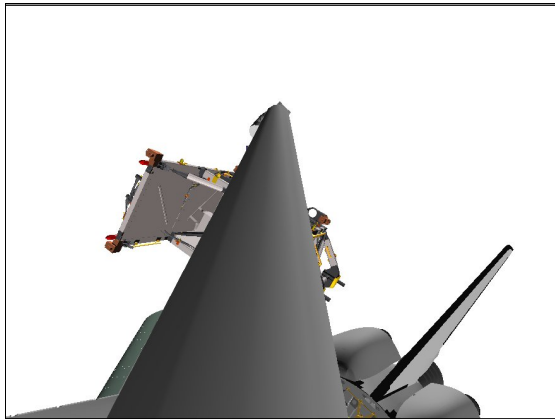
MODE – ORB LD, ENTER

Mnvr to S5 STBD posn:

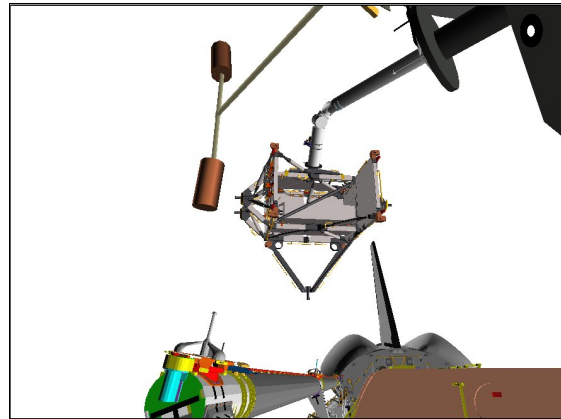
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1017	+116	-650	186	18	179	4
SY	SP	EP	WP	WY	WR	
-47.0	+66.5	-69.3	-49.9	+32.9	-1.1	

BRAKES – ON (tb-ON)

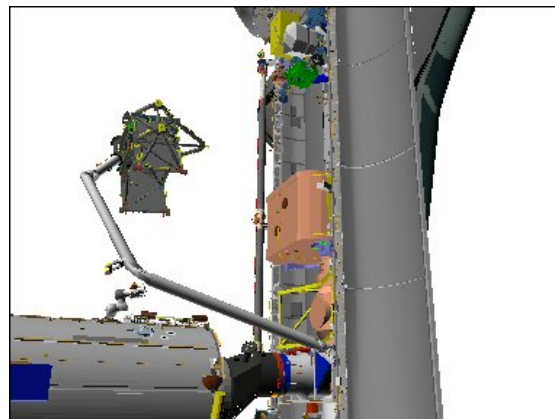
√MODE – not DIRECT



ELBOW (0,-20)



CCTV D (-10,25)



P1 LOOB (115,20)

2. MNVR TO S5 LOW HOVER

Mon 1	P1 LOOB
DwnInk	Elbow
Mon 2	D
DTV	B (C)

RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – SINGLE, ENTER

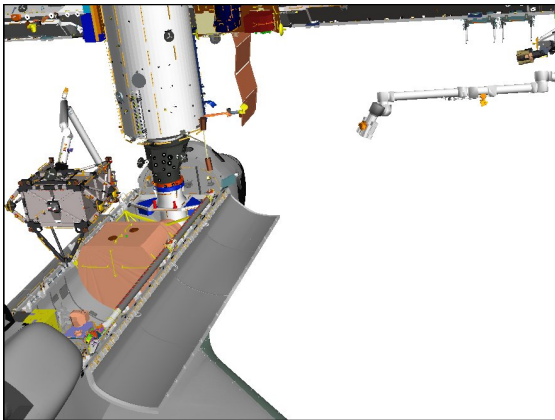
Drive SY positive to -28.4

S5 LOW HOVER posn:

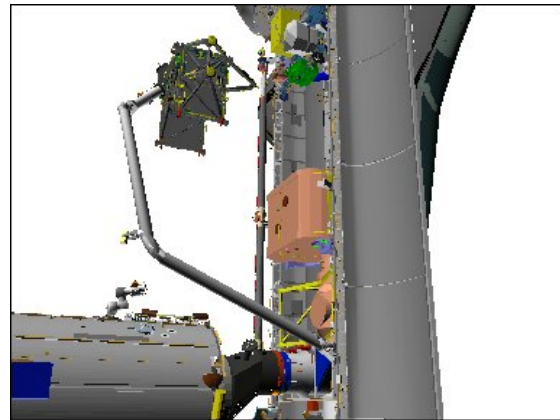
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1089	0	-610	180	0	180	4
SY	SP	EP	WP	WY	WR	
-28.4	+66.5	-69.3	-49.9	+32.9	-1.1	

BRAKES – ON (tb-ON)

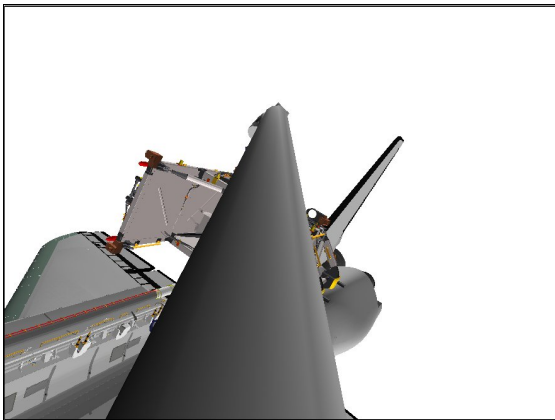
√MODE – not DIRECT



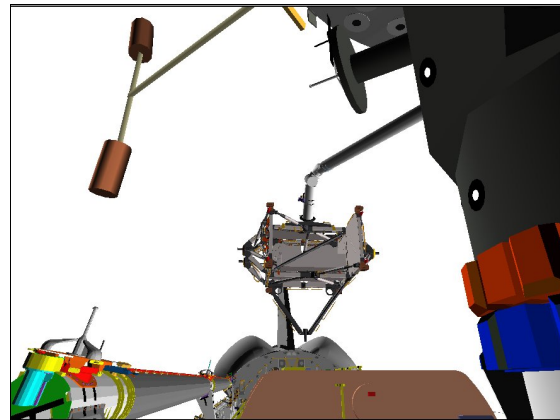
BIRD'S EYE



P1 LOOB (115,20)



ELBOW (0,-20)



CCTV D (5,25)

3. MNVR TO S5 BERTHED

Mon 1	Lab (P1 LOOB)
DwnInk	Elbow (A)
Mon 2	Mux B & C
DTV	D

CAUTION
 Monitor clearances between STBD trunnions and OBSS during reberth. Minimum clearance of approximately 4 inches expected

If using Shuttle attitude control:
 DAP: FREE

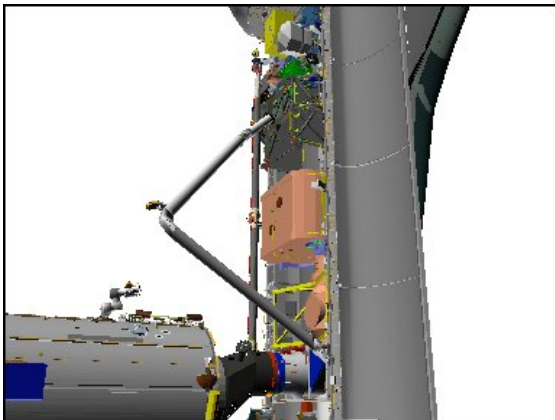
RATE – VERN (RATE MIN tb-ON)
 BRAKES – OFF (tb-OFF)
 MODE – ORB LD, ENTER

Mnvr to S5 BERTHED posn (insert data from S5 GRAPPLE):

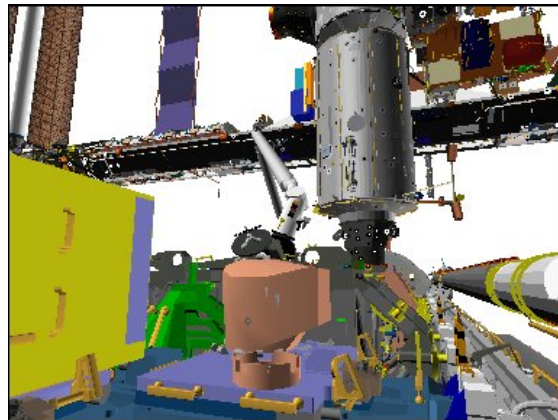
	X	Y	Z	PITCH	YAW	ROLL	PL ID
							4
Expected	-1089	0	-414	180	0	180	4
	SY	SP	EP	WP	WY	WR	
Expected	-19.4	+57.8	-97.8	-8.6	+27.2	-9.1	

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

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



P1 LOOB (115,20)



CCTV C (-20,10)

4. 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 (four) – OFF
√PL SEL – 1
LOGIC PWR SYS 1,2 (two) – ON

R13L PL BAY MECH PWR SYS 1,2 (two) – ON

SM 97 PL RETENTION

√PL SEL 1 RDY-FOR-LAT 1,2,3,4,5 (ten): 1
√LAT 1,2,3,4,5 (ten): 0

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

5. AKA LATCH

√PL RETEN PL SEL – 1
√LAT 5 tb – REL
√RDY 5 tb – gray

Note single motor times (> 30 sec)
PL RETEN LAT 5 – LAT (tb-LAT), 60 sec max
– OFF

6. PRLA LATCH

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

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

7. DEACTIVATE LATCHES

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

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

A7U

- 8. S5 UNGRAPPLE SETUP
 CCTV – RMS WRIST, zoom 34.0 HFOV
 focus 5 ft

Mon 1	S1 LOOB
DwnInk	EE
Mon 2	C
DTV	D

SM 94 PDRS CONTROL

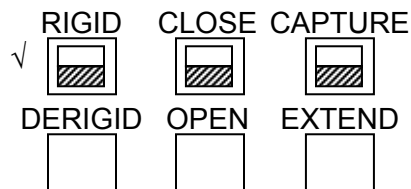
PL ID – ITEM 3 +0 EXEC
 INIT ID – ITEM 24 +0 EXEC

- 9. S5 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

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

EE MODE – OFF

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

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OFF-NOMINAL ESP-3 OPS

ESP-3 SJ GRAPPLE	FS 4-2
UNBERTH	FS 4-9
HANDOFF	FS 4-11
UNGRAPPLE	FS 4-17
CONTINGENCY REBERTH	FS 4-23

**OFF-NOMINAL
ESP-3 OPS**

ESP-3 SJ GRAPPLE

- A7U 1. SJ MNVR TO PRE-GRAPPLE
 CCTV – perform PAN/TILT RESET
 – fully zoom out for SJ pictures

SM 94 PDRS CONTROL

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

Mon 1	A
DwnInk	Elbow (EE)
Mon 2	S1 LOOB 03 (P1 LOOB 09)
DTV	B (C)

RATE – as required (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – best available

Mnvr to PRE-GRAPPLE posn (reference pictures as reqd):

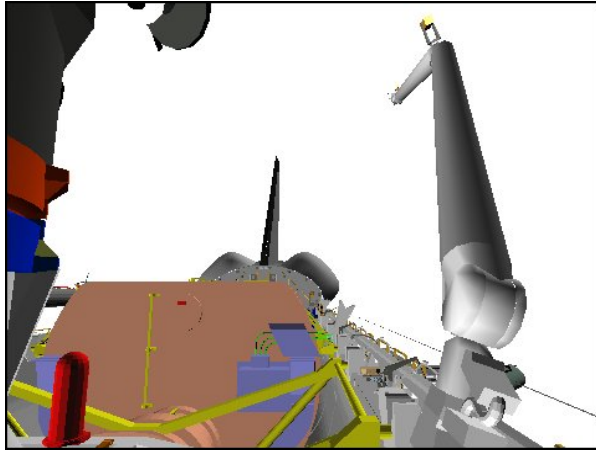
	SY	SP	EP	WP	WY	WR	
Pre-cradle	0.0	+25.0	-25.0	+5.0	0.0	0.0	
1: SP +		+47.8					
2: WP +				+7.5			
3: WY +					+16.4		
4: SY -	-7.3						
5: EP -			-86.7				
6: WR -						-172.9	
ESP-3	-7.3	+47.8	-86.7	+7.5	+16.4	-172.9	
Pre-grapple	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-1132	+60	-435	328	0	181	0

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

OFF-NOMINAL
ESP-3 OPS

Step 1:

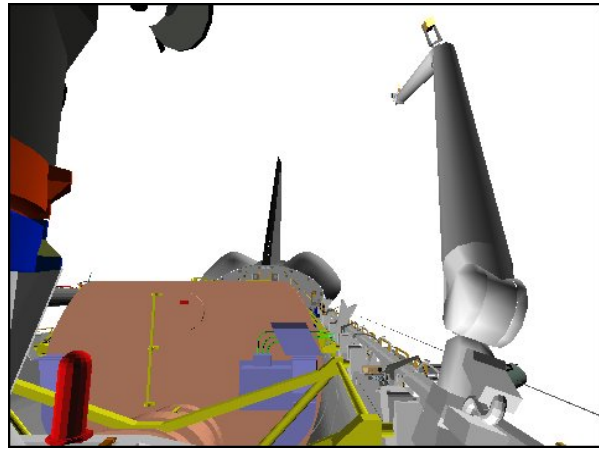
Drive SP+ (for 22.8°)
From +25.0 to +47.8



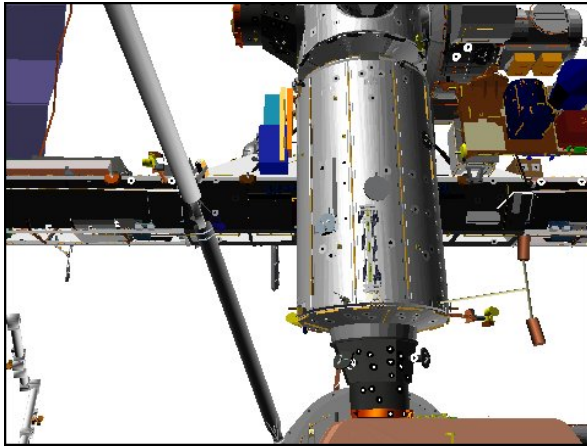
CCTV A (0,10)

Step 2:

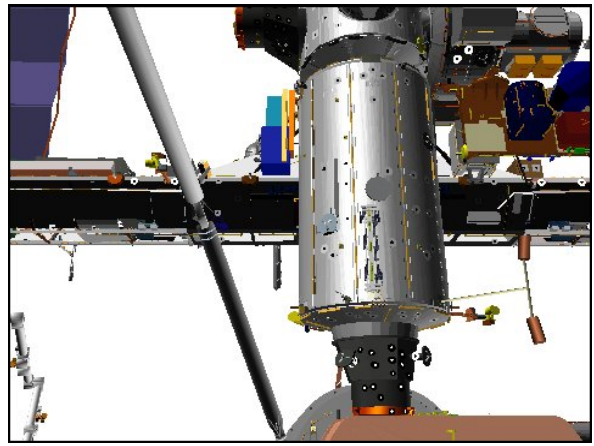
Drive WP+ (for 2.5°)
From +5.0 to +7.5



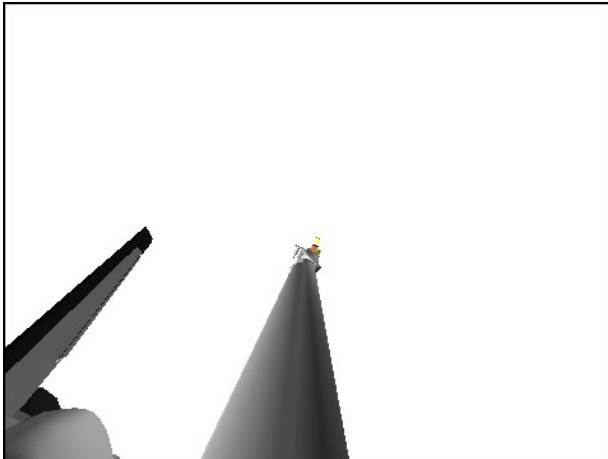
CCTV A (0,10)



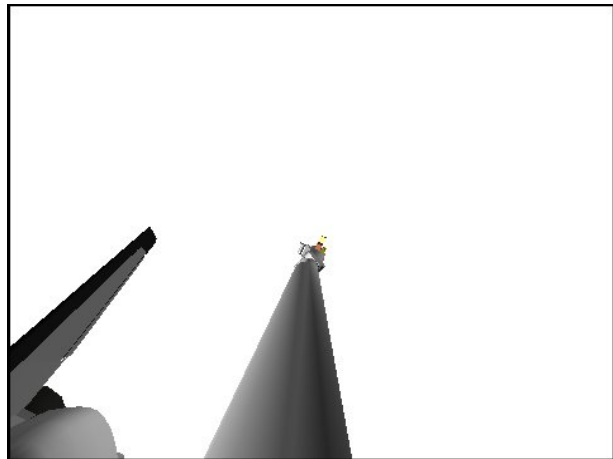
CCTV B (0,20)



CCTV B (0,20)



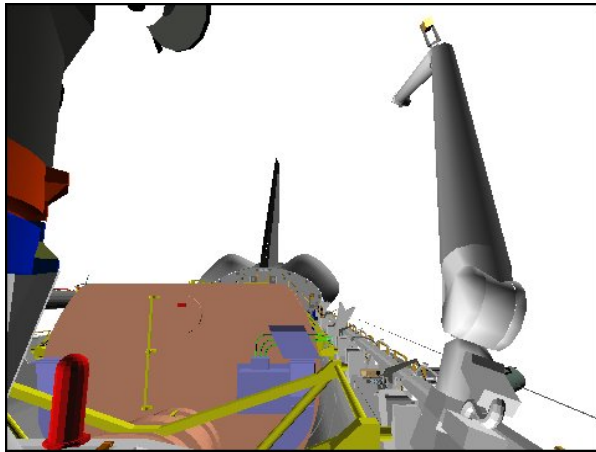
ELBOW (0,0)



ELBOW (0,0)

Step 3:

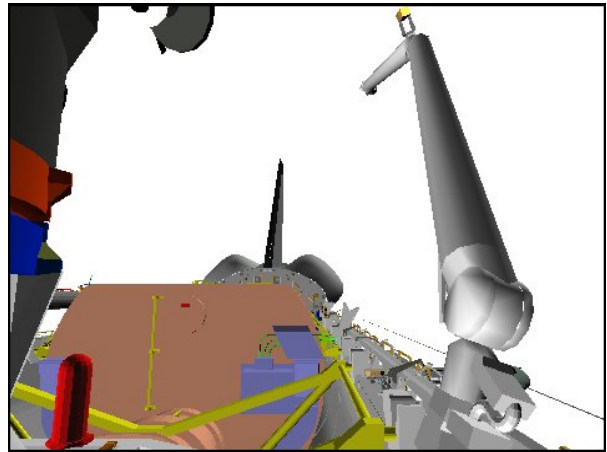
Drive WY+ (for 16.4°)
From 0.0 to +16.4



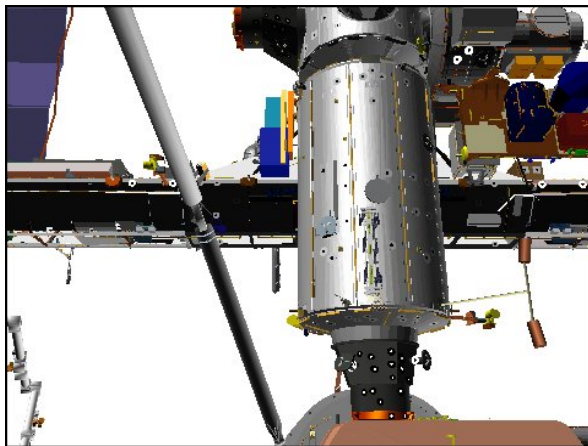
CCTV A (0,10)

Step 4:

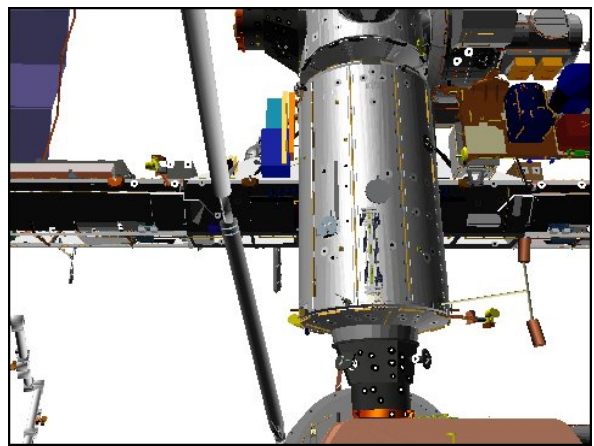
Drive SY- (for 7.3°)
From 0.0 to -7.3



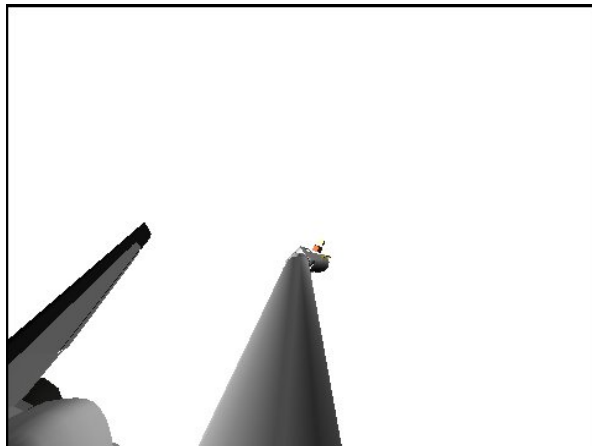
CCTV A (0,10)



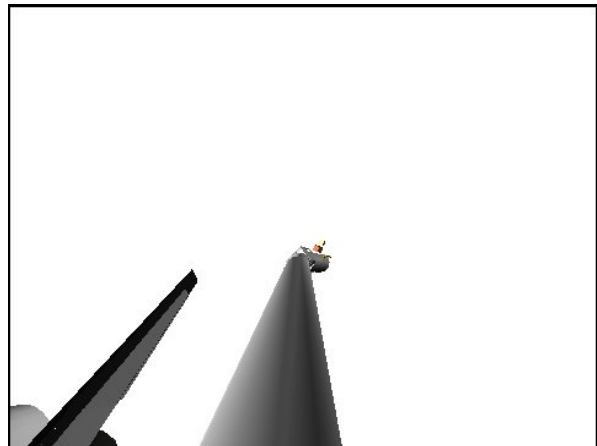
CCTV B (0,20)



CCTV B (0,20)



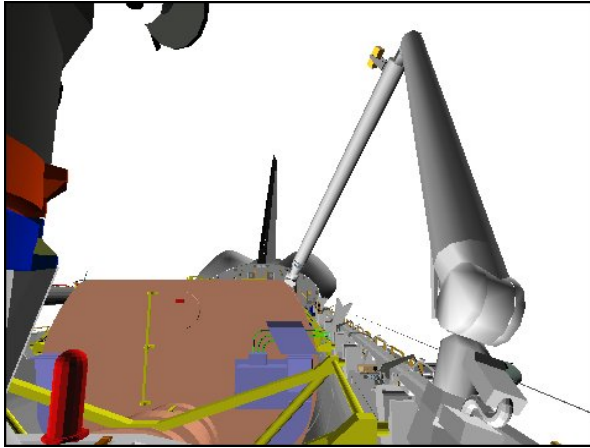
ELBOW (0,0)



ELBOW (0,0)

Step 5:

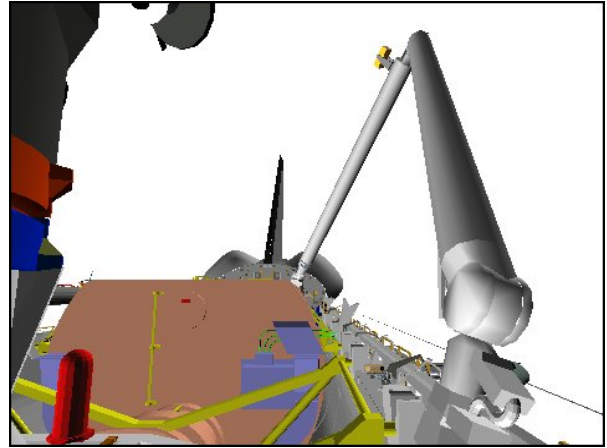
Drive EP- (for 61.7°)
From -25.0 to -86.7



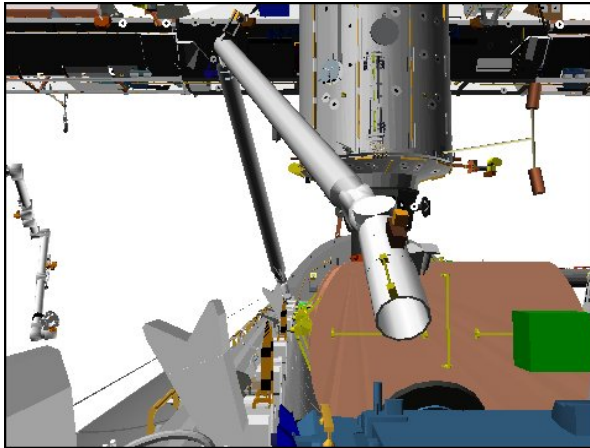
CCTV A (0,10)

Step 6:

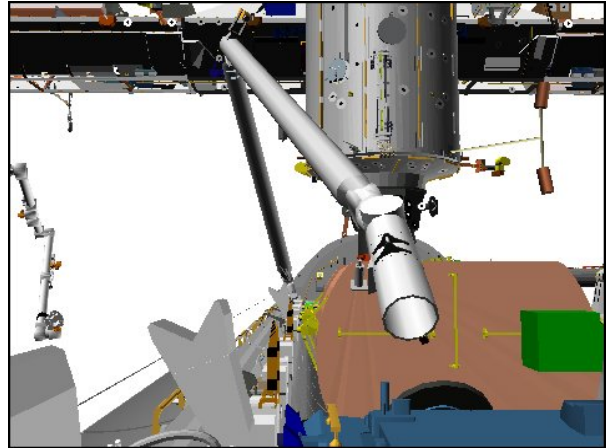
Drive WR- (for 172.9°)
From 0.0 to -172.9



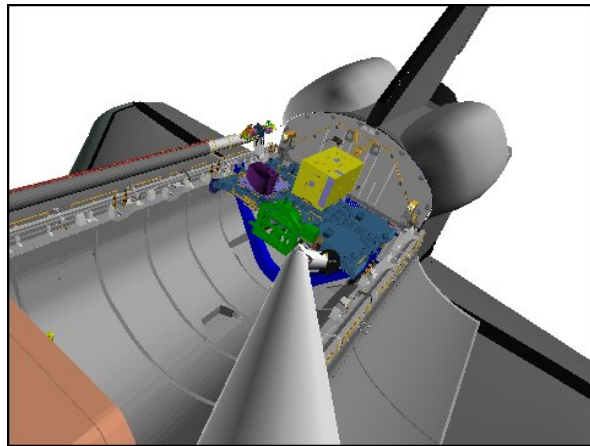
CCTV A (0,10)



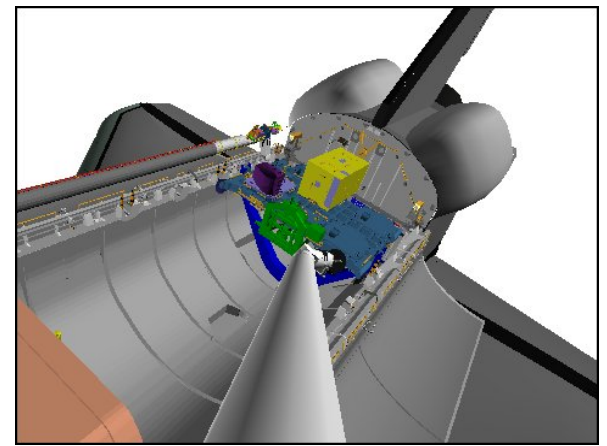
CCTV B (0,5)



CCTV B (0,5)



ELBOW (0,0)



ELBOW (0,0)

A7U

2. SJ MNVR TO ESP-3 GRAPPLE

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	A
DwnInk	EE (Elbow)
Mon 2	S1 LOOB 03 (P1 LOOB 09)
DTV	B

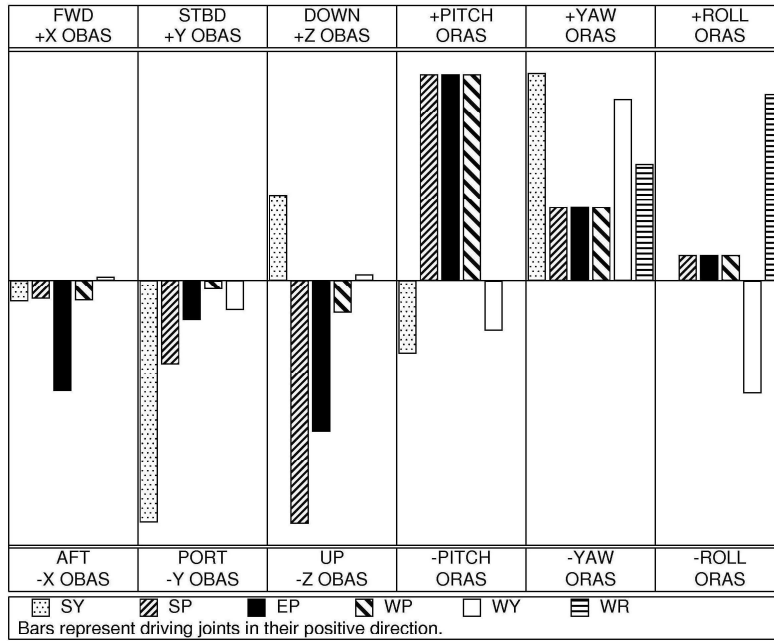
RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – best available

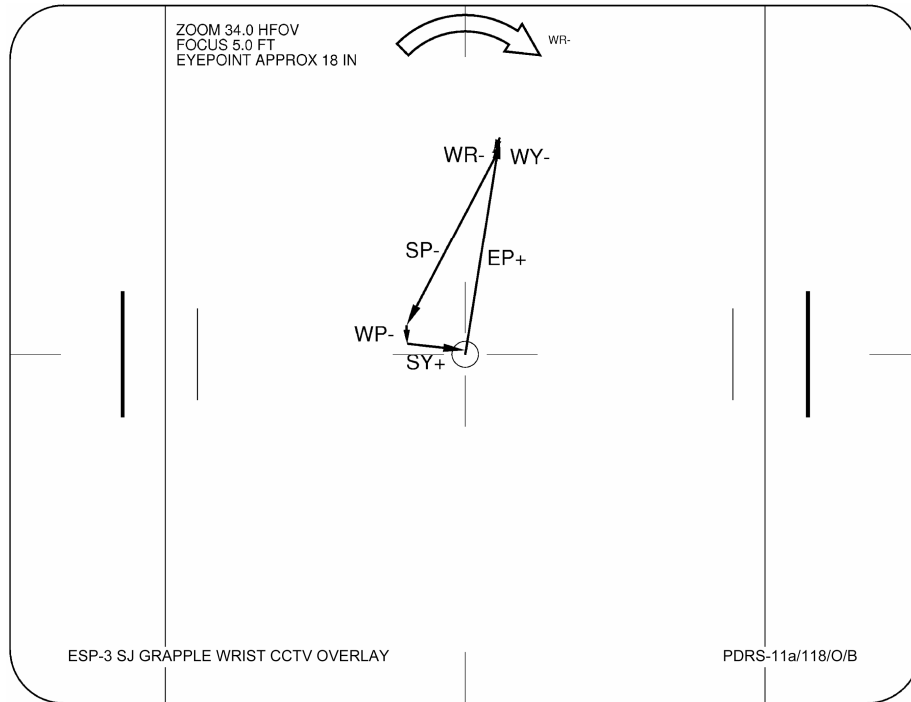
Drive joints per ESP-3 SJ GRAPPLE WRIST CCTV OVERLAY and diagram until EE within grapple envelope

ESP-3 SJ GRAPPLE



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

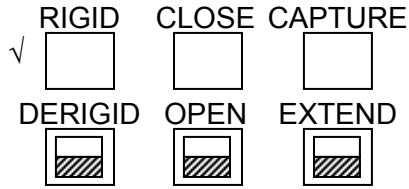
ΔSY	ΔSP	ΔEP	ΔWP	ΔWY	ΔWR
+1.3	-8.0	+10.1	-1.8	-1.1	-0.7



3. ESP-3 GRAPPLE

CAUTION
Monitor EE tb timing to prevent EE motor burnout

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

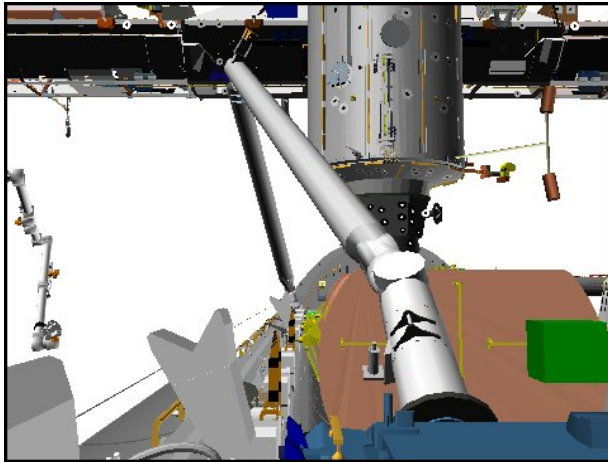


CRITICAL TIMES (28 sec total):
 CAPTURE tb – gray, then
 CLOSE tb – gray, 3 sec max, then
 RIGID tb – gray, 25 sec max

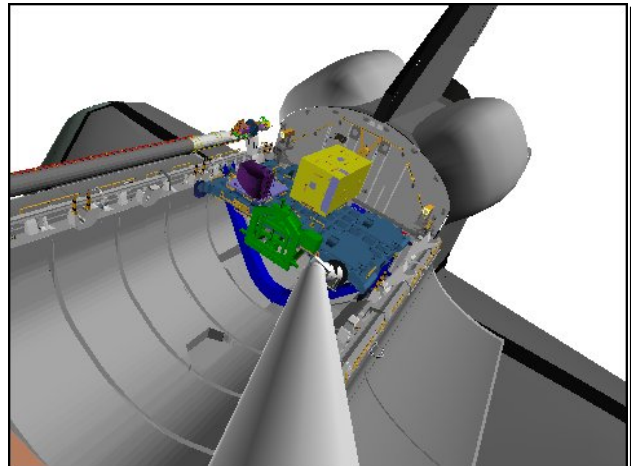
- * If manual grapple reqd: *
- * EE MODE – MAN *
- * CAPTURE sw – depress (hold until CLOSE tb-gray, *
- * 3 sec max) *
- * MAN CONTR – RIGID (hold until RIGID tb-gray, *
- * 25 sec max) *

EE MODE – OFF

BRAKES – ON (tb-ON)
MODE – not DIRECT



CCTV B (0,5)



ELBOW (0,0)

SM 94 PDRS CONTROL

PL ID – ITEM 3 +5 EXEC
INIT ID – ITEM 24 +5 EXEC

Record POS/ATT and Joint Angles:

	X	Y	Z	PITCH	YAW	ROLL	PL ID
							5
	SY	SP	EP	WP	WY	WR	
Expected	-6.0	+39.8	-76.6	+5.7	+15.3	-173.6	

Record POS/ATT and Joint Angles in ESP-3 CONTINGENCY REBERTH

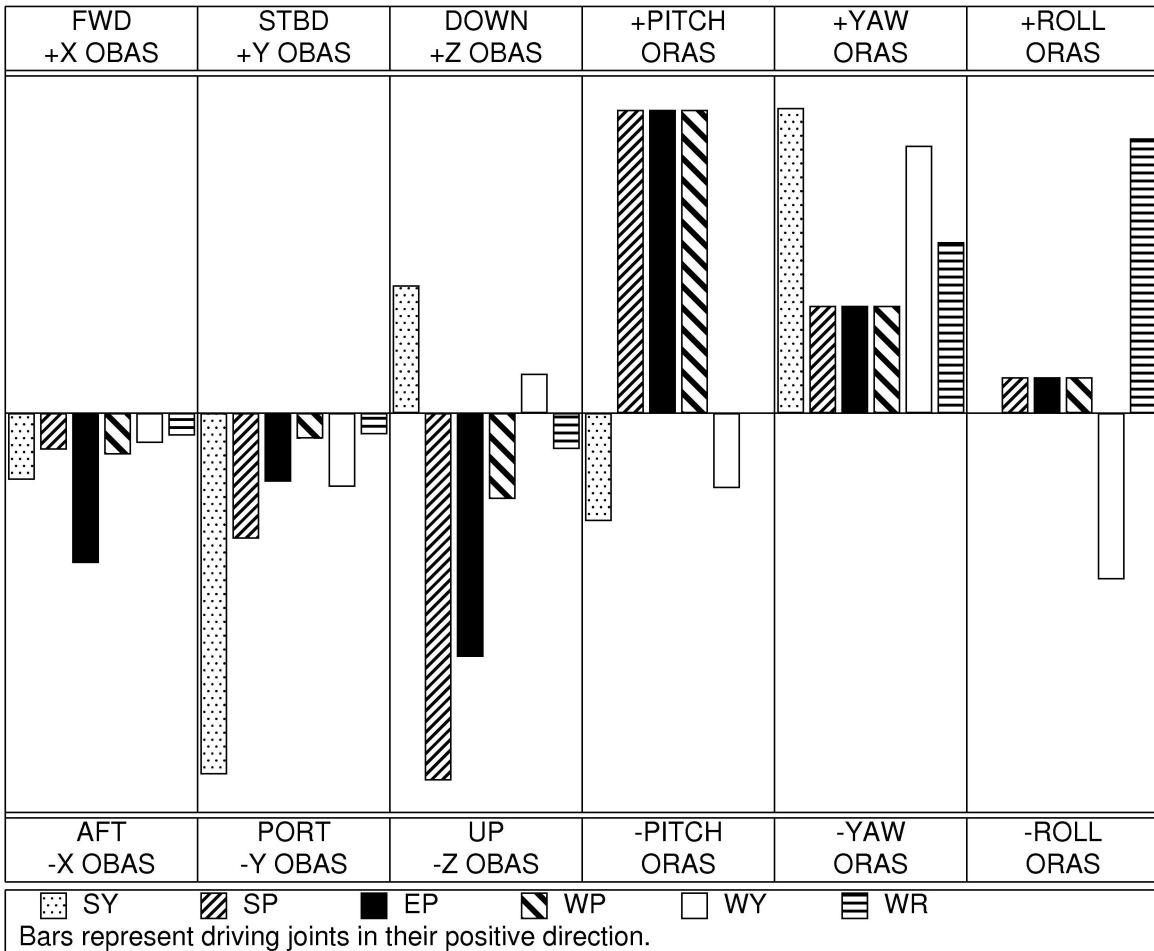
Review GENERIC END EFFECTOR CUE CARD – ISS/SHUTTLE DOCKED OPS

ESP-3 SJ UNBERTH

1. SETUP
Perform ESP-3 UNBERTH, steps 1-4 (NOMINAL ESP-3 OPS)
2. SJ MNVR TO TOP OF V-GUIDES
 RATE – as required (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – best available

Drive joints per ESP-3 SJ TOP OF V-GUIDES histogram until ESP-3 trunnions at top of V-guides (Z = -440)

ESP-3 SJ TOP OF V-GUIDES



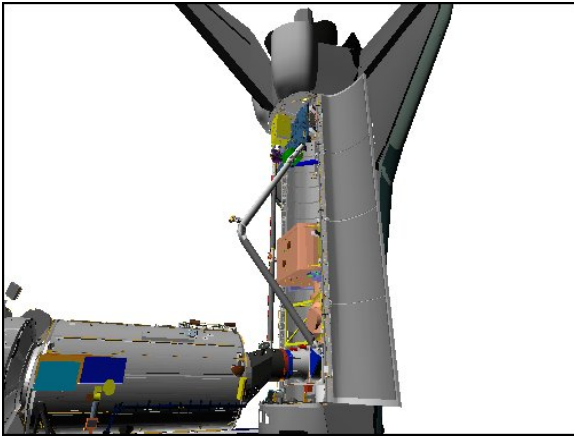
To get:	Drive:	To get:	Drive:
+X (fwd)	-EP, -SY	+PITCH	+WP, +EP
+Y (stbd)	-SY	+YAW	+WY, +SY
+Z (down)	-SP, -EP	+ROLL	+WR, -WY

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

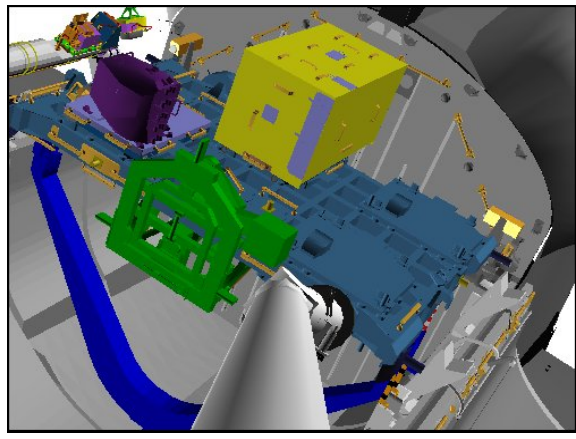
ΔSY	ΔSP	ΔEP	ΔWP	ΔWY	ΔWR
-0.7	+3.3	+0.2	-3.6	+0.7	+0.4

SUGGESTED JOINT ORDER

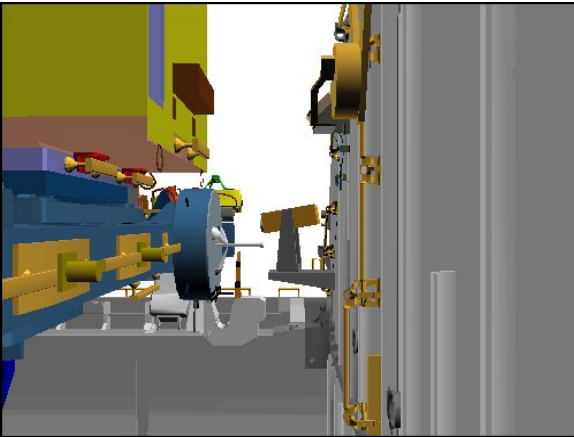
SP+, SY-, WP-, EP+, WY+, WR+ as reqd



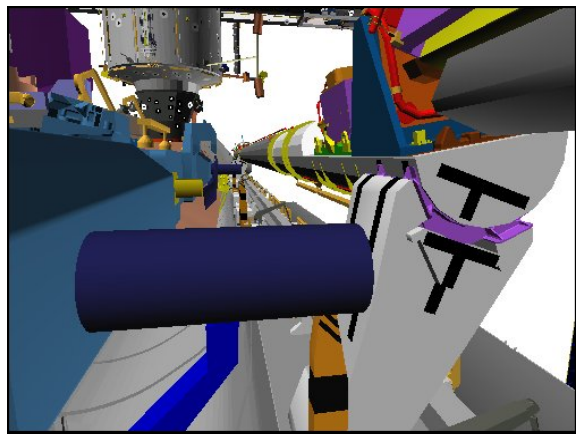
P1 LOOB (115,25)



ELBOW (0,0)



CCTV B (90,0)



CCTV C (10,-10)

ESP-3 SJ HANDOFF

1. SJ MNVR TO ESP-3 HANDOFF POSN

Mon 1	B
DwnInk	Elbow
Mon 2	A
DTV	Mast 37 (P1 LOOB 09)

RATE – as reqd (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – best available

Mnvr to ESP-3 HANDOFF posn (reference pictures as reqd):

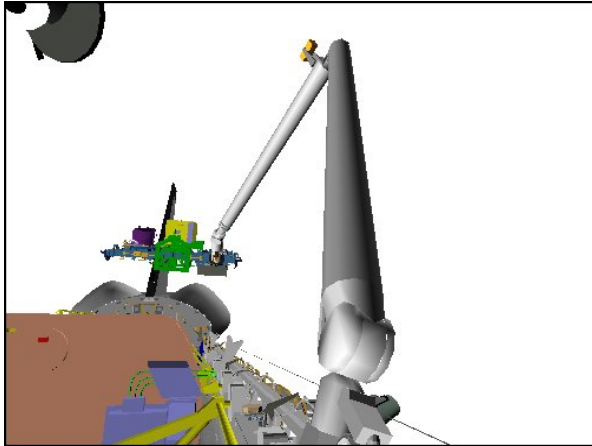
	SY	SP	EP	WP	WY	WR	
ESP-3 Top of V-Guides	-6.7	+43.1	-76.4	+2.1	+16.0	-173.2	
1: SP +		+56.0					
2: EP +			-65.0				
3: SY +	+60.0						
4: WP +				+19.1			
5: WR +						-155.9	
6: WY +					+24.5		
7: EP -			-106.7				
8: SY +	+135.8						
9: SP +		+68.7					
ESP-3 Handoff	+135.8	+68.7	-106.7	+19.1	+24.5	-155.9	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-353	-435	-385	352	336	19	5

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

Notify ISS, GO for ESP-3 Grapple

Step 1:

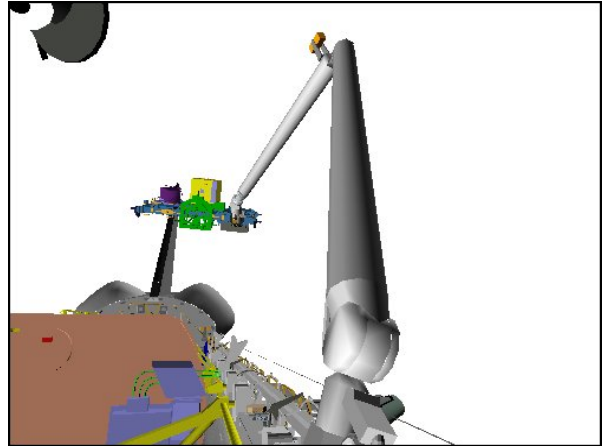
Drive SP+ (for 12.9°)
From +43.1 to +56.0



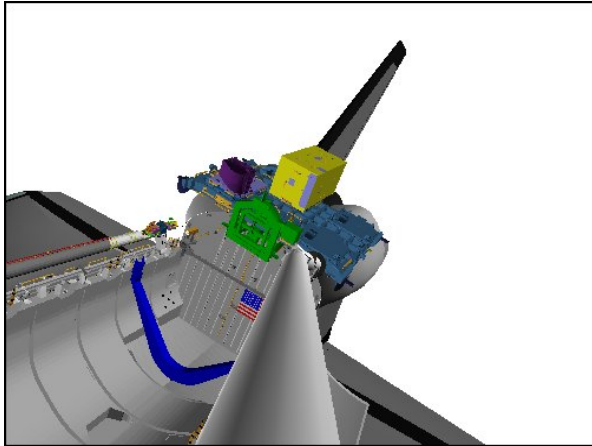
CCTV A (15,15)

Step 2:

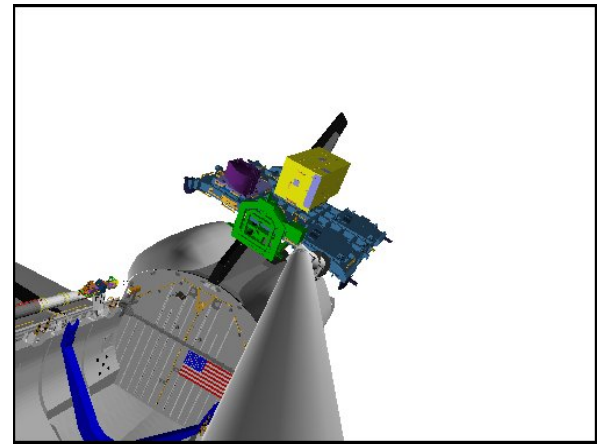
Drive EP+ (for 11.4°)
From -76.4 to -65.0



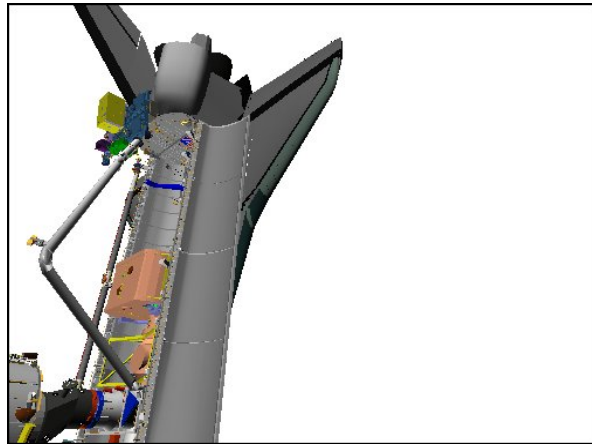
CCTV A (15,15)



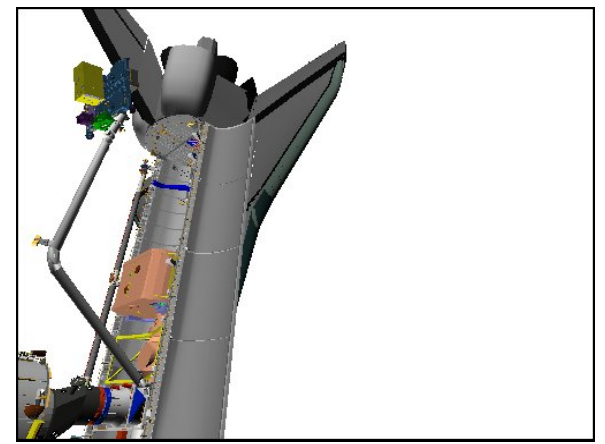
ELBOW (0,0)



ELBOW (0,0)



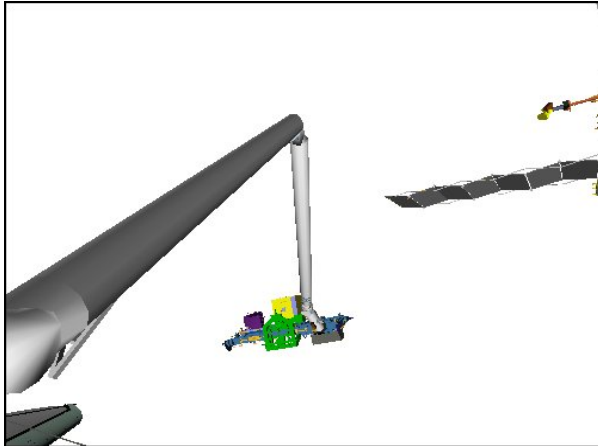
P1 LOOB (140,30)



P1 LOOB (140,30)

Step 3:

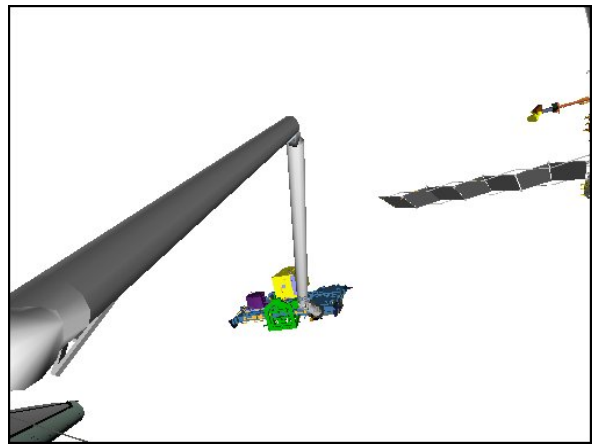
Drive SY+ (for 66.7°)
From -6.7 to +60.0



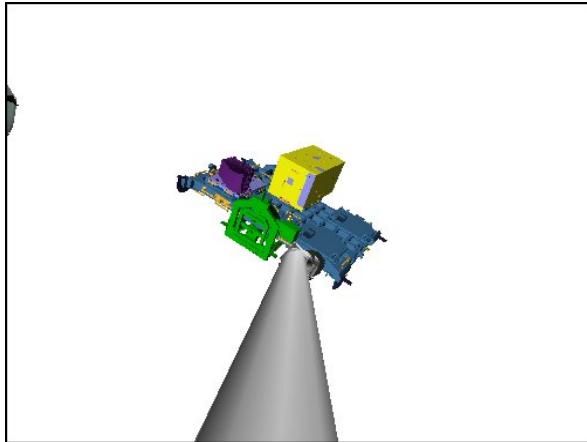
CCTV A (55,15)

Step 4:

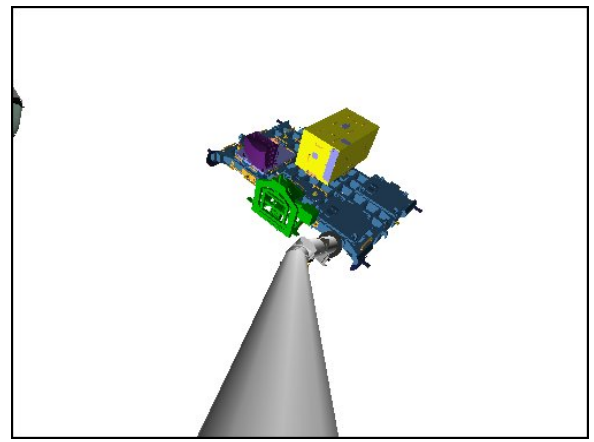
Drive WP+ (for 17.0°)
From +2.1 to +19.1



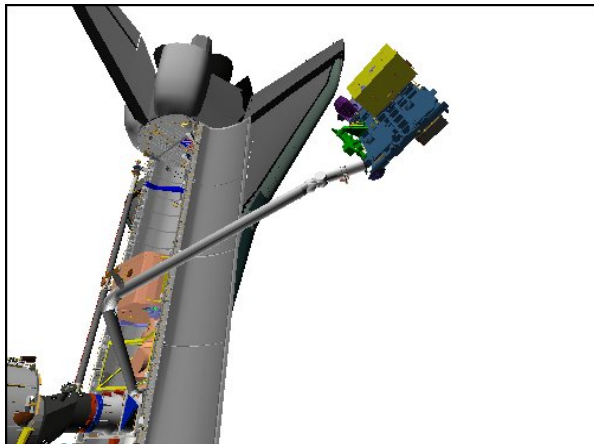
CCTV A (55,15)



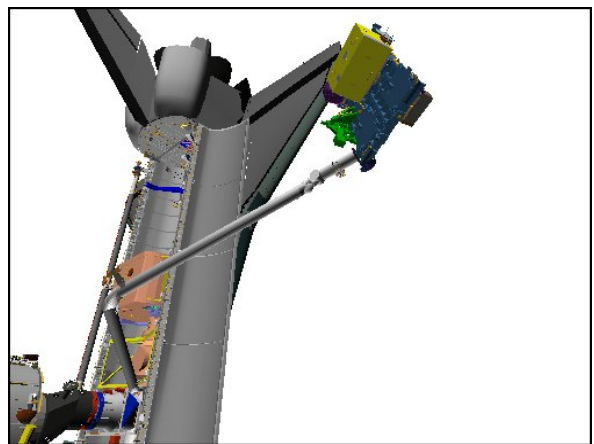
ELBOW (0,0)



ELBOW (0,0)



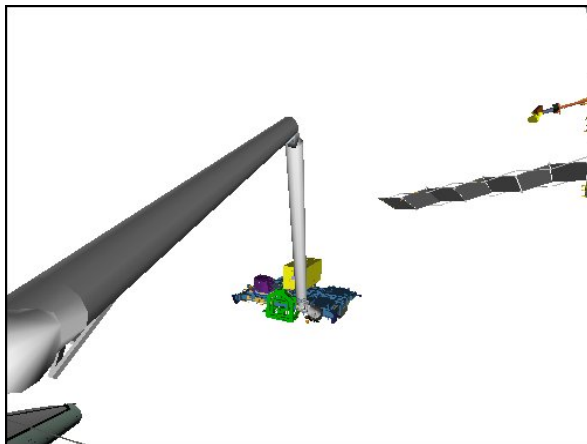
P1 LOOB (140,30)



P1 LOOB (140,30)

Step 5:

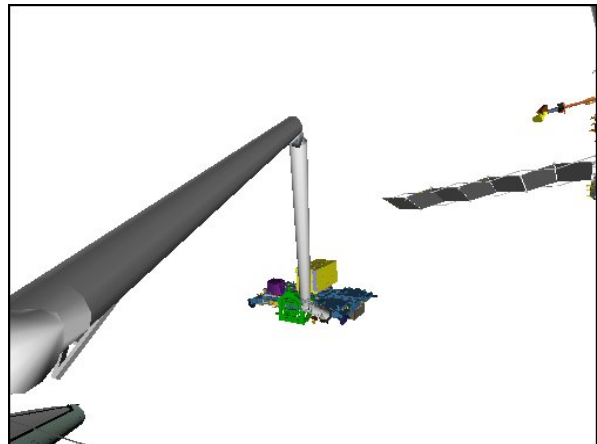
Drive WR+ (for 17.3°)
From -173.2 to -155.9



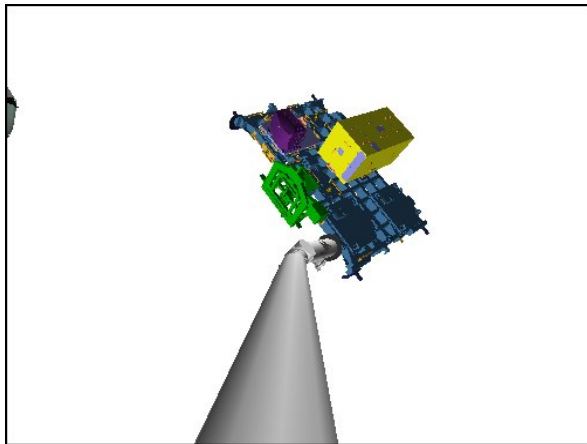
CCTV A (55,15)

Step 6:

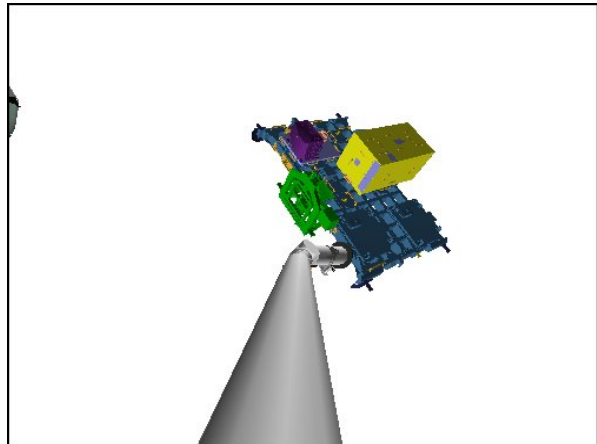
Drive WY+ (for 8.5°)
From +16.0 to +24.5



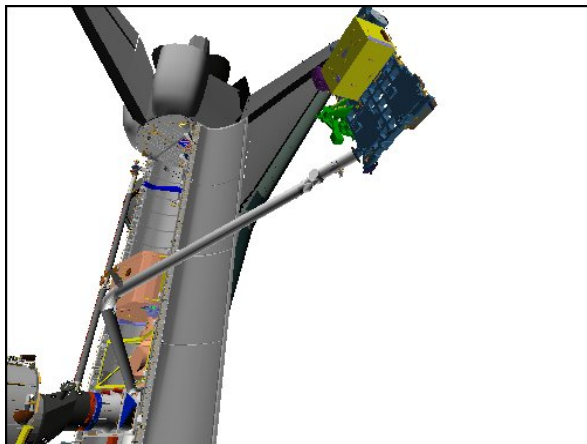
CCTV A (55,15)



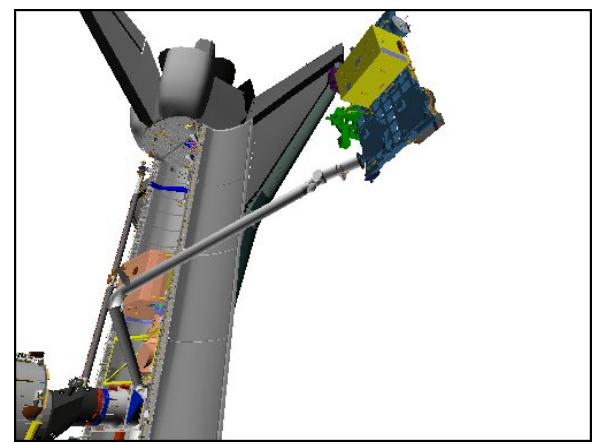
ELBOW (0,0)



ELBOW (0,0)



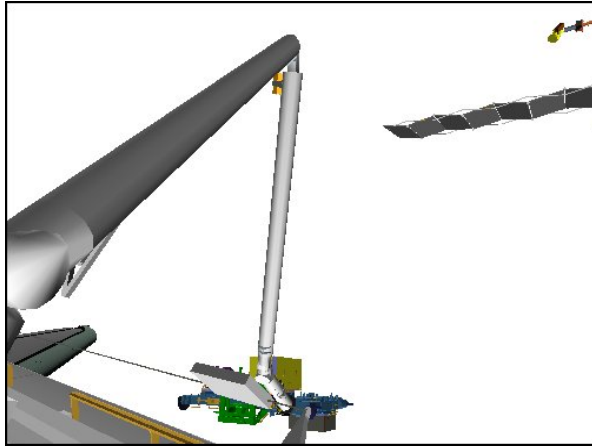
P1 LOOB (140,30)



P1 LOOB (140,30)

Step 7:

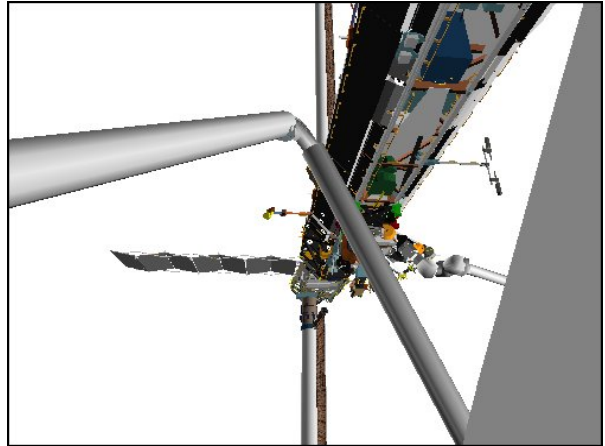
Drive EP- (for 41.7°)
From -65.0 to -106.7



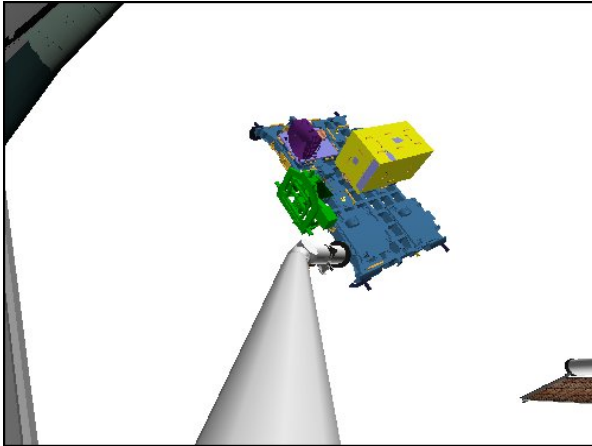
P1 LOOB (140,30)

Step 8:

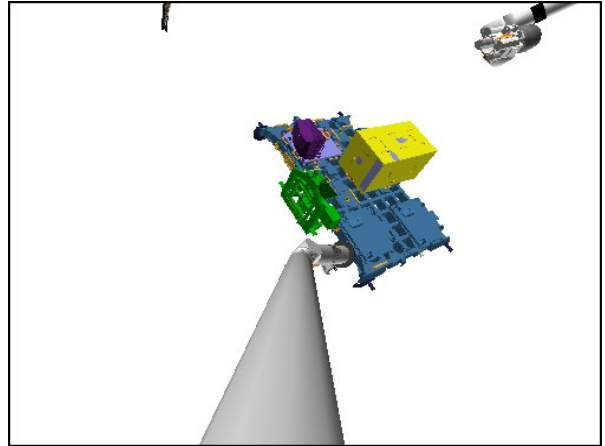
Drive SY+ (for 75.8°)
From +60.0 to +135.8



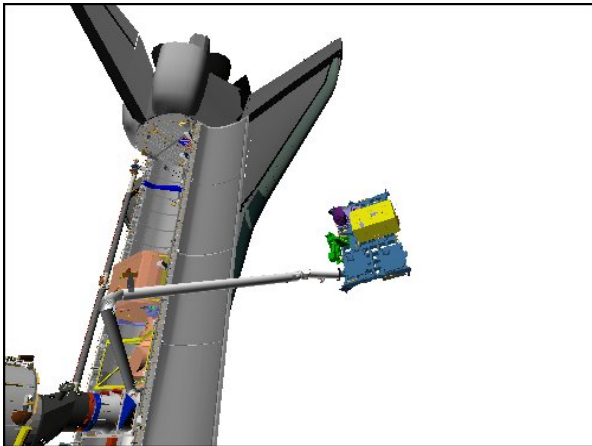
MBS MAST (-150,45)



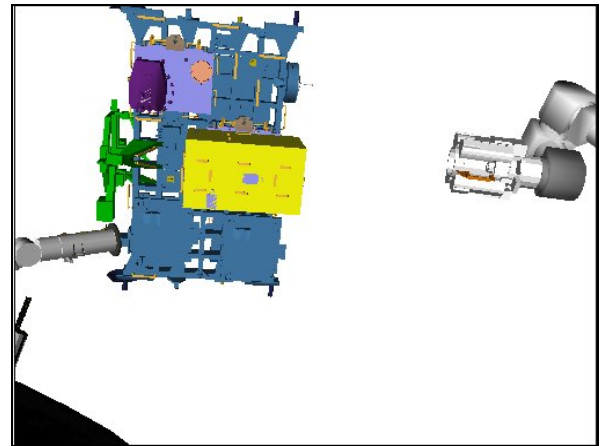
ELBOW (0,0)



ELBOW (0,0)



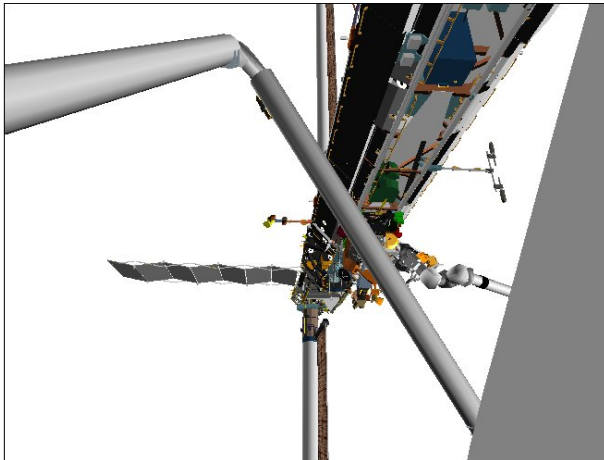
CCTV A (55,5)



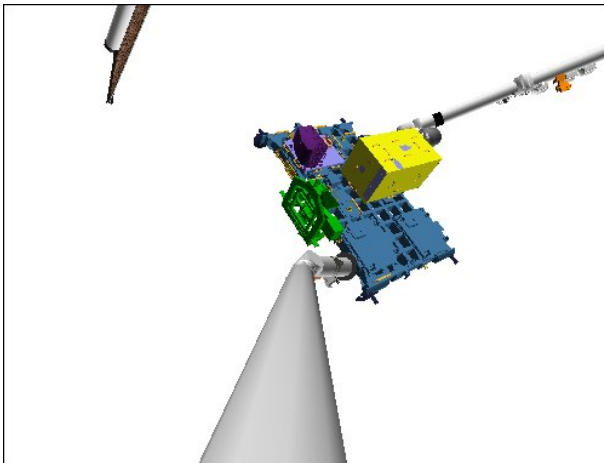
CCTV A (95,25)

Step 9:

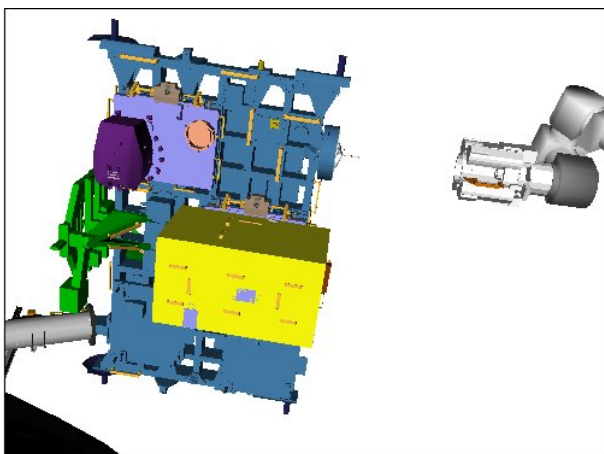
Drive SP+ (for 12.7°)
From +56.0 to +68.7



CCTV A (95,25)



ELBOW (0,0)



MBS MAST (-150,45)

ESP-3 SJ UNGRAPPLE

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

Mon 1	A
DwnInk	EE
Mon 2	Mast 37 (P1 LOOB 09)
DTV	B

2. ESP-3 UNGRAPPLE
 On ISS GO, perform ESP-3 Ungrapple (Verify SSRMS grappled to ESP-3 with Brakes-ON)

If SINGLE MODE available:

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 (*)

PL ID – ITEM 3 +0 EXEC

INIT ID – ITEM 24 +0 EXEC

RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – best available

CAUTION

Monitor EE tb timing to prevent EE motor burnout

SM 169 PDRS STATUS

EE MODE – MAN

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

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

✓ RIGID	CLOSE	CAPTURE
DERIGID	OPEN	EXTEND

CRITICAL TIMES (8 sec total):

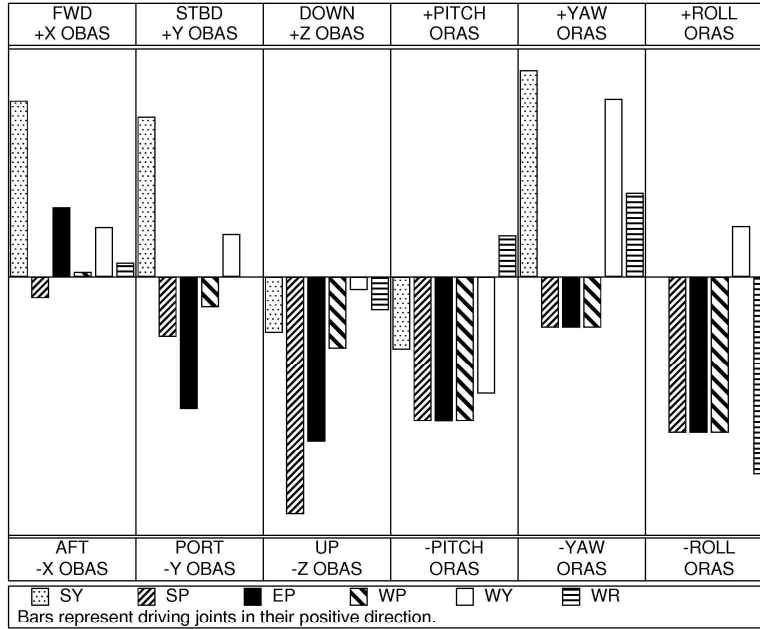
DERIGID tb – gray, 5 sec max, then

OPEN tb – gray, 3 sec max

3. MNVR ARM CLEAR OF ESP-3

Drive joints per ESP-3 SJ UNGRAPPLE WRIST CCTV OVERLAY until EE clear of grapple fixture

ESP-3 SJ UNGRAPPLE



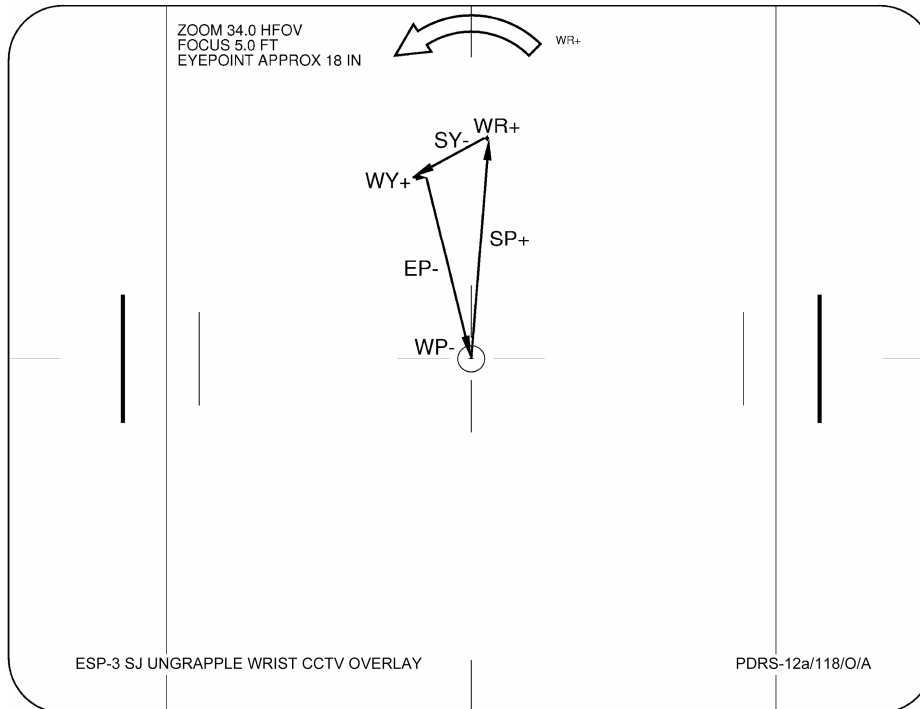
To get:	Drive:
+X (fwd)	+SY, +EP
+Y (stbd)	+SY, -EP
+Z (down)	-SP, -EP

To get:	Drive:
+PITCH	-WP, -EP
+YAW	+WY, +SY
+ROLL	-WR, -WP

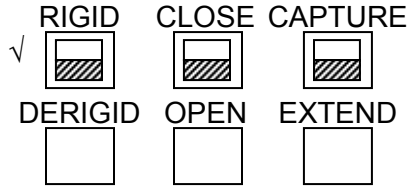
Driving:	Results In:
+SY	+X (fwd), +YAW
+SP	-Z (up), -ROLL
+EP	-Z (up), -ROLL

Driving:	Results In:
+WP	-Z (up), -ROLL
+WY	+X (fwd), +YAW
+WR	-Z (up), -ROLL

ΔSY	ΔSP	ΔEP	ΔWP	ΔWY	ΔWR
-2.8	+7.4	-7.4	-0.5	+2.6	+1.0

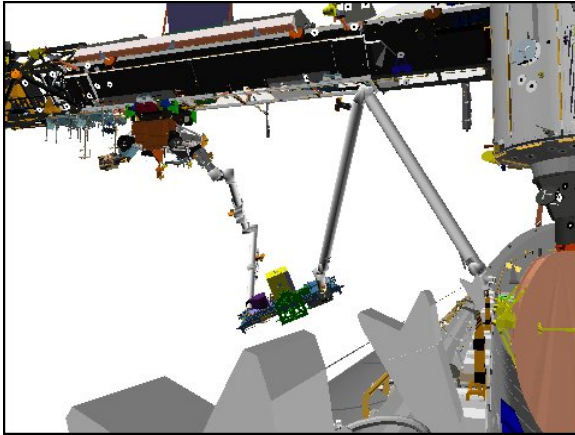


EE MAN CONTR – DERIG (hold until EXTEND tb-gray, 20 sec max)
 MODE – OFF

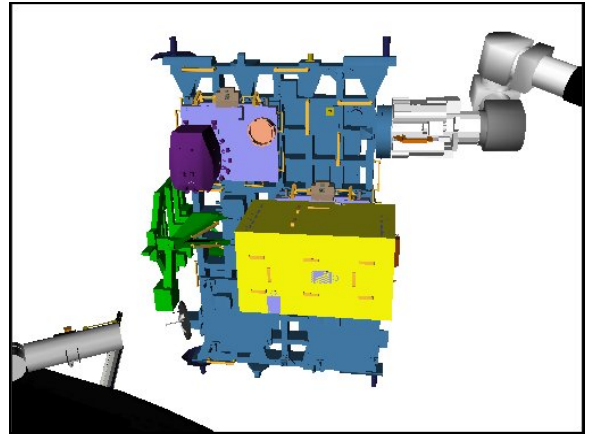


CRITICAL TIMES (20 sec total):
 EXTEND tb – gray, 20 sec max

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



CCTV B (-20,5)



MBS MAST (-160,45)

4. SRMS MNVR TO ESP-3 INSTALL VIEWING

Mon 1	A
DwnInk	Elbow
Mon 2	B
DTV	P1 LOOB 09

RATE – as required (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – best available

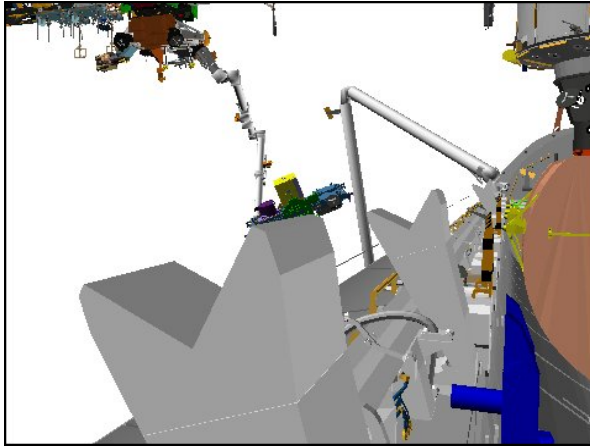
Mnvr to ESP-3 INSTALL VIEWING posn (reference pictures as reqd):

	SY	SP	EP	WP	WY	WR	
Ungrapple Backoff	+133.0	+76.1	-114.1	+18.6	+27.1	-154.9	
1: SP –		+41.9					
2: SY –	+110.0						
3: WP +				+95.3			
4: WY –					+14.8		
5: WR –						-194.8	
6: EP +			-69.8				
ESP-3 Install Viewing	+110.0	+41.9	-69.8	+95.3	+14.8	-194.8	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-506	-552	-399	116	33	21	0

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

Step 1:

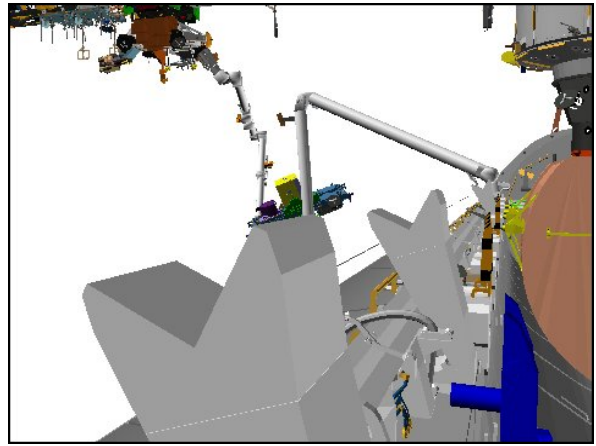
Drive SP- (for 34.2°)
From +76.1 to +41.9



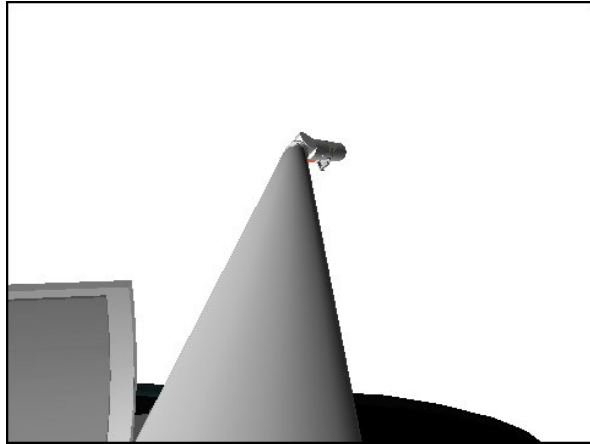
CCTV B (-20,-5)

Step 2:

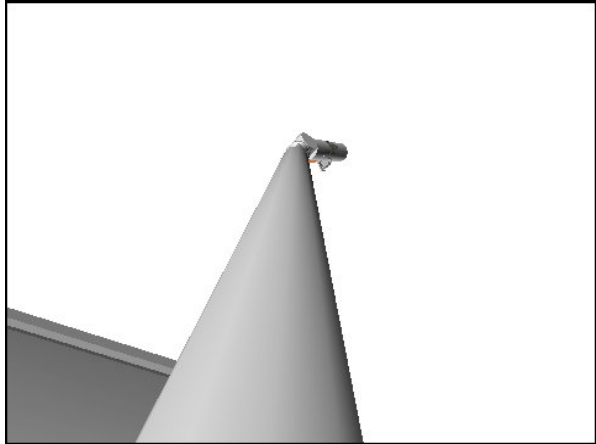
Drive SY- (for 23.0°)
From +133.0 to +110.0



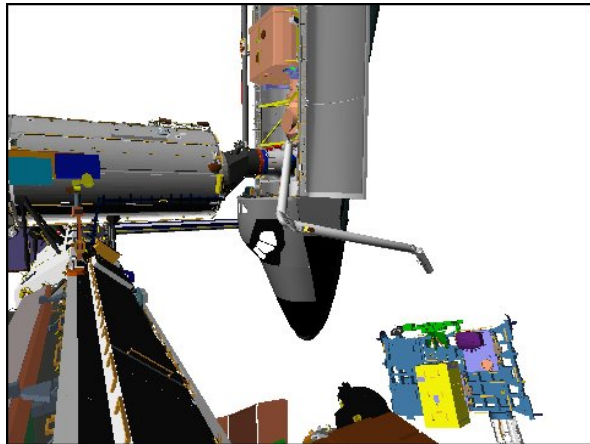
CCTV B (-20,-5)



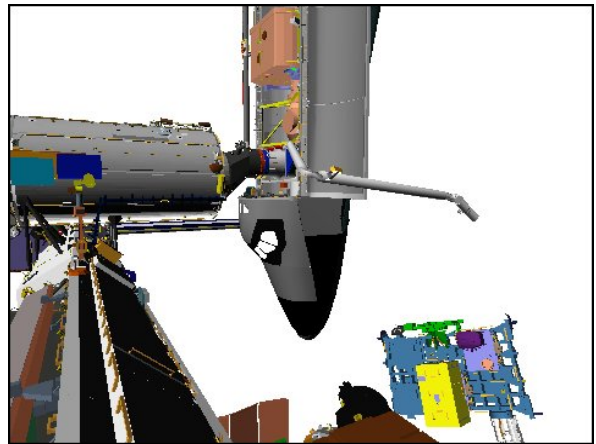
ELBOW (0,-15)



ELBOW (0,-15)



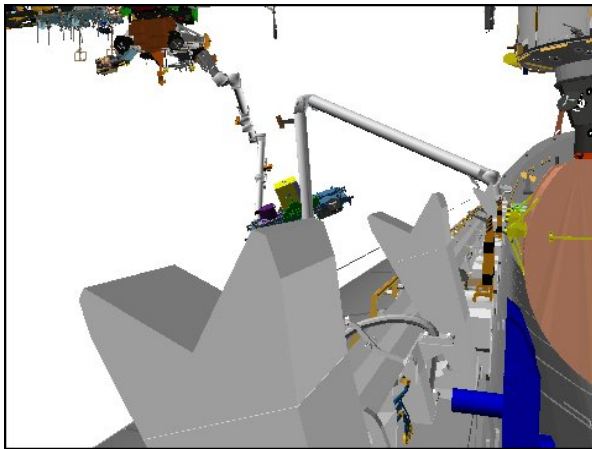
P1 LOOB (120,-5)



P1 LOOB (120,-5)

Step 3:

Drive WP+ (for 76.7°)
From +18.6 to +95.3



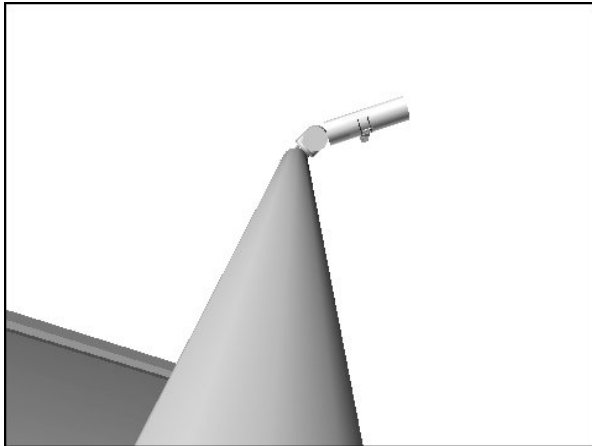
CCTV B (-20,-5)

Step 4:

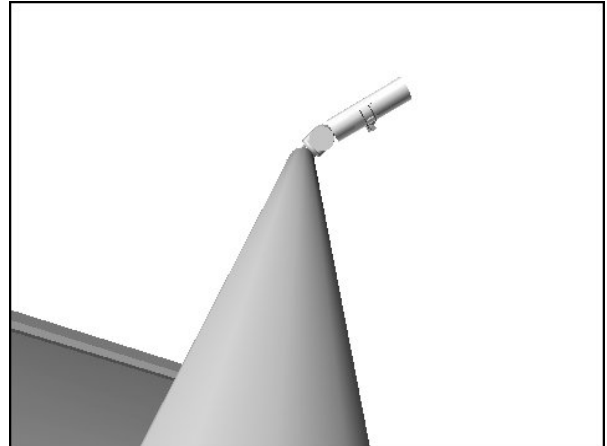
Drive WY- (for 12.3°)
From +27.1 to +14.8



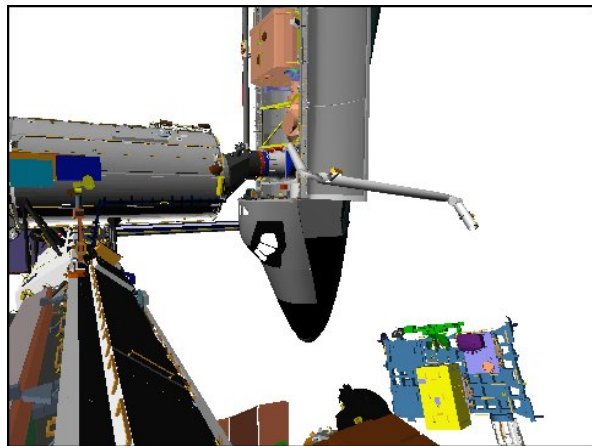
CCTV B (-20,-5)



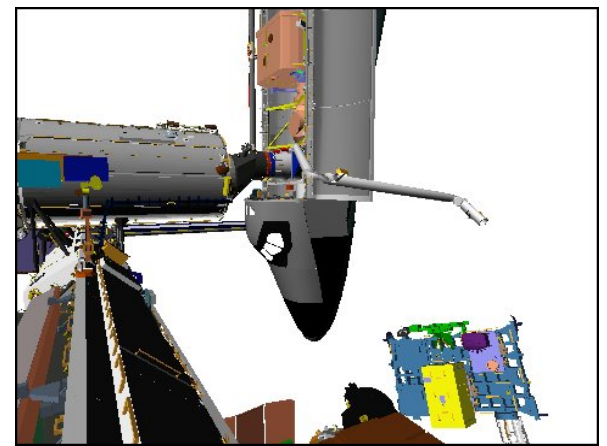
ELBOW (0,-15)



ELBOW (0,-15)



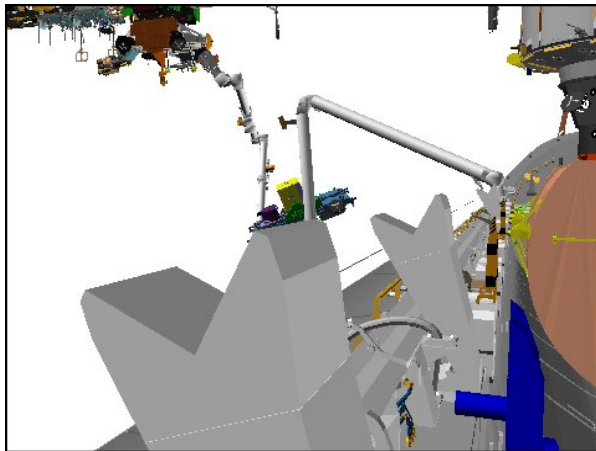
P1 LOOB (120,-5)



P1 LOOB (120,-5)

Step 5:

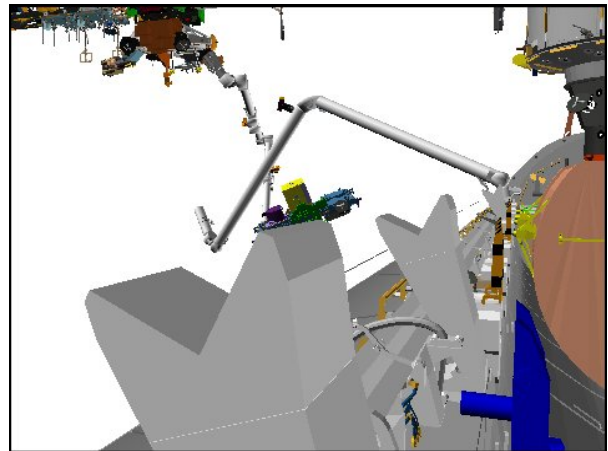
Drive WR- (for 39.9°)
From -154.9 to -194.8



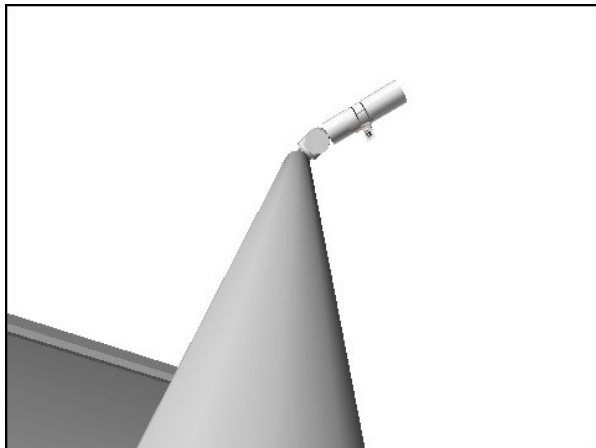
CCTV B (-20,-5)

Step 6:

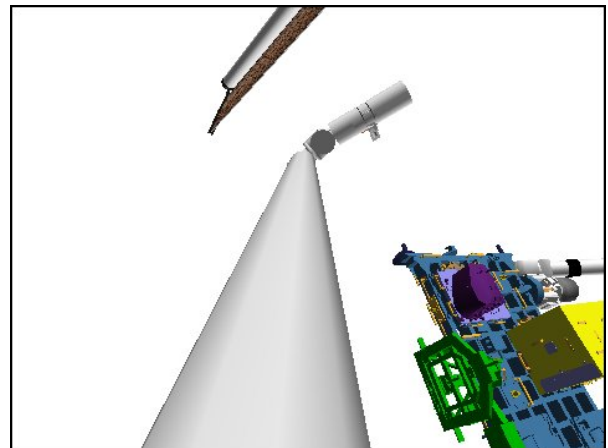
Drive EP+ (for 44.3°)
From -114.1 to -69.8



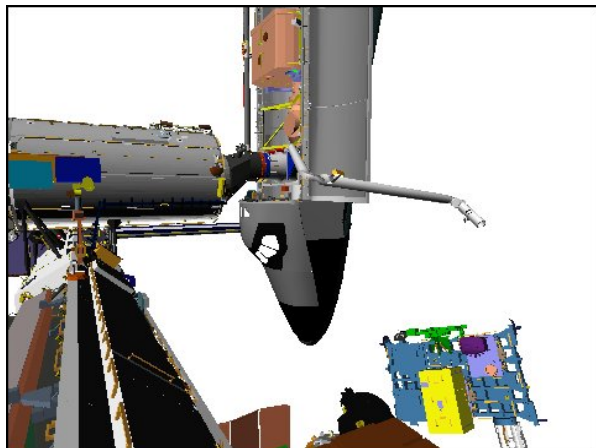
CCTV B (-20,-5)



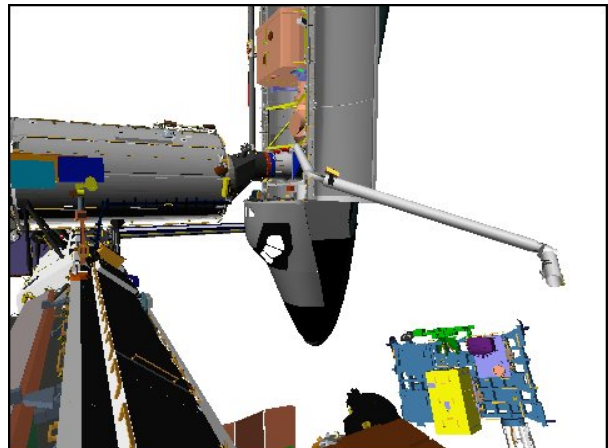
ELBOW (0,-15)



ELBOW (0,-15)



P1 LOOB (120,-5)



P1 LOOB (120,-5)

ESP-3 CONTINGENCY REBERTH

1. SRMS MNVR TO ESP-3 INTERMEDIATE

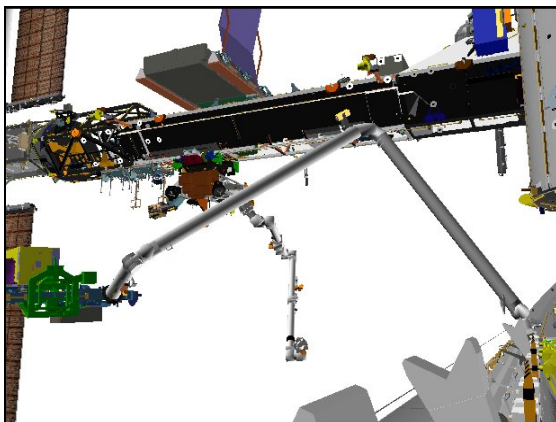
Mon 1	B
DwnInk	Elbow
Mon 2	P1 LOOB 09
DTV	A

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

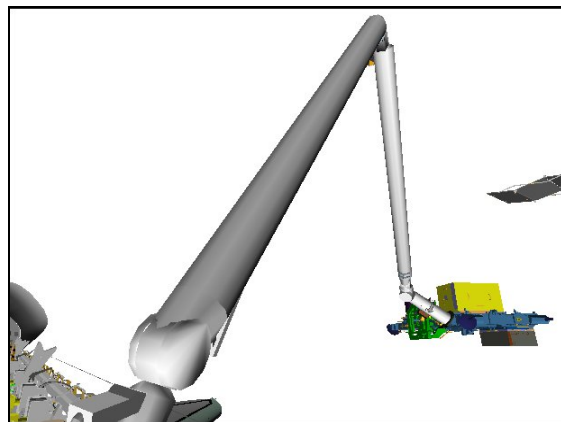
Mnvr to ESP-3 INTERMEDIATE posn:

X	Y	Z	PITCH	YAW	ROLL	PL ID
-870	-575	-460	0	295	2	5
SY	SP	EP	WP	WY	WR	
+59.5	+74.3	-90.5	-6.8	+51.0	-135.4	

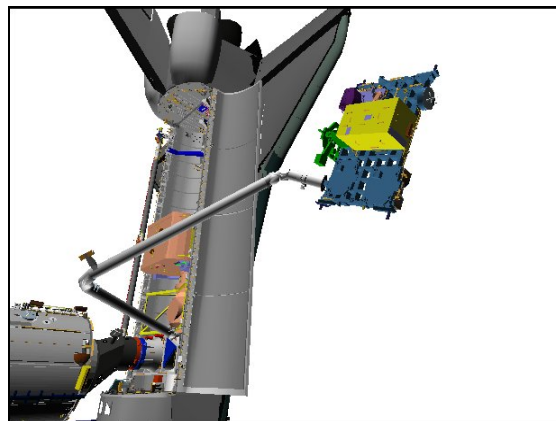
BRAKES – ON (tb-ON)
 √MODE – not DIRECT



CCTV B (-25,10)



CCTV A (37,18)



P1 LOOB (135,25)

2. SRMS MNVR TO ESP-3 PORT

Mon 1	B
DwnInk	Elbow
Mon 2	P1 LOOB 09
DTV	A

RATE – as required (VERN within 10 ft)

BRAKES – OFF (tb-OFF)

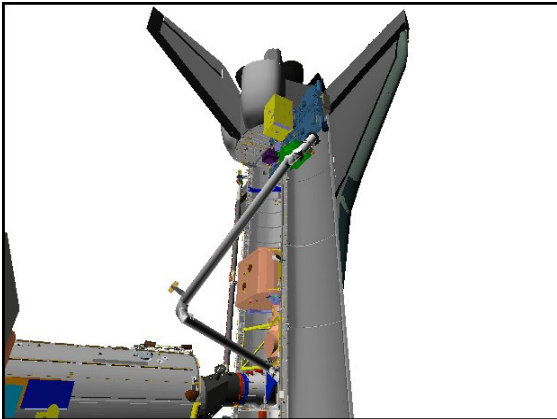
MODE – ORB LD, ENTER

Mnvr to ESP-3 PORT posn:

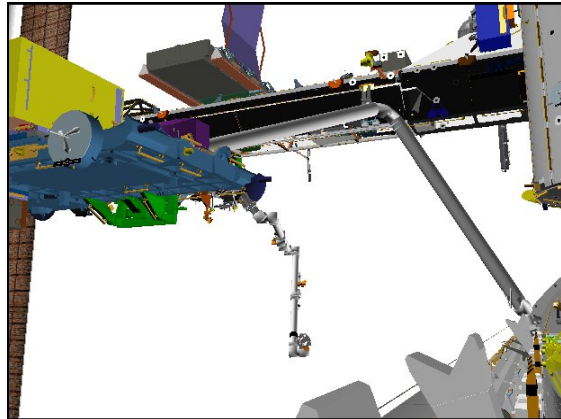
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1068	-322	-520	180	0	180	5
SY	SP	EP	WP	WY	WR	
+38.4	+75.5	-85.0	-23.4	-22.8	-196.7	

BRAKES – ON (tb-ON)

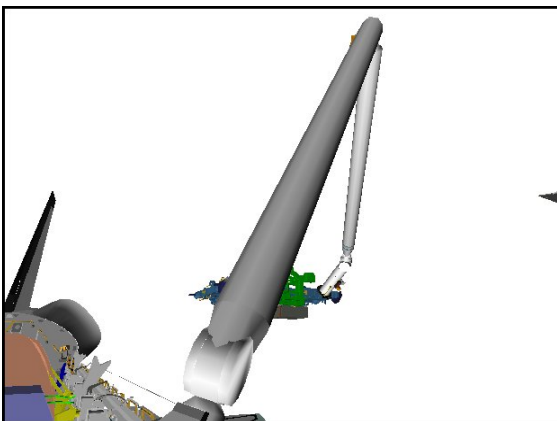
√MODE – not DIRECT



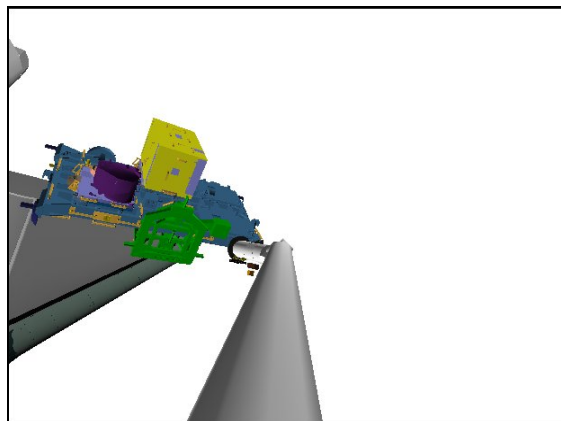
P1 LOOB (120,30)



CCTV B (-25,10)



CCTV A (30,20)



ELBOW (0,0)

3. MNVR TO ESP-3 LOW HOVER

Mon 1	B
DwnInk	Elbow
Mon 2	P1 LOOB 09
DTV	C

RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

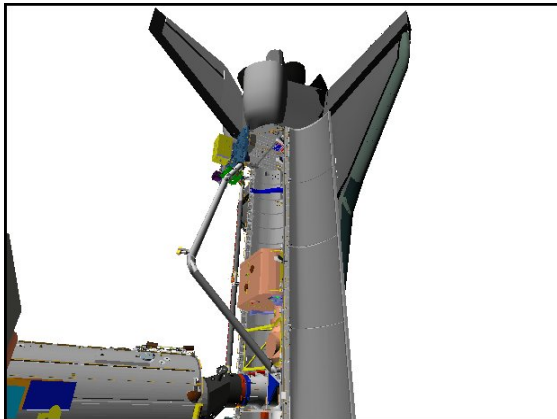
MODE – ORB LD, ENTER

Mnvr to ESP-3 LOW HOVER posn:

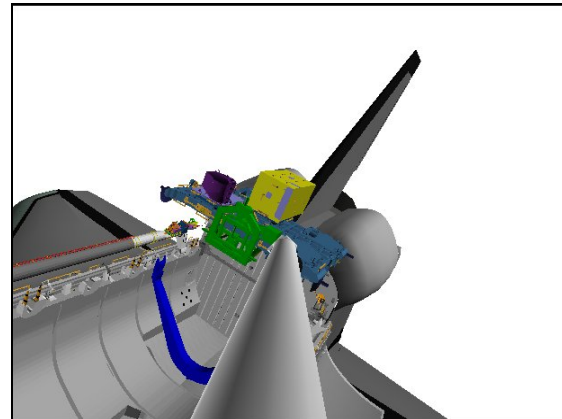
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1222	-3	-520	180	0	180	5
SY	SP	EP	WP	WY	WR	
-10.2	+50.2	-71.1	-10.9	+18.9	-171.3	

BRAKES – ON (tb-ON)

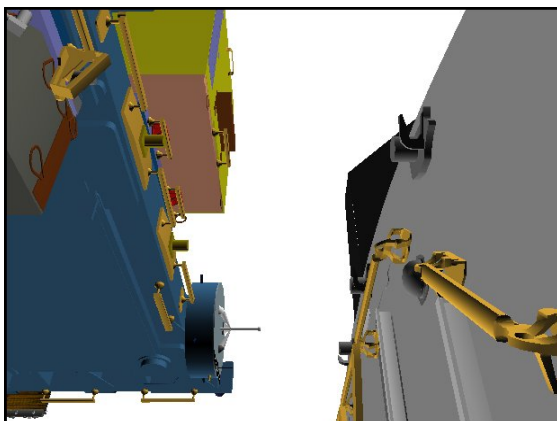
√MODE – not DIRECT



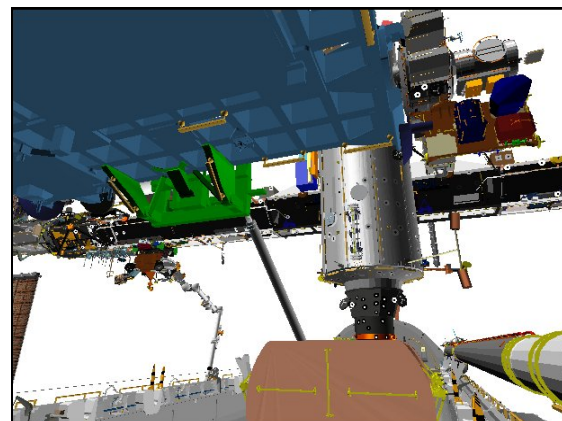
P1 LOOB (120,30)



ELBOW (0,0)



CCTV B (90,40)



CCTV C (-20,20)

4. MNVR TO ESP-3 BERTHED

Mon 1	Mux B/C (C)
DwnInk	Elbow
Mon 2	Lab 13 (P1 LOOB 09)
DTV	Mux D/A (B)

CAUTION

Monitor clearances between STBD trunnions and OBSS during unberth. Minimum clearance of approximately 4 inches expected
 Gradually remove 3-inch -Y bias starting at Z= -440 and complete by Z= -430

If using Shuttle attitude control:

DAP: FREE

RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – ORB LD, ENTER

Mnvr to ESP-3 BERTHED posn (insert data from ESP-3 GRAPPLE):

	X	Y	Z	PITCH	YAW	ROLL	PL ID
							5
Expected	-1222	0	-414	180	0	180	5
	SY	SP	EP	WP	WY	WR	
Expected	-6.0	+39.8	-76.6	+5.7	+15.3	-173.6	

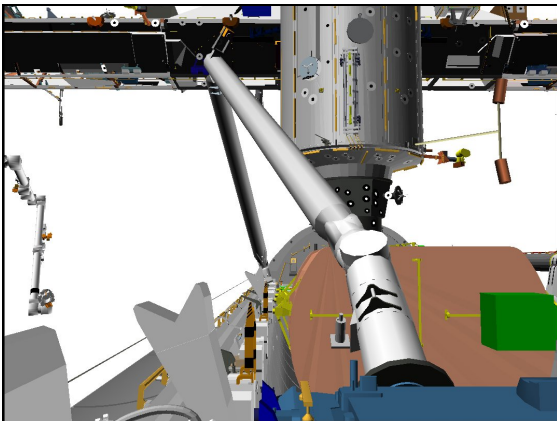
A6U

PL RETEN PL SEL – 3

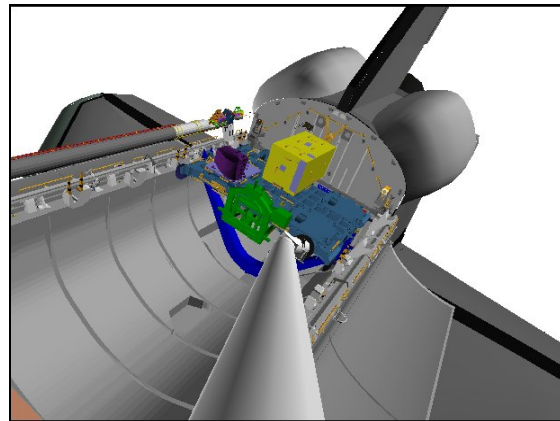
√RDY 1,2,3,4 tb (four) – gray

BRAKES – ON (tb-ON)

√MODE – not DIRECT



CCTV B (0,5)



ELBOW (0,0)

5. 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 (four) – OFF
√PL SEL – 3
LOGIC PWR SYS 1,2 (two) – ON

R13L PL BAY MECH PWR SYS 1,2 (two) – ON

SM 97 PL RETENTION

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

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

6. PRLA LATCH

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

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

7. DEACTIVATE LATCHES

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

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

8. ESP-3 UNGRAPPLE SETUP

A7U CCTV – RMS WRIST, zoom 34.0 HFOV
focus 5 ft

Mon 1	A
DwnInk	EE (Elbow)
Mon 2	S1 LOOB 03 (P1 LOOB 09)
DTV	B

SM 94 PDRS CONTROL

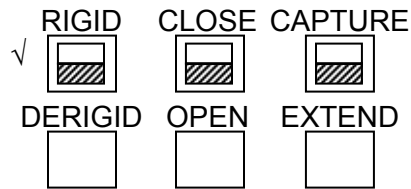
PL ID – ITEM 3 +0 EXEC
INIT ID – ITEM 24 +0 EXEC

9. ESP-3 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

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

EE MODE – OFF

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

OBSS OPERATIONS

OBSS HANDOFF FROM SSRMS (WS4) TO SRMS.....	FS 5-2
SRMS TO SSRMS (WS4).....	FS 5-7
SJ HANDOFF FROM SSRMS (WS4) TO SRMS	FS 5-13
SRMS TO SSRMS (WS4).....	FS 5-23

OBSS HANDOFF FROM SSRMS (WS4) TO SRMS

1. SETUP

SM 94 PDRS CONTROL

√PL ID, ITEM 3: 0

√INIT ID, ITEM 24: 0

Mon 1	Elbow
DwnInk	A
Mon 2	B
DTV	P1 LOOB

2. PRE-GRAPPLE MNVR

RHC

RATE – as reqd (VERN within 10 ft)

BRAKES – OFF (tb-OFF)

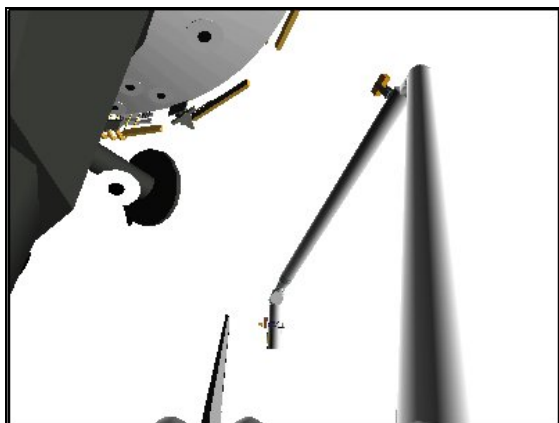
MODE – ORB UNL, ENTER

Mnvr to OBSS PRE-GRAPPLE AT HANDOFF posn:

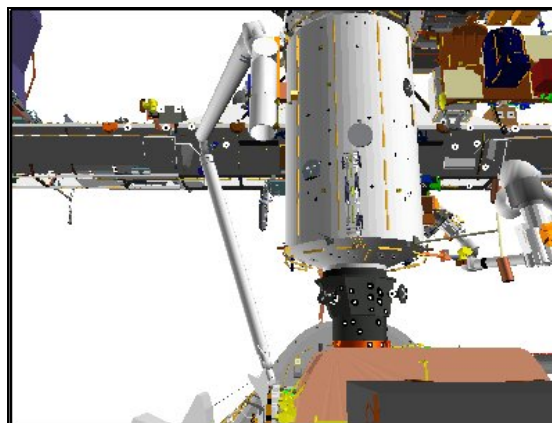
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1023	-100	-565	284	0	270	0
SY	SP	EP	WP	WY	WR	
-11.4	+77.0	-91.6	-64.7	+21.4	-63.4	

BRAKES – ON (tb-ON)

Notify SSRMS Operator, SRMS at OBSS PRE-GRAPPLE AT HANDOFF posn,
GO for maneuver to OBSS Pre-Grapple



CCTV A (5,35)



CCTV B (0,15)

3. CONFIGURE POWER

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

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

A6U

EVENT TIMER MODE – UP
CNTL – START

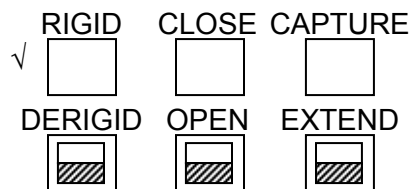
OBSS
OPERATIONS

RHC 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

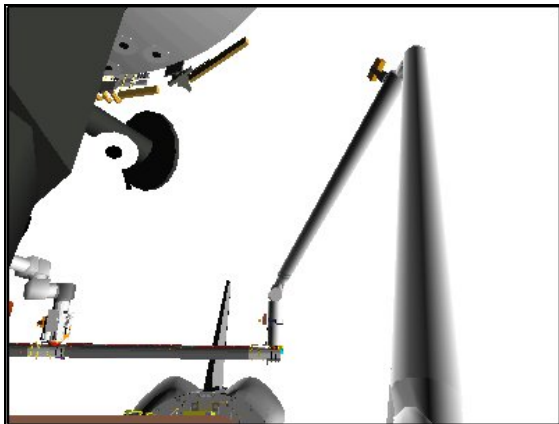
MODE – TEST, ENTER
 Wait 5 sec

BRAKES – ON (tb-ON)

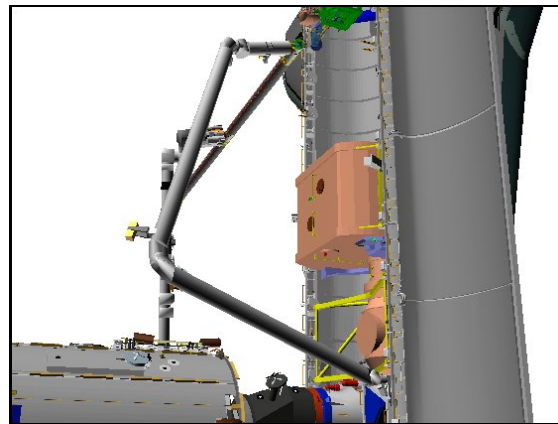
SM 94 PDRS CONTROL
 PL ID – ITEM 3 +2 EXEC
 INIT ID – ITEM 24 +2 EXEC

Expected OBSS HANDOFF posn:

✓	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-1030	+492	-526	2	270	348	2
✓	SY	SP	EP	WP	WY	WR	
	-9.2	+73.5	-94.3	-57.7	+21.0	-65.7	



CCTV A (5,30)



P1 LOOB (112,19)

R12(OBSS) RSC PWR – OFF, ON

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

A15 APCU 1 CONV – OFF

Perform LCH ACTIVATION (LCS Cue Card, PHOTO/TV)

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

Notify SSRMS Operator, OBSS Grapple complete, GO for OBSS Ungrapple

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

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OBSS HANDOFF FROM SRMS TO SSRMS (WS4)

1. SETUP

SM 94 PDRS CONTROL

√PL ID, ITEM 3: 2

√INIT ID, ITEM 24: 2

Mon 1	Elbow
DwnInk	A
Mon 2	P1 LOOB
DTV	C (D)

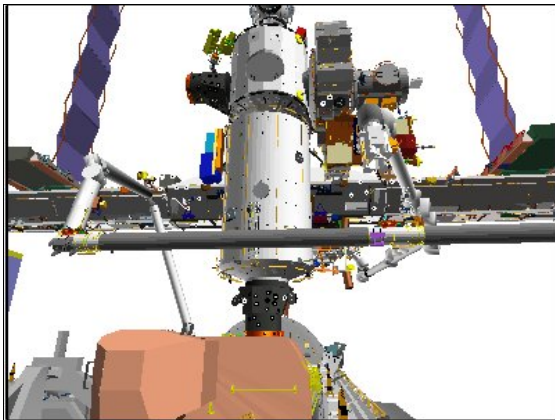
Review GENERIC END EFFECTOR CUE CARD – ISS/SHUTTLE DOCKED OPS

Verify at OBSS HANDOFF posn:

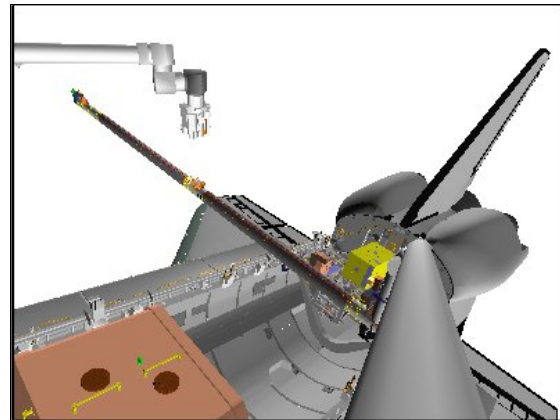
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1030	+492	-526	2	270	348	2
SY	SP	EP	WP	WY	WR	
-9.2	+73.5	-94.3	-57.7	+21.0	-65.7	

√BRAKES – ON (tb-ON)

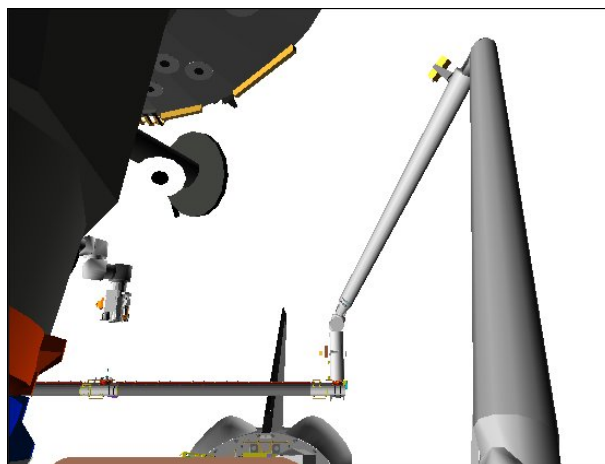
Notify SSRMS Operator, SRMS at OBSS HANDOFF posn, GO for maneuver to Handoff Pre-Grapple position



CCTV C (-5,20)



ELBOW (-20,0)



CCTV A (0,30)

A7U 2. STOW PTU
MON2 ← PL2

CAMR CMD PAN/TILT – HI RATE
PAN – L (to hard stop)
TILT – UP (to hard stop)
PAN/TILT – RESET, HI RATE (LO within 10°)
PAN: +108 (right)
TILT: -175 (down)

Perform LCC DEACTIVATION (LCS Cue Card, PHOTO/TV)
Perform LCH DEACTIVATION (LCS Cue Card, PHOTO/TV)

<p><u>CAUTION</u> STBD RMS HTR power must be applied within 90 min to prevent sensor package damage</p>

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

A15 APCU 1 CONV – ON

3. OBSS UNGRAPPLE
On SSRMS Operator GO for OBSS ungrapple, SSRMS Grapple complete

A7U CCTV – config for ungrapple
– RMS WRIST, zoom 34.0 HFOV
focus 5 ft

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

RHC RATE – COARSE (RATE MIN tb-OFF)

<p><u>SM 94 PDRS CONTROL</u></p>

AUTO BRAKE INH – ITEM 10 EXEC (*)

BRAKES – OFF (tb-OFF)
MODE – TEST, ENTER
Wait 5 sec

BRAKES – ON (tb-ON)

<p><u>SM 94 PDRS CONTROL</u></p>

AUTO BRAKE ENA – ITEM 9 EXEC (*)
PL ID – ITEM 3 +0 EXEC
INIT ID – ITEM 24 +0 EXEC

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

5. CONFIGURE FOR MONITORING

On SSRMS Operator notification to watch for STBD RMS RFLs,

SM 94 PDRS CONTROL

RMS STBD – ITEM 2 EXEC (*)

Notify SSRMS operator when STBD RMS R-F-L tb (three) – gray

6. STBD MRL LATCH

On SSRMS Operator GO to latch STBD MRLs to Topological Capture,

√STBD RMS R-F-L tb (three) – gray

SM 94 PDRS CONTROL

√STBD AFT, MID, FWD LAT (six) = 0

R13L PL BAY MECH PWR SYS (two) – ON

NOTE

Expect single motor drive time for MRL latching (18 sec max).

The following STBD RMS RETEN LAT – OFF and PL BAY

MECH PWR SYS (two) – OFF actions are to be performed simo

Verify AOS for latching to Topological Capture

STBD RMS RETEN LAT – LAT (6 sec, tb remains bp)

– OFF

R13L PL BAY MECH PWR SYS (two) – OFF

Notify SSRMS Operator GO to Limp All SSRMS Joints and Derigidize

R13L On SSRMS Operator GO to continue STBD MRL latching,

PL BAY MECH PWR SYS (two) – ON

STBD RMS RETEN LAT – LAT (tb-LAT) (12 sec max)

– OFF

7. RECONFIGURE POWER

R13L PL BAY MECH PWR SYS (two) – OFF

STBD RMS HTR A,B (two) – AUTO

A6U EVENT TIMER CNTL – STOP

SM 94 PDRS CONTROL

√STBD AFT, MID, FWD LAT (six) = 1

RMS PORT – ITEM 1 EXEC (*)

MA73C:C cb MCA PWR AC3 3Φ MID 2 – cl

√AC2 3Φ MID 2 – op

MA73C:D √AC3 3Φ MID 4 – op

Notify SSRMS Operator GO for OBSS Ungrapple

On SSRMS Operator GO, mnvr to Pre-Cradle position

RHC

8. MNVR TO PRE-CRADLE POSN
RATE – as reqd (VERN within 10 ft)
BRAKES – OFF (tb-OFF)
MODE – as desired

Mnvr to 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 DIRECT
PARAM – PORT TEMP
JOINT – CRIT TEMP

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OBSS SJ HANDOFF FROM SSRMS (WS4) TO SRMS

- A7U 1. SJ MNVR TO PRE-GRAPPLE
 CCTV – perform PAN/TILT RESET
 – fully zoom out for SJ pictures

SM 94 PDRS CONTROL

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

Mon 1	B (Elbow)
Dwnlnk	A
Mon 2	C
DTV	P1 LOOB (Lab)

- RATE – as required (VERN within 10 ft)
- BRAKES – OFF (tb-OFF)
- MODE – best available

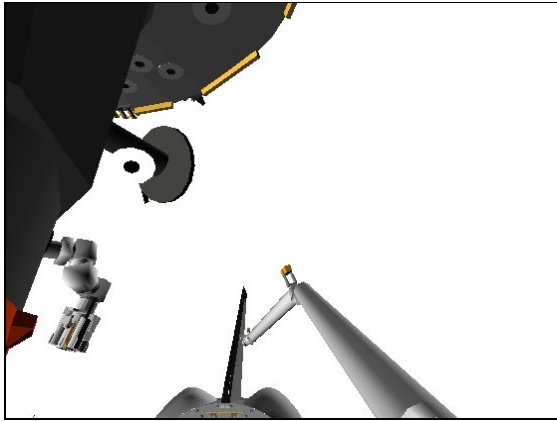
Mnvr to PRE-GRAPPLE posn (reference pictures as reqd):

	SY	SP	EP	WP	WY	WR	
Pre-cradle	0.0	+25.0	-25.0	+5.0	0.0	0.0	
1: SY –	-11.4						
2: SP +		+77.0					
3: EP –			-91.6				
4: WP –				-64.7			
5: WY +					+21.4		
6: WR –						-63.4	
OBSS	-11.4	+77.0	-91.6	-64.7	+21.4	-63.4	
Pre-grapple	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-1023	-100	-565	284	0	270	0

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

Step 1:

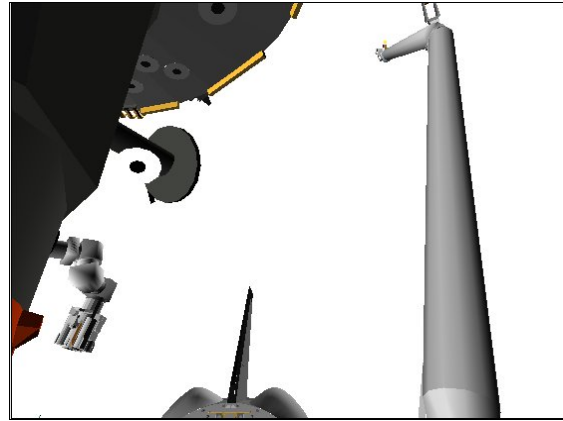
Drive SY+ (for 11.4°)
From 0.0 to -11.4



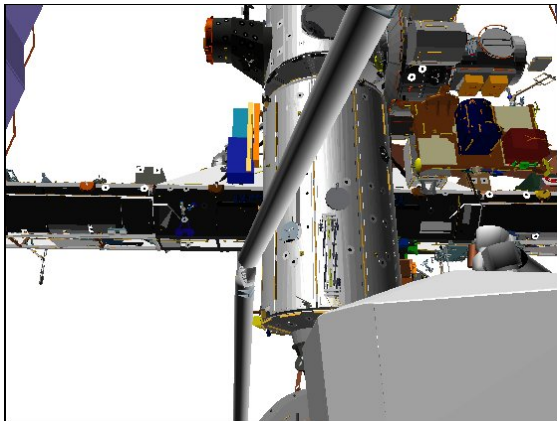
CCTV A (2,32)

Step 2:

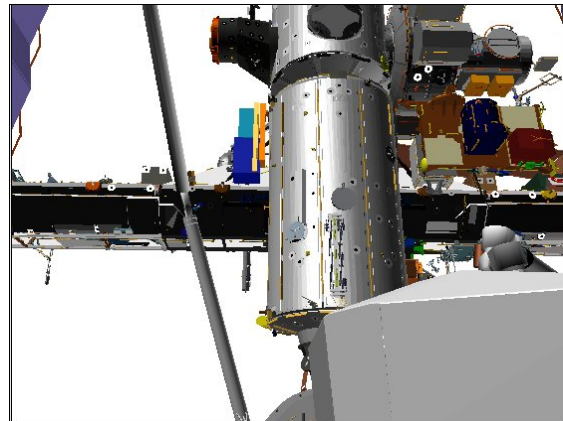
Drive SP+ (for 52.0°)
From +25.0 to +77.0



CCTV A (2,32)



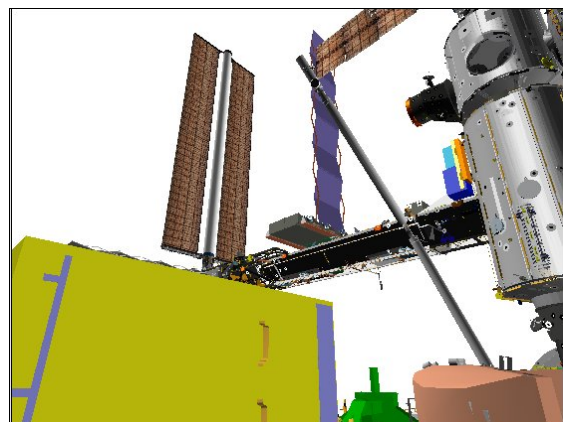
CCTV B (2,22)



CCTV B (2,22)



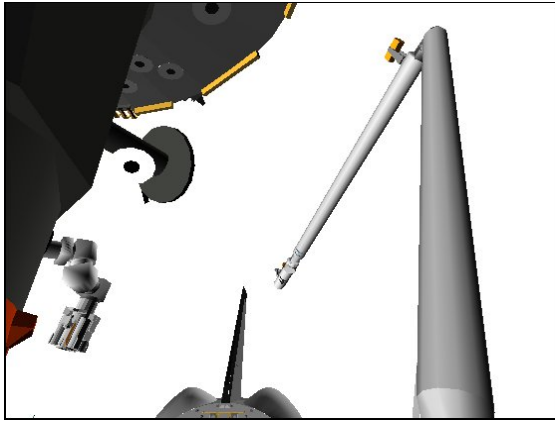
CCTV C (-45,24)



CCTV C (-45,24)

Step 3:

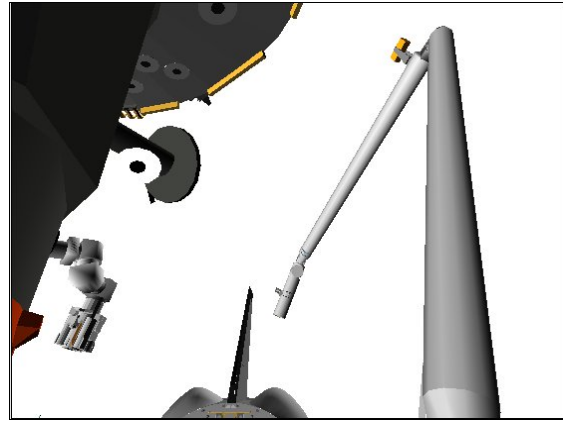
Drive EP- (for 66.6°)
From -25.0 to -91.6



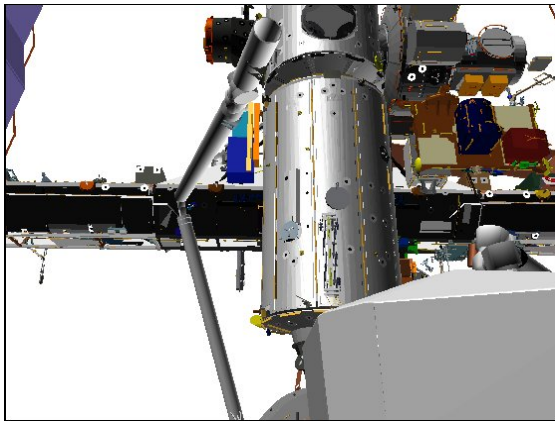
CCTV A (2,32)

Step 4:

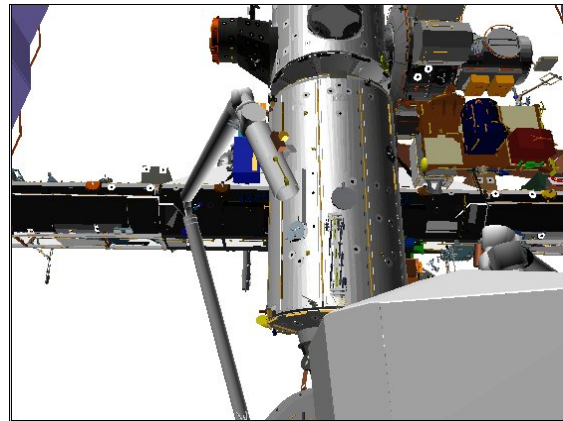
Drive WP- (for 69.7°)
From +5.0 to -64.7



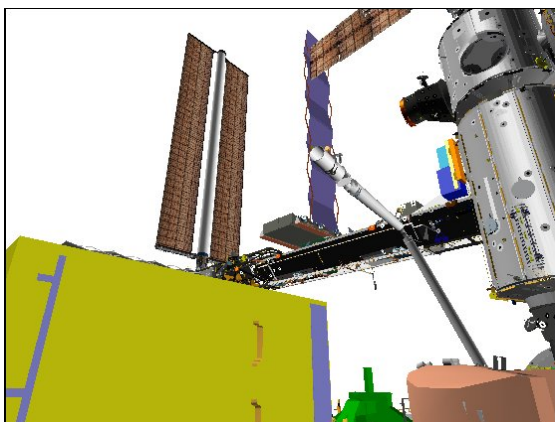
CCTV A (2,32)



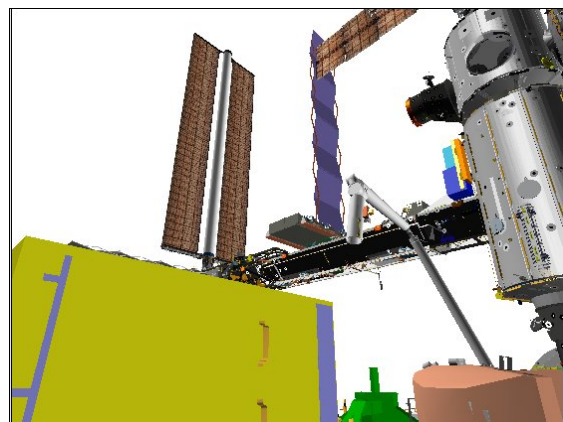
CCTV B (2,22)



CCTV B (2,22)



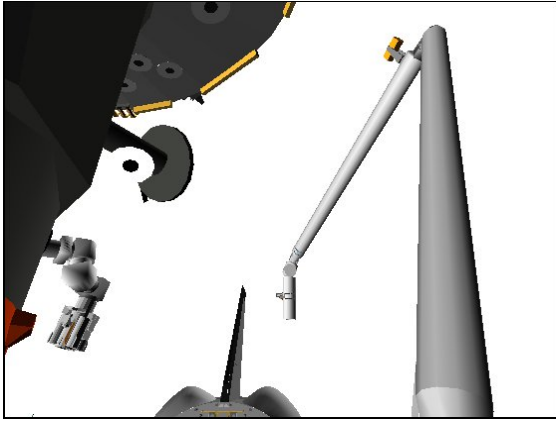
CCTV C (-45,24)



CCTV C (-45,24)

Step 5:

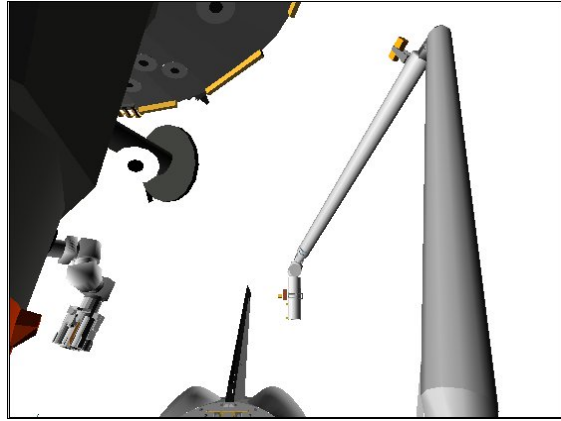
Drive WY+ (for 21.4°)
From 0.0 to +21.4



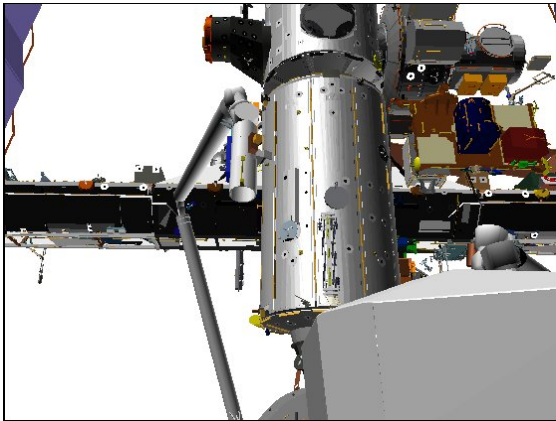
CCTV A (2,32)

Step 6:

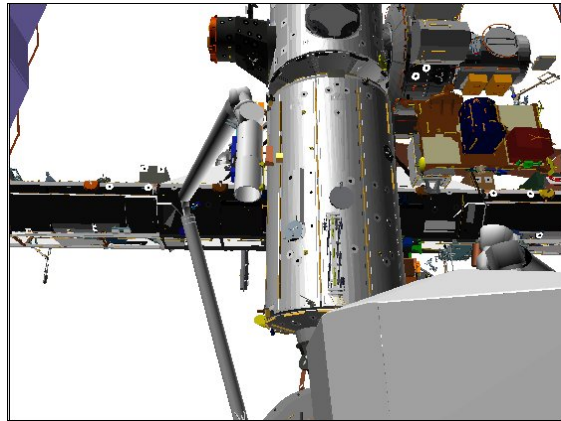
Drive WR- (for 63.4°)
From 0.0 to -63.4



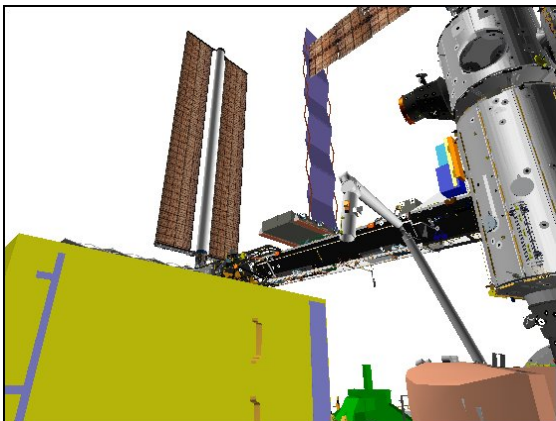
CCTV A (2,32)



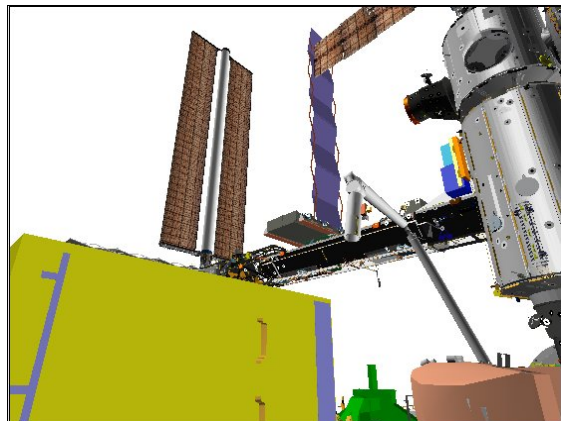
CCTV B (2,22)



CCTV B (2,22)



CCTV C (-45,24)



CCTV C (-45,24)

2. CONFIGURE POWER

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

On SSRMS Operator GO for STBD MRL release,
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
- MA73C:D √AC3 3Φ MID 4 – op
- R13L PL BAY MECH PWR SYS (two) – ON

3. 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

4. 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
- :D √AC3 3Φ MID 4 – op

Notify SSRMS Operator MRLs released, GO for OBSS Unberth
Monitor RFL Status

After OBSS Unberth,
style="text-align: center;">SM 94 PDRS CONTROL
RMS PORT – ITEM 1 EXEC (*)

5. 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 ~18 in when using grapple overlay

R12(OBSS) √SPEE PWR – OFF

A15 √APCU 2 OUTPUT – OFF

I

6. SJ MNVR TO OBSS GRAPPLE

On SSRMS Operator GO for SRMS OBSS Grapple, SSRMS at OBSS Handoff position

Mon 1	B
DwnInk	EE
Mon 2	A
DTV	P1 LOOB

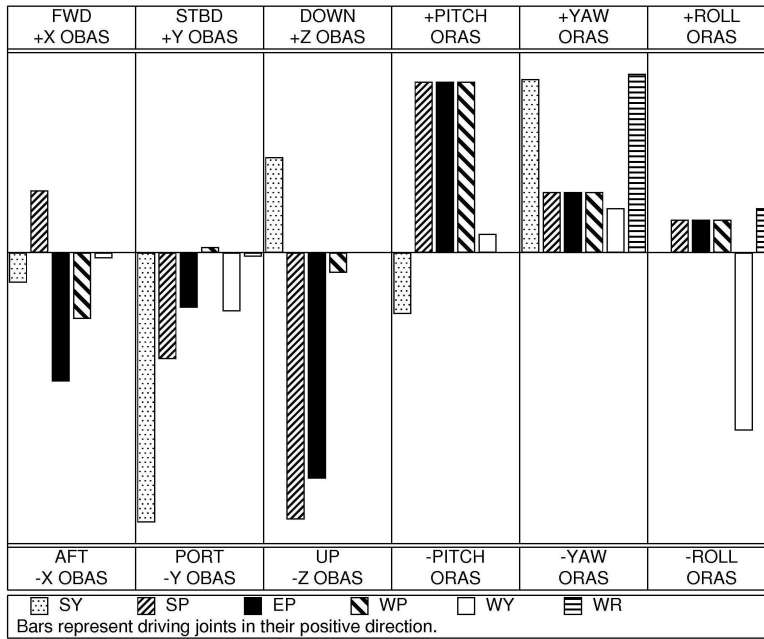
RATE – VERN (RATE MIN tb-ON)

BRAKES – OFF (tb-OFF)

MODE – best available

Drive joints per OBSS SJ GRAPPLE AT HANDOFF WRIST CCTV OVERLAY and diagram until EE within grapple envelope

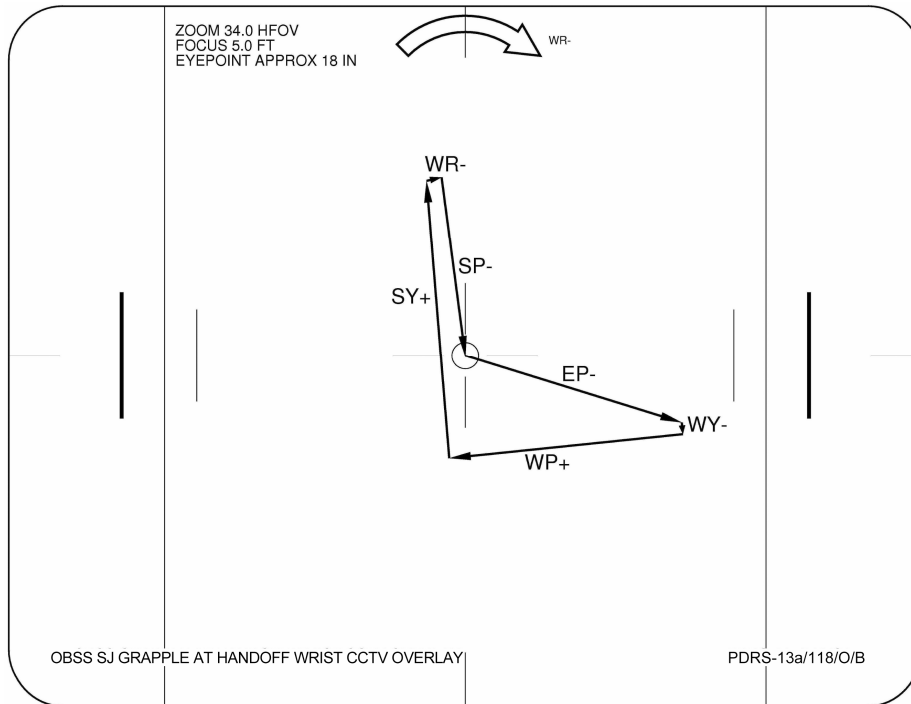
OBSS GRAPPLE AT HANDOFF



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

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

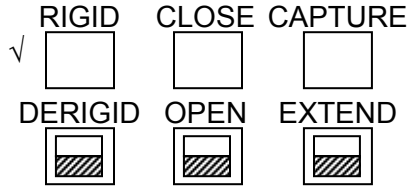
ΔSY	ΔSP	ΔEP	ΔWP	ΔWY	ΔWR
+2.2	-3.5	-2.7	+7.0	-0.4	-2.0



7. OBSS GRAPPLE

CAUTION
Monitor EE tb timing to prevent EE motor burnout

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

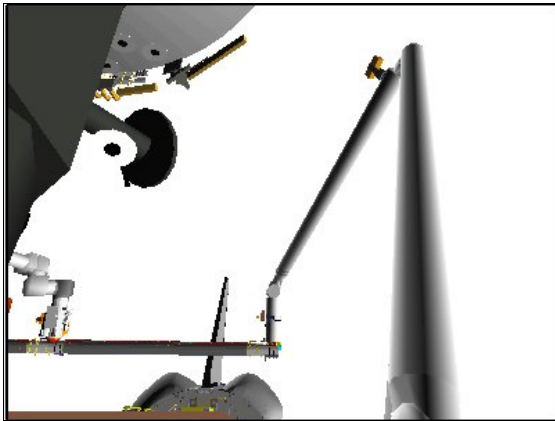


CRITICAL TIMES (28 sec total):
CAPTURE tb – gray, then
CLOSE tb – gray, 3 sec max, then
RIGID tb – gray, 25 sec max

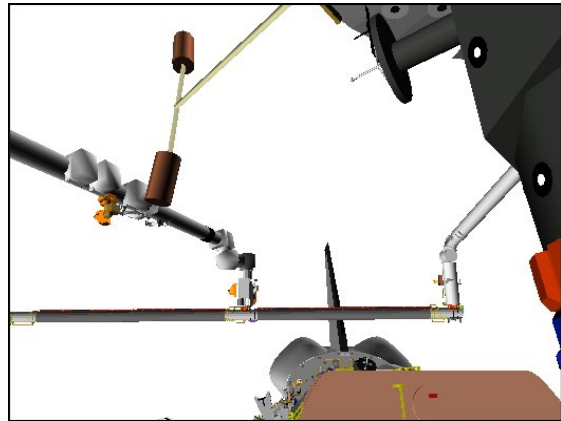
- * If manual grapple reqd: *
- * EE MODE – MAN *
- * CAPTURE sw – depress (hold until CLOSE tb-gray, 3 sec max) *
- * MAN CONTR – RIGID (hold until RIGID tb-gray, 25 sec max) *

EE MODE – OFF

BRAKES – ON (tb-ON)
MODE – not DIRECT



CCTV A (5,30)



CCTV D (-3,30)

SM 94 PDRS CONTROL

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

Record POS/ATT and Joint Angles:

	X	Y	Z	PITCH	YAW	ROLL	PL ID
							2
	SY	SP	EP	WP	WY	WR	
Expected	-9.2	+73.5	-94.3	-57.7	+21.0	-65.7	

R12(OBSS) RSC PWR – OFF, ON

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

A15

APCU 1 CONV – OFF

I

Perform LCH ACTIVATION (LCS Cue Card, PHOTO/TV)

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

Notify SSRMS Operator, OBSS Grapple complete, GO for OBSS Ungrapple

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

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OBSS SJ HANDOFF FROM SRMS TO SSRMS (WS4)

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

Mon 1	B
DwnInk	EE
Mon 2	A
DTV	P1 LOOB

- A7U 2. STOW PTU
On SSRMS Operator GO for OBSS Ungrapple,
MON2 ← PL2

CAMR CMD PAN/TILT – HI RATE
PAN – L (to hard stop)
TILT – UP (to hard stop)
PAN/TILT – RESET, HI RATE (LO within 10°)
PAN: +108 (right)
TILT: -175 (down)

Perform LCC DEACTIVATION (LCS Cue Card, PHOTO/TV)
Perform LCH DEACTIVATION (LCS Cue Card, PHOTO/TV)

<u>CAUTION</u> STBD RMS HTR power must be applied within 90 min to prevent sensor package damage
--

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

A15 APCU 1 CONV – ON

3. OBSS UNGRAPPLE
On SSRMS Operator GO for OBSS ungrapple, SSRMS Grapple complete

A7U CCTV – config for ungrapple
– RMS WRIST, zoom 34.0 HFOV
focus 5 ft

If SINGLE MODE available:

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

RATE – COARSE (RATE MIN tb-OFF)

<u>SM 94 PDRS CONTROL</u>

AUTO BRAKE INH – ITEM 10 EXEC (*)

BRAKES – OFF (tb-OFF)

MODE – TEST, ENTER
Wait 5 sec

BRAKES – ON (tb-ON)

<u>SM 94 PDRS CONTROL</u>

AUTO BRAKE ENA – ITEM 9 EXEC (*)
PL ID – ITEM 3 +0 EXEC
INIT ID – ITEM 24 +0 EXEC

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

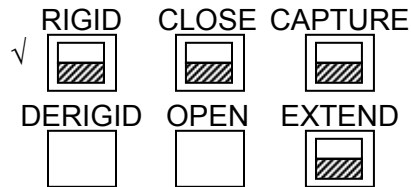
CAUTION
Monitor EE tb timing to prevent EE motor burnout

SM 169 PDRS STATUS

EE MODE – MAN

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

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



CRITICAL TIMES (8 sec total):

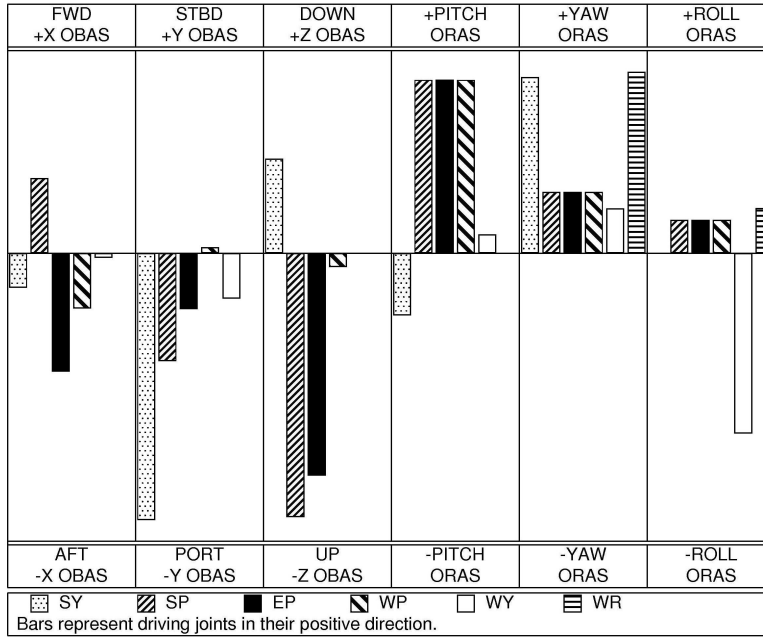
DERIGID tb – gray, 5 sec max, then

OPEN tb – gray, 3 sec max

2. MNVR ARM CLEAR OF OBSS

Drive joints per OBSS SJ UNGRAPPLE AT HANDOFF WRIST CCTV OVERLAY
until EE clear of grapple fixture

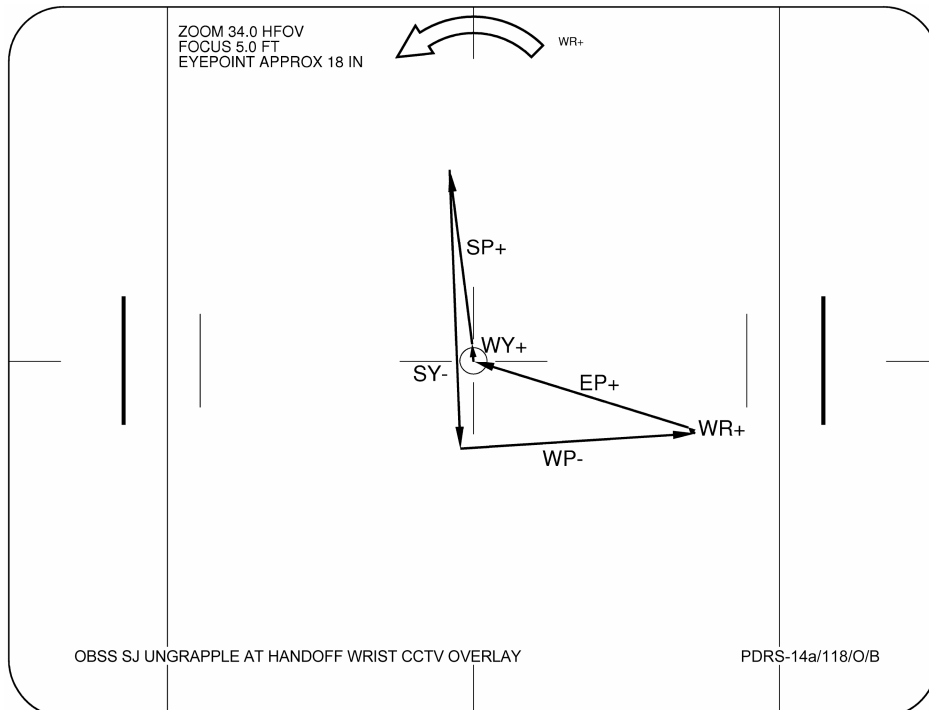
OBSS SJ UNGRAPPLE AT HANDOFF



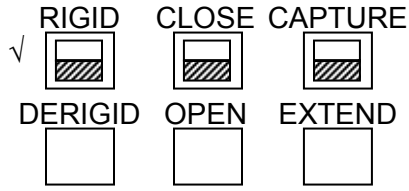
To get:	Drive:	To get:	Drive:
+X (fwd)	-EP, -WP	+PITCH	+WP, +EP
+Y (stbd)	-SY, -SP	+YAW	+WR, +SY
+Z (down)	-SP, -EP	+ROLL	-WY

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

ΔSY	ΔSP	ΔEP	ΔWP	ΔWY	ΔWR
-2.2	+3.5	+2.7	-7.0	+0.4	+2.3



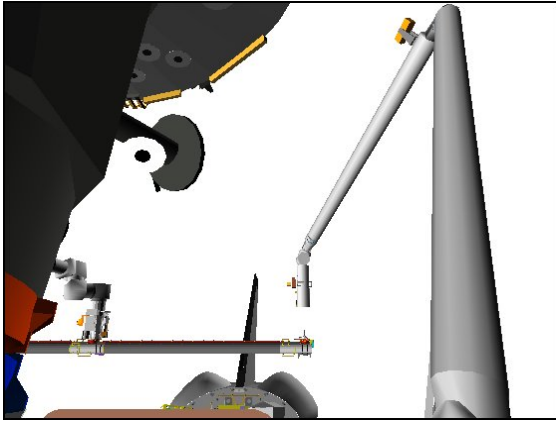
EE MAN CONTR – DERIG (hold until EXTEND tb-gray, 20 sec max)
 MODE – OFF



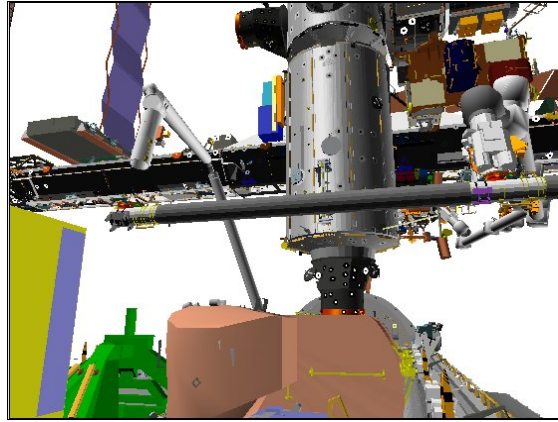
CRITICAL TIMES (20 sec total):
 EXTEND tb – gray, 20 sec max

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

Notify SSRMS Operator ungrapple complete, GO to maneuver to Clear UHF position



CCTV A (0,30)



CCTV C (-15,15)

A7U

3. SJ MNVR TO PRE-CRADLE
 CCTV – perform PAN/TILT RESET

SM 94 PDRS CONTROL

✓PL ID, ITEM 3: 0
 ✓INIT ID, ITEM 24: 0

Mon 1	B
Dwnlnk	A
Mon 2	C
DTV	P1 LOOB (Lab)

RATE – as required (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – best available

Mnvr to PRE-CRADLE (reference pictures as reqd):

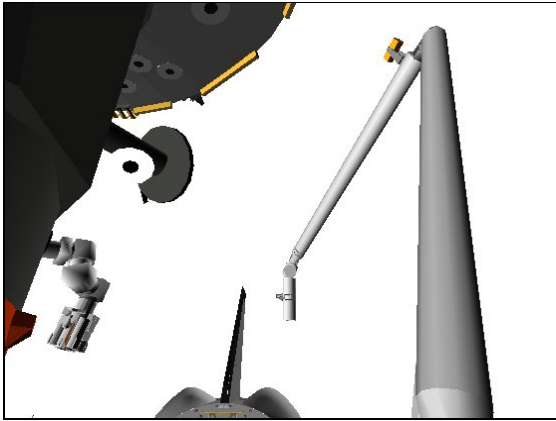
OBSS
 Pre-grapple
 1: WR +
 2: WY -
 3: WP +
 4: EP +
 5: SP -
 6: SY +
 Pre-cradle

SY	SP	EP	WP	WY	WR	
-11.4	+77.0	-91.6	-64.7	+21.4	-63.4	
					0.0	
				0.0		
			+5.0			
		-25.0				
	+25.0					
0.0						
0.0	+25.0	-25.0	+5.0	0.0	0.0	
X	Y	Z	PITCH	YAW	ROLL	PL ID
-1282	-108	-445	0	0	0	0

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

Step 1:

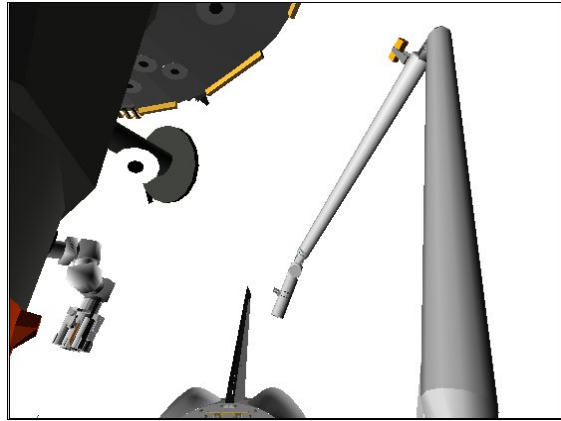
Drive WR+ (for 63.4°)
From -63.4 to 0.0



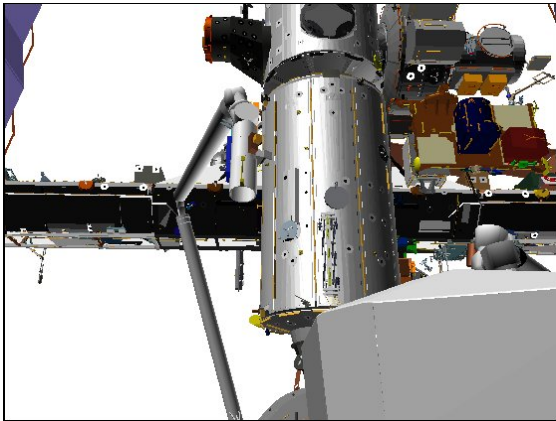
CCTV A (2,32)

Step 2:

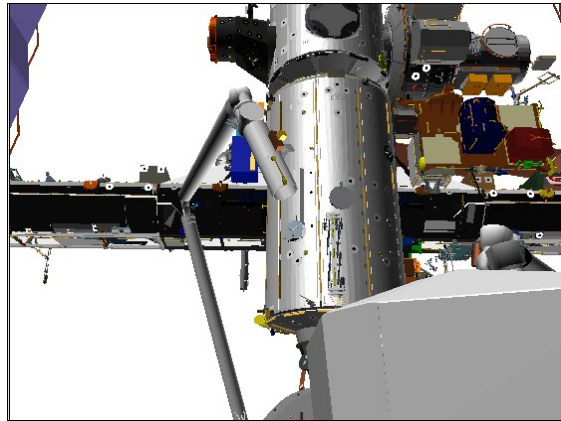
Drive WY- (for 21.4°)
From +21.4 to 0.0



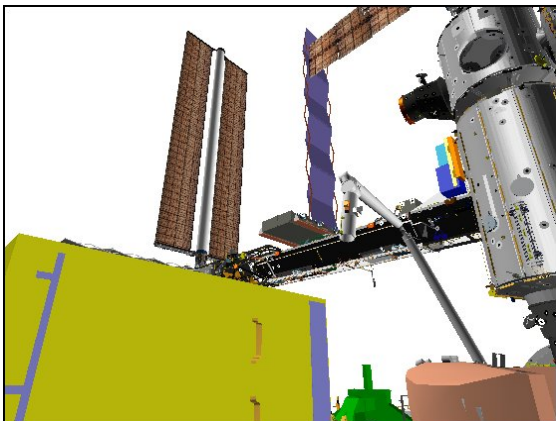
CCTV A (2,32)



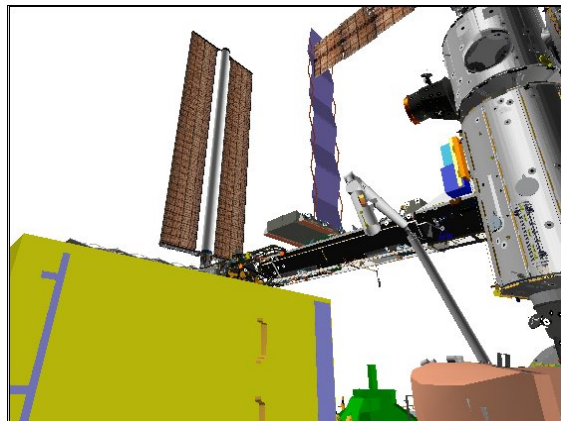
CCTV B (2,22)



CCTV B (2,22)



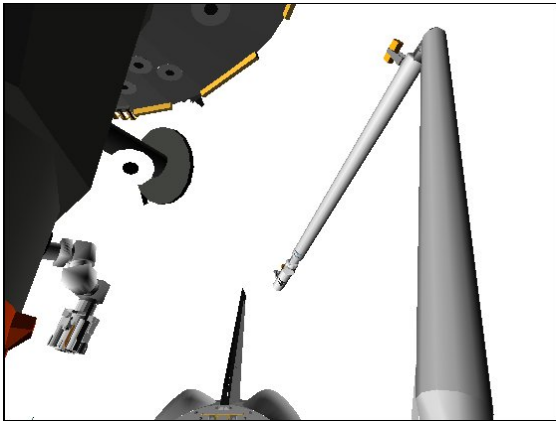
CCTV C (-45,24)



CCTV C (-45,24)

Step 3:

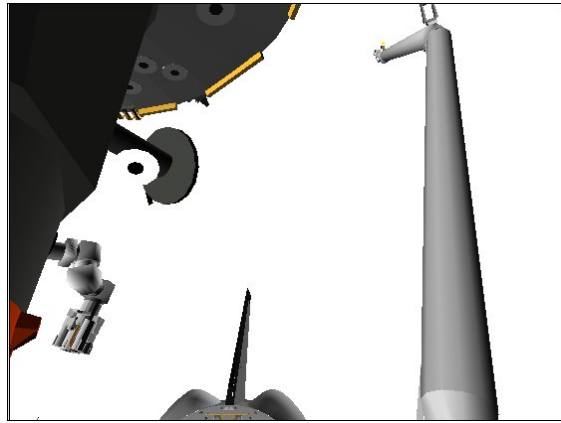
Drive WP+ (for 69.7°)
From -64.7 to +5.0



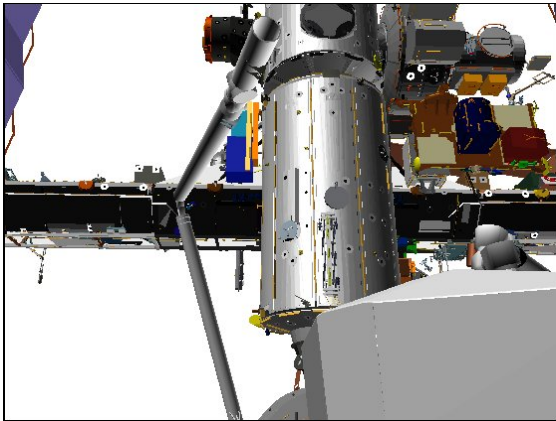
CCTV A (2,32)

Step 4:

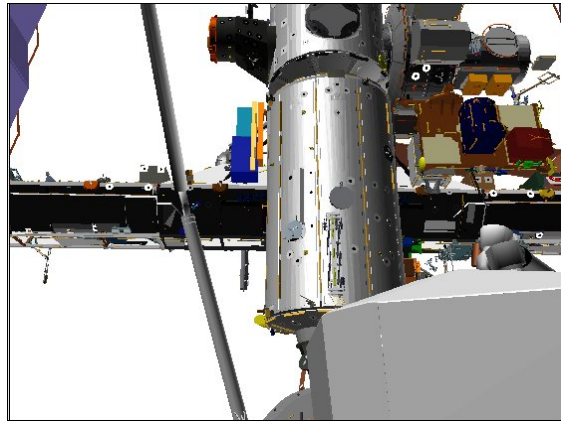
Drive EP+ (for 66.6°)
From -91.6 to -25.0



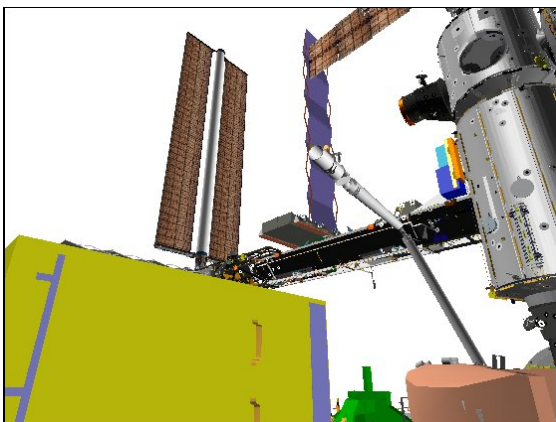
CCTV A (2,32)



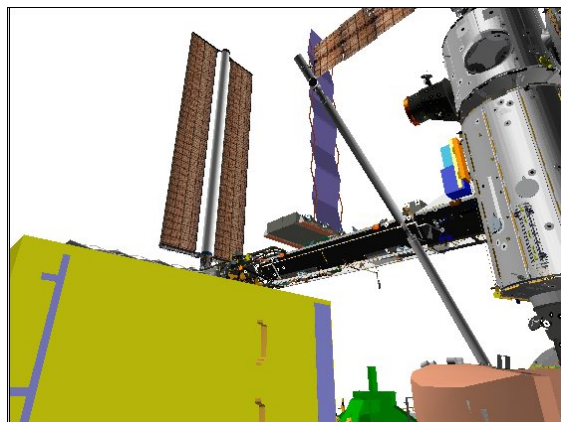
CCTV B (2,22)



CCTV B (2,22)



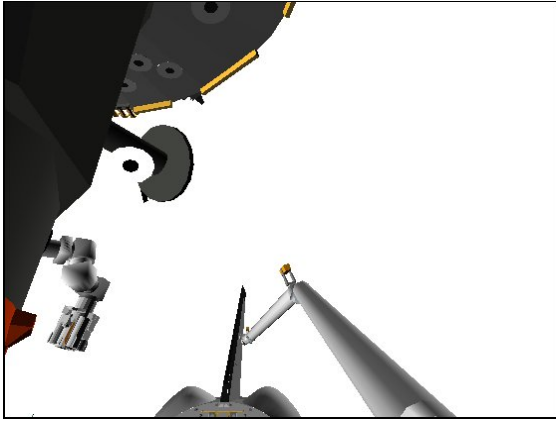
CCTV C (-45,24)



CCTV C (-45,24)

Step 5:

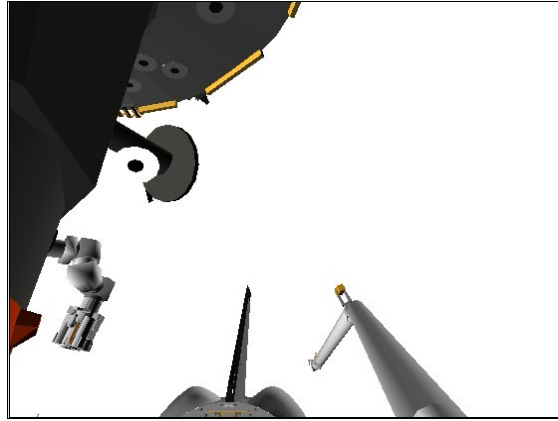
Drive SP- (for 52.0°)
From +77.0 to +25.0



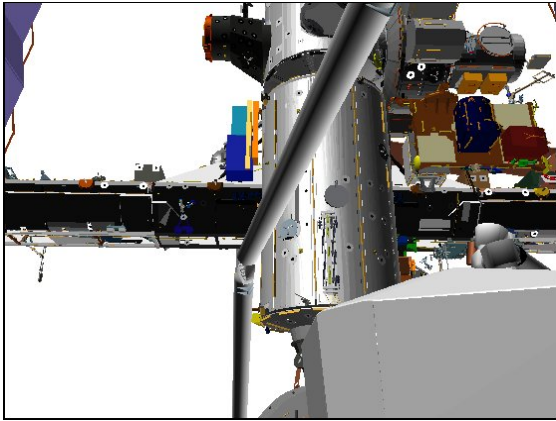
CCTV A (2,32)

Step 6:

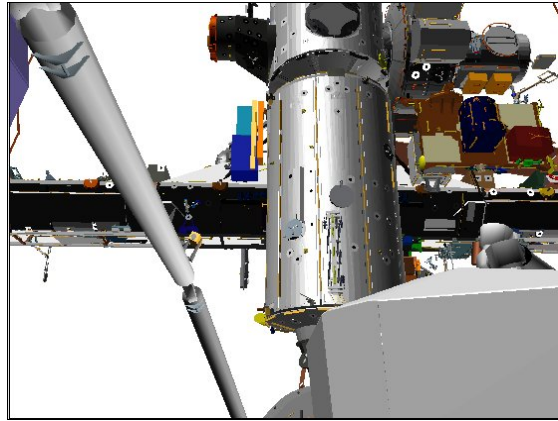
Drive SY+ (for 11.4°)
From -11.4 to 0.0



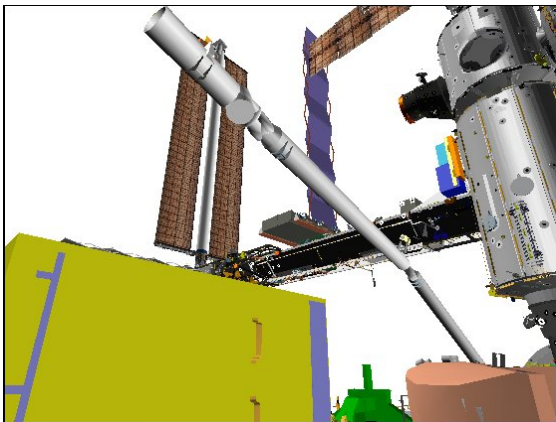
CCTV A (2,32)



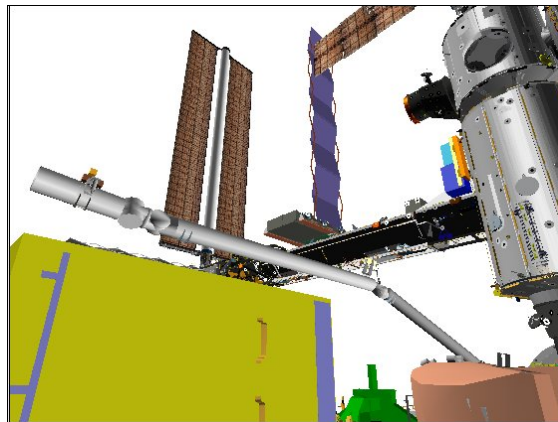
CCTV B (2,22)



CCTV B (2,22)



CCTV C (-45,24)



CCTV C (-45,24)

VIEWING SUPPORT

EVA 1 – P6 PVR CINCH VIEWING	FS 6-2
EVA 2 – CMG R&R VIEWING	FS 6-7
EVA 3 – P6 SASA RELOCATE VIEWING	FS 6-9

**VIEWING
SUPPORT**

EVA 1 – P6 PVR CINCH VIEWING

VIEWING
SUPPORT

- A7U 1. SETUP
CCTV – config for P6 PVR CINCH viewing

Mon 1	B
DwnInk	EE (Elbow)
Mon 2	P1 LOOB (LAB)
DTV	A

SM 94 PDRS CONTROL

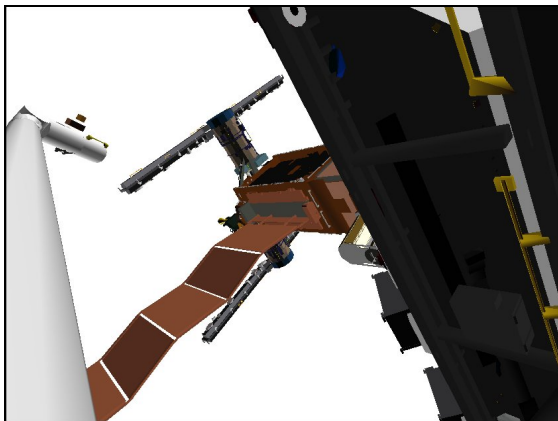
- √PL ID, ITEM 3: 0
- √INIT ID, ITEM 24: 0

- RHC 2. MNVr TO P6 PVR ZENITH CINCH VIEWING POSN
RATE – as reqd (VERN within 10 ft)
BRAKES – OFF (tb-OFF)
MODE – as desired

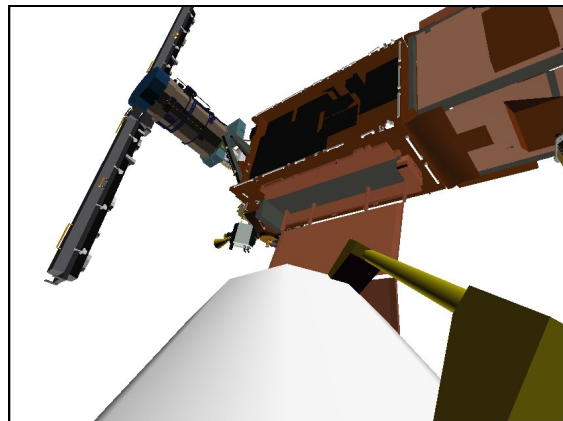
Mnvr to P6 PVR ZENITH CINCH VIEWING posn:

	SY	SP	EP	WP	WY	WR	
S5 Install Viewing	-58.5	+36.4	-53.9	+0.9	-51.7	-45.1	
1: SP +		+50.0					
2: SY +	+174.0						
3: WP +				+13.0			
4: WY +					+53.0		
5: WR +						0.0	
6: EP +			-35.0				
Zenith Cinch	+174.0	+50.0	-35.0	+13.0	+53.0	0.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-199	-210	-717	140	323	142	0

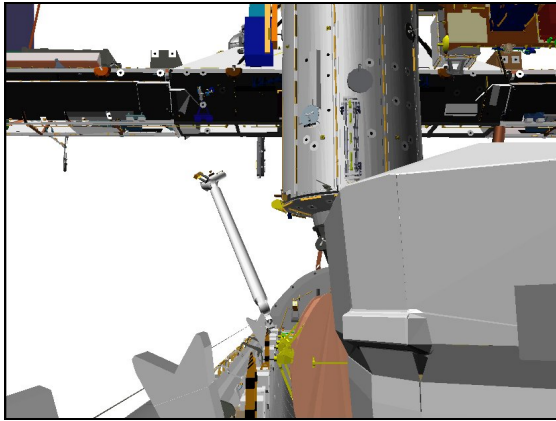
- BRAKES – ON (tb-ON)
- √MODE – not DIRECT (lt off)



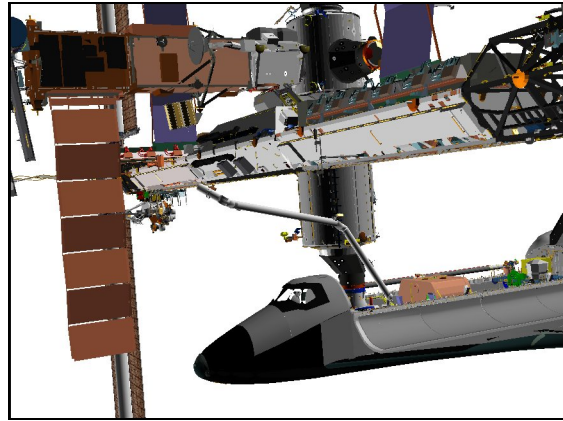
ELBOW (33,-19)



EE



CCTV B (0,10)



BIRD'S EYE

3. MNVR TO P6 PVR STBD CINCH VIEWING POSN

On MCC GO:

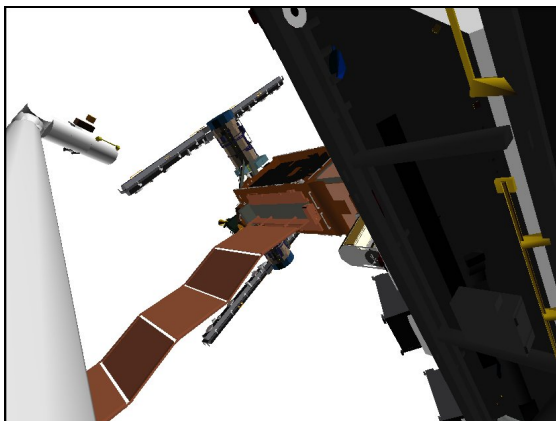
- RATE – as reqd (VERN within 10 ft)
- BRAKES – OFF (tb-OFF)
- MODE – SINGLE, ENTER

Mnvr to P6 PVR STBD CINCH VIEWING posn:

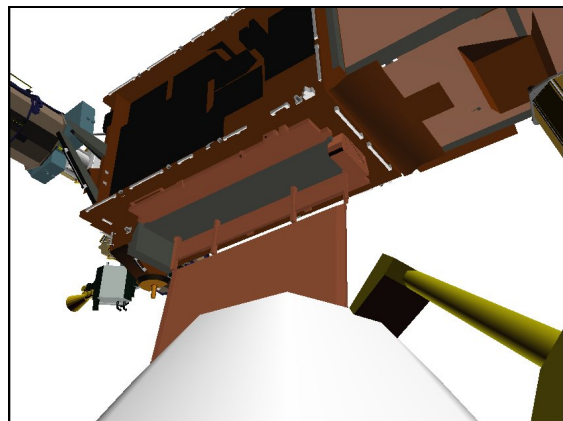
Zenith Cinch
1: WP +
2: WY +
Stbd Cinch

SY	SP	EP	WP	WY	WR	
+174.0	+50.0	-35.0	+13.0	+53.0	0.0	
			+22.0			
				+62.0		
+174.0	+50.0	-35.0	+22.0	+62.0	0.0	
X	Y	Z	PITCH	YAW	ROLL	PL ID
-209	-205	-721	130	316	144	0

- BRAKES – ON (tb-ON)
- √MODE – not DIRECT (lt off)



ELBOW (33,-19)



EE

4. MNVR TO P6 PVR PORT CINCH VIEWING POSN

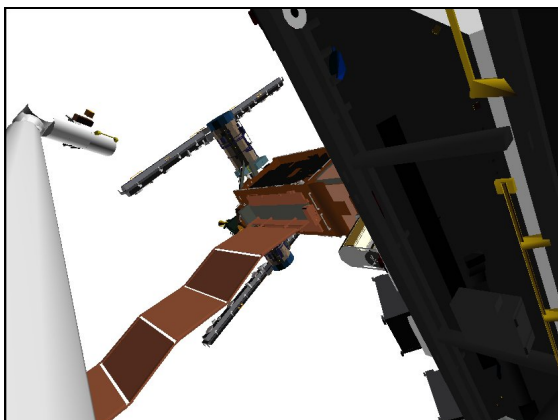
On MCC GO:

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

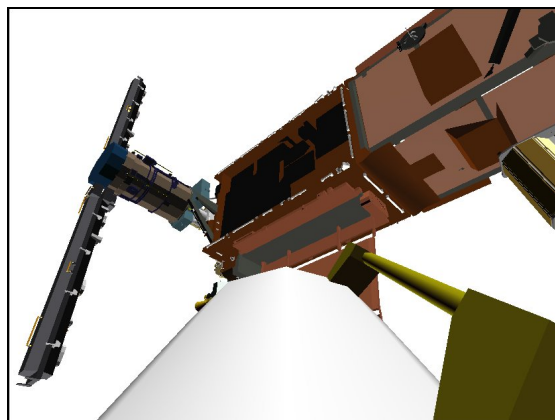
Mnvr to P6 PVR PORT CINCH VIEWING posn:

	SY	SP	EP	WP	WY	WR	
Stbd Cinch	+174.0	+50.0	-35.0	+22.0	+62.0	0.0	
1: WP +				+25.0			
2: WY -					+54.0		
Port Cinch	+174.0	+50.0	-35.0	+25.0	+54.0	0.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-205	-212	-725	131	324	147	0

BRAKES – ON (tb-ON)
 √MODE – not DIRECT (lt off)



ELBOW (33,-19)



EE

5. MNVR TO P6 PVR NADIR CINCH VIEWING POSN

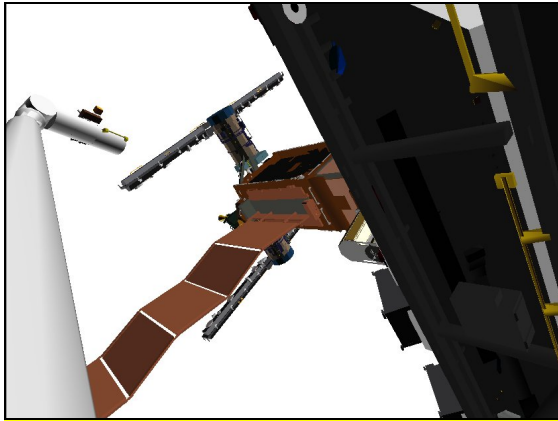
On MCC GO:

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

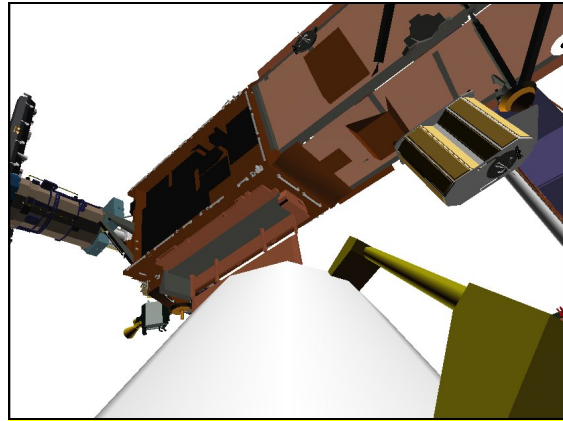
Mnvr to P6 PVR NADIR CINCH VIEWING posn:

	SY	SP	EP	WP	WY	WR	
Port Cinch	+174.0	+50.0	-35.0	+25.0	+54.0	0.0	
1: WP +				+34.0			
2: WY +					+64.0		
Nadir Cinch	+174.0	+50.0	-35.0	+34.0	+64.0	0.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-216	-206	-727	122	315	149	0

BRAKES – ON (tb-ON)
 √MODE – not DIRECT (lt off)



ELBOW (33,-19)



EE

6. MNVR TO SRMS PRE-CRADLE POSN

On MCC GO:

RATE – as reqd (VERN within 10 ft)

BRAKES – OFF (tb-OFF)

MODE – as desired

Mnvr to SRMS PRE-CRADLE posn:

	SY	SP	EP	WP	WY	WR	
Nadir Cinch	+174.0	+50.0	-35.0	+34.0	+64.0	0.0	
1: SP –		+25.0					
2: WP –				+5.0			
3: WY –					0.0		
4: EP +			-25.0				
5: SY –	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 (It off)

PARAM – PORT TEMP

JOINT – CRIT TEMP

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EVA 2 – CMG R&R VIEWING

I

- A7U 1. SETUP
CCTV – config for CMG R&R viewing

Mon 1	B
Dwnlnk	Elbow (EE)
Mon 2	P1 LOOB
DTV	A

SM 94 PDRS CONTROL

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

- RHC 2. MNVR TO CMG R&R VIEWING POSN
RATE – as reqd (VERN within 10 ft)
BRAKES – OFF (tb-OFF)
MODE – as desired

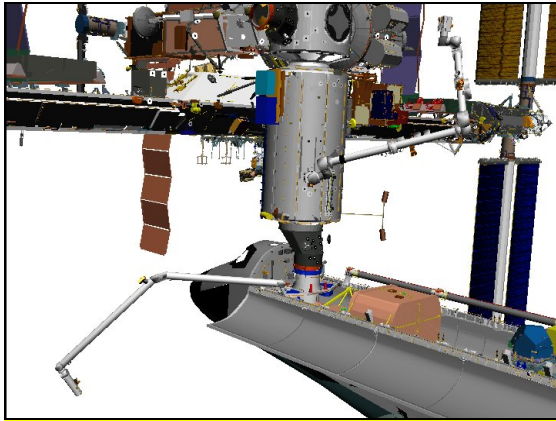
Mnvr to CMG R&R VIEWING posn:

	SY	SP	EP	WP	WY	WR	
Pre-Cradle	0.0	+25.0	-25.0	+5.0	0.0	0.0	
1: SY +	+125.0						
2: SP –		+20.0					
3: EP –			-50.0				
4: WP –				-75.0			
5: WR –						-145.0	
CMG Viewing	+125.0	+20.0	-50.0	-75.0	0.0	-145.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-414	-423	-201	280	329	325	0

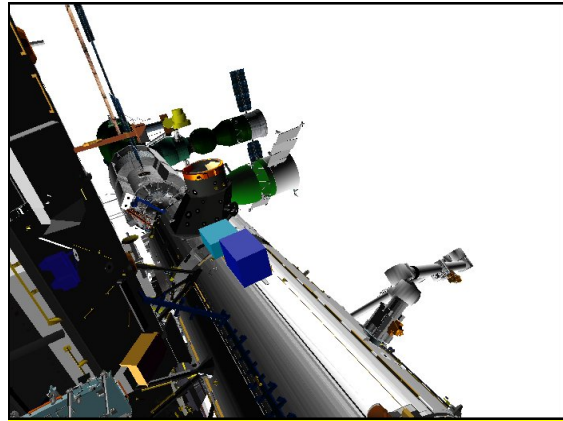
- BRAKES – ON (tb-ON)
√MODE – not DIRECT (It off)

NOTE

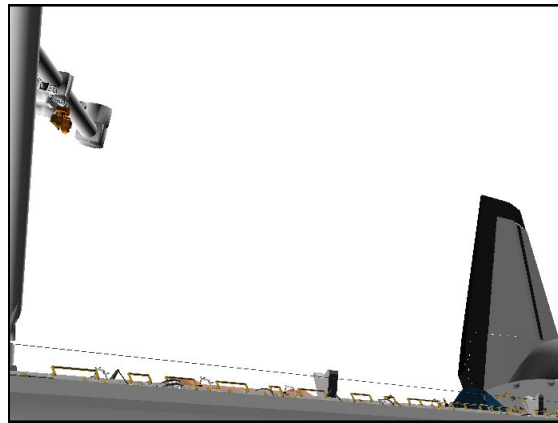
Pan and Tilt Elbow camera as required for
CMG R&R viewing



BIRD'S EYE



ELBOW (170,0)



RSC

NOTE

When CMG R&R viewing complete,
maneuver to SRMS Pre-Cradle position

3. MNVR TO SRMS PRE-CRADLE POSN

RATE – as reqd (VERN within 10 ft)

BRAKES – OFF (tb-OFF)

MODE – as desired

Mnvr to SRMS PRE-CRADLE posn:

	SY	SP	EP	WP	WY	WR	
CMG Viewing	+125.0	+20.0	-50.0	-75.0	0.0	-145.0	
1: WR +						0.0	
2: WP +				+5.0			
3: EP +			-25.0				
4: SP +		+25.0					
5: SY –	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 (It off)

PARAM – PORT TEMP

JOINT – CRIT TEMP

EVA 3 – P6 SASA RELOCATE VIEWING

I

1. SETUP
 A7U CCTV – config for P6 SASA RELOCATION viewing

Mon 1	Elbow (EE)
Dwnlnk	P1 LOOB
Mon 2	B
DTV	A

SM 94 PDRS CONTROL

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

2. MNVR TO P6 SASA RELOCATION VIEWING POSN

- RATE – as required (VERN within 10 ft)
- BRAKES – OFF (tb-OFF)
- MODE – as desired

If starting at PRE-CRADLE:

√	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	

Mnvr to P6 SASA RELOCATION VIEWING posn:

	SY	SP	EP	WP	WY	WR	
Pre-Cradle	0.0	+25.0	-25.0	+5.0	0.0	0.0	
1: SY +	+150.0						
2: WP +				+90.0			
3: WY +					+50.0		
SASA Viewing	+150.0	+25.0	-25.0	+90.0	+50.0	0.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-218	-366	-524	115	336	192	0

If starting at ESP-3 INSTALL VIEWING:

√	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-506	-552	-399	116	33	21	0
√	SY	SP	EP	WP	WY	WR	
	+110.0	+41.9	-69.8	+95.3	+14.8	-194.8	

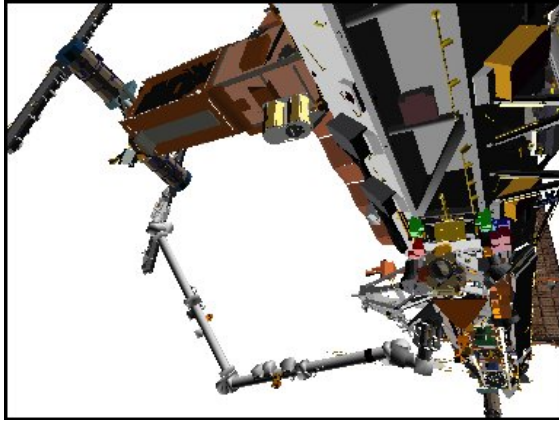
Mnvr to P6 SASA RELOCATION VIEWING posn:

	SY	SP	EP	WP	WY	WR	
ESP-3 Viewing	+110.0	+41.9	-69.8	+95.3	+14.8	-194.8	
1: SY +	+150.0						
2: WP –				+90.0			
3: WY +					+50.0		
4: WR +						0.0	
5: SP –		+25.0					
6: EP +			-25.0				
SASA Viewing	+150.0	+25.0	-25.0	+90.0	+50.0	0.0	
	X	Y	Z	PITCH	YAW	ROLL	PL ID
	-218	-366	-524	115	336	192	0

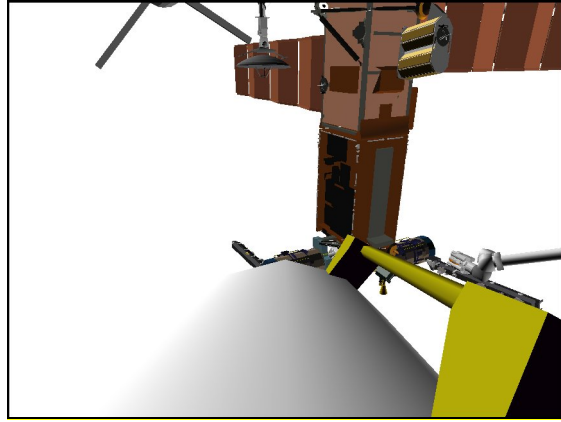
BRAKES – ON (tb-ON)
 ✓MODE – not DIRECT

NOTE

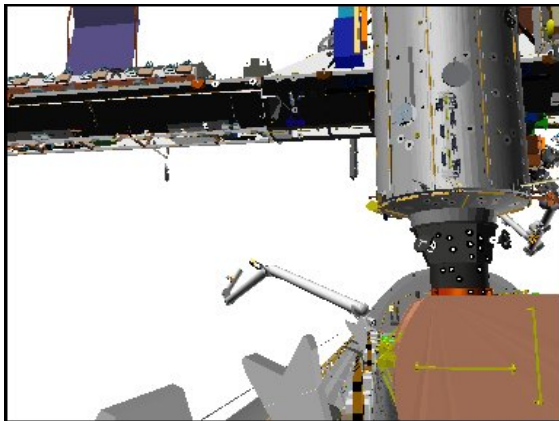
Pan and Tilt Elbow camera as required for
 P6 SASA relocation viewing



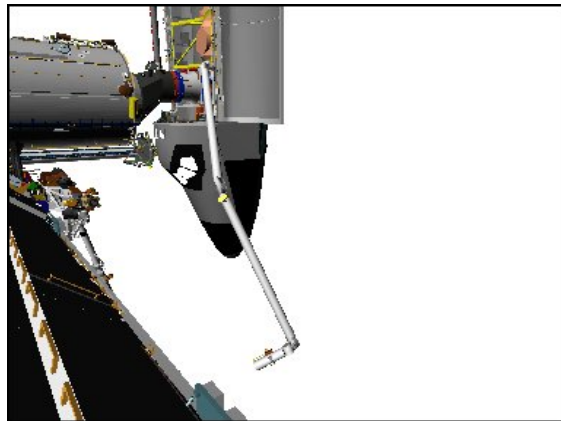
SRMS ELBOW (90,-30)



SRMS EE



CCTV B (-10,10)



P1 LOOB (130,-13)

NOTE

When P6 SASA relocation viewing is complete,
 maneuver to SRMS Pre-Cradle position

3. MNVR TO SRMS PRE-CRADLE POSN

RATE – as required (VERN within 10 ft)
 BRAKES – OFF (tb-OFF)
 MODE – as desired

Mnvr to SRMS PRE-CRADLE posn:

	SY	SP	EP	WP	WY	WR	
SASA Viewing	+150.0	+25.0	-25.0	+90.0	+50.0	0.0	
1: WY –					0.0		
2: WP –				+5.0			
3: SY –	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

S5 REFERENCE DATA

JOINT ANGLES VS POR COORDINATES	FS 7-2
S5 COORDINATE SYSTEM – PL ID 4.....	FS 7-3
PRLA CONFIGURATION	FS 7-4
S5 INSTALL CAMERA MATRIX	FS 7-5

S5
REF DATA

JOINT ANGLES VS POR COORDINATES

S5 PRE-GRAPPLE

X	Y	Z	PITCH	YAW	ROLL	PL ID
-1040	0	-492	315	0	331	0
SY	SP	EP	WP	WY	WR	
-22.1	+64.9	-102.7	-11.9	+29.0	-6.8	

S5 GRAPPLE

X	Y	Z	PITCH	YAW	ROLL	PL ID
-1066	0	-466	315	0	331	0
-1089	0	-414	180	0	180	4
SY	SP	EP	WP	WY	WR	
-19.4	+57.8	-97.8	-8.6	+27.2	-9.1	

S5 LOW HOVER

X	Y	Z	PITCH	YAW	ROLL	PL ID
-1066	0	-662	315	0	331	0
-1089	0	-610	180	0	180	4
SY	SP	EP	WP	WY	WR	
-28.4	+66.5	-69.3	-49.9	+32.9	-1.1	

S5 STBD

X	Y	Z	PITCH	YAW	ROLL	PL ID
-990	+108	-700	320	347	319	0
-1018	+116	-651	186	18	179	4
SY	SP	EP	WP	WY	WR	
-47.0	+66.5	-69.3	-49.9	+32.9	-1.1	

S5 HANDOFF

X	Y	Z	PITCH	YAW	ROLL	PL ID
-863	+408	-562	240	306	205	0
-850	+441	-517	323	66	34	4
SY	SP	EP	WP	WY	WR	
-67.9	+10.6	-21.0	-49.4	-29.9	-40.0	

BACKED OFF

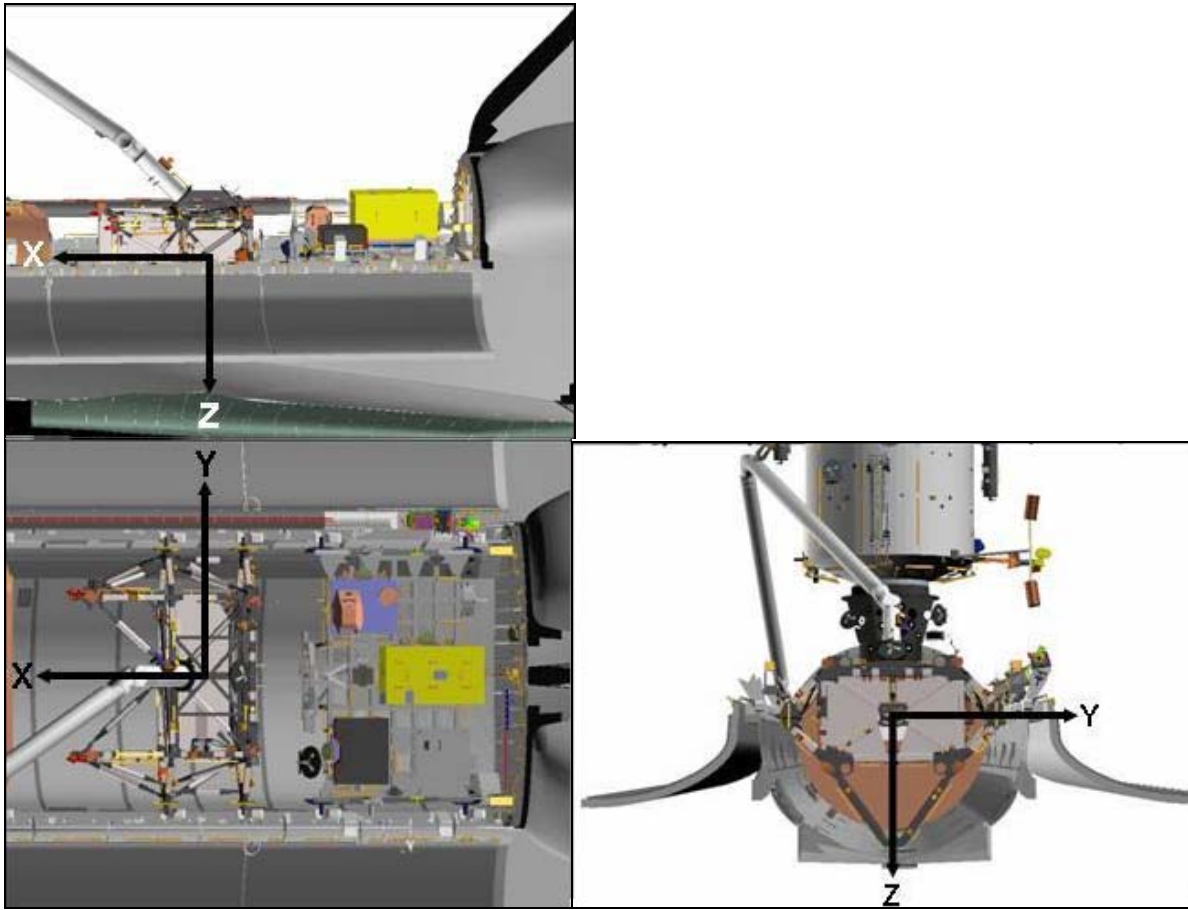
X	Y	Z	PITCH	YAW	ROLL	PL ID
-873	+379	-580	240	306	206	0
SY	SP	EP	WP	WY	WR	
-66.0	+21.2	-35.3	-46.8	-30.6	-41.7	

S5 INSTALL VIEWING

X	Y	Z	PITCH	YAW	ROLL	PL ID
-915	+317	-649	159	293	102	0
SY	SP	EP	WP	WY	WR	
-58.5	+36.4	-53.9	+0.9	-51.7	-45.1	

S5
REF DATA

S5 COORDINATE SYSTEM – PL ID 4

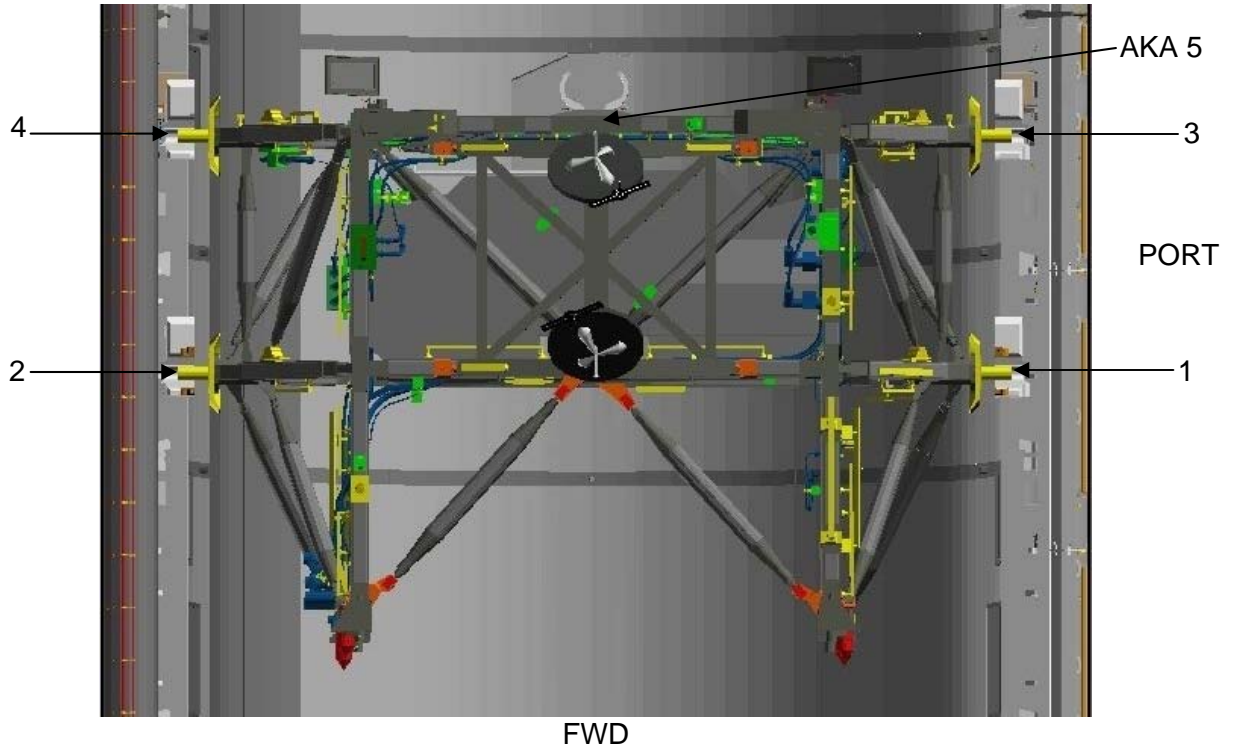


POR: At midpoint between forward and aft trunnions, at trunnion level

PURPOSE: S5 Unberth and Maneuvering

RATES:	<u>COARSE</u>	<u>VERN</u>
TRANS LIM ft/sec	0.35	0.12
ROT LIM deg/sec	1.44	0.48

PRLA CONFIGURATION



LAT/REL SEQUENCE	PL SEL	LAT/REL
AKA	1	5
PRLA	1	1,2 (fwds)
PRLA	1	3,4 (afts)

S5 INSTALL CAMERA MATRIX

	Task	Shuttle				Station				
		MON 1	MON 2 (Orb Ch 1) (DCPL 92)	Downlink (Orb Ch 2) (DCPL 91)	DTV	Mon 1	Mon 2	Mon 3	To Orbiter	Downlink
P	S5 Grapple	S1 LOOB	C	Elbow (EE) → EE	A (D)				03: S1 LOOB	
P	S5 Unberth	Lab Stbd Zenith (P1 LOOB)	B/C	Elbow (A)	D				28: Lab Stbd Zenith 19: P1 LOOB	
P	S5 Stbd	P1 LOOB	D	Elbow	B (C)				19: P1 LOOB	
P	S5 Handoff Maneuver	P1 LOOB	D	Elbow	B (C)				19: P1 LOOB	
R	SSRMS Grapple S5		D	Elbow	B	24: Tip Elbow	03: S1 LOOB	37: MBS Mast (22: Base Elbow)		
P	SRMS Ungrapple S5	P1 LOOB	D	EE	C				19: P1 LOOB	
P	S5 Install View	P1 LOOB	D	Elbow	C				19: P1 LOOB	
R	Maneuver to S5 Pre-Install		D	Elbow		92: D	22: Base Elbow	37: MBS Mast 03: S1 LOOB		
R	S5 Install		D	Elbow		03: S1 LOOB	22: Base Elbow	24: Tip Elbow (91: SRMS Elbow)		
R	S5 Ungrapple		C	Elbow		22: Base Elbow (24: Tip Elbow)	25: Tip LEE	37: MBS Mast		
R	SSRMS PVRGF View		D	Elbow		22: Base Elbow	25: Tip LEE	24: Tip Elbow		

Legend:

A, B, C, D: Orbiter Payload Bay Camera A, B, C, D
 Elbow: SRMS Elbow
 EE: SRMS End Effector
 Base LEE: SSRMS Base LEE (DCP: 21, PCS: 40)
 Base Elbow: SSRMS Base Elbow (DCP: 22, PCS: 43)
 Tip Elbow: SSRMS TIP Elbow (DCP: 24, PCS: 48)
 Tip LEE: SSRMS TIP LEE (DCP: 25, PCS: 51)
 P1 LOOB: P1 Lower Outboard (DCP: 09, PCS: 19)
 S1 LOOB: S1 Lower Outboard (DCP: 03, PCS: 4)
 Lab Stbd Zenith: Lab Starboard Zenith (DCP: 13, PCS: 28)

R: ROBO Procedure
 P: PDRS Procedure

1. Cameras in parentheses are backup camera options
2. If specific cameras are not identified, DCPL 91 and 92 are displayed to the ISS crew for situational awareness
3. Images displayed on monitors 1 and 2 are recorded on the Orbiter
4. ISS video comes to Orbiter on PL2. The desired source is routed to 11 – VTR 2
5. Camera numbers on Mon 1 (Station), Mon 2 (Station), and Mon 3 (Station) are camera numbers for RWS DCP routing. Camera numbers in To Orbiter (Station) and Downlink (Station) are for video routing via the PCS

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ESP-3 REFERENCE DATA

JOINT ANGLES VS POR COORDINATES	FS 8-2
ESP-3 COORDINATE SYSTEM – PL ID 5.....	FS 8-3
PRLA CONFIGURATION	FS 8-4
ESP-3 INSTALL CAMERA MATRIX	FS 8-5

ESP-3
REF DATA

JOINT ANGLES VS POR COORDINATES

ESP-3 PRE-GRAPPLE

X	Y	Z	PITCH	YAW	ROLL	PL ID
-1132	-60	-435	328	0	181	0
SY	SP	EP	WP	WY	WR	
-7.3	+47.8	-86.7	+7.5	+16.4	-172.9	

ESP-3 GRAPPLE

X	Y	Z	PITCH	YAW	ROLL	PL ID
-1163	-60	-416	328	0	181	0
-1222	0	-414	180	0	180	5
SY	SP	EP	WP	WY	WR	
-6.0	+39.8	-76.6	+5.7	+15.3	-173.6	

ESP-3 LOW HOVER

X	Y	Z	PITCH	YAW	ROLL	PL ID
-1162	-63	-522	328	0	181	0
-1222	-3	-520	180	0	180	5
SY	SP	EP	WP	WY	WR	
-10.2	+50.2	-71.1	-10.9	+18.9	-171.3	

ESP-3 PORT

X	Y	Z	PITCH	YAW	ROLL	PL ID
-1008	-382	-522	328	0	181	0
-1068	-322	-520	180	0	180	5
SY	SP	EP	WP	WY	WR	
+38.4	+75.5	-85.0	-23.4	-22.8	-196.7	

ESP-3 INTERMEDIATE

X	Y	Z	PITCH	YAW	ROLL	PL ID
-841	-496	-464	235	50	311	0
-870	-575	-460	0	295	2	5
SY	SP	EP	WP	WY	WR	
+59.5	+74.3	-90.5	-6.8	+51.0	-135.4	

ESP-3 HANDOFF

X	Y	Z	PITCH	YAW	ROLL	PL ID
-388	-360	-401	203	11	332	0
-353	-435	-385	352	336	19	5
SY	SP	EP	WP	WY	WR	
+135.8	+68.7	-106.7	+19.1	+24.5	-155.9	

UNGRAPPLE BACKOFF

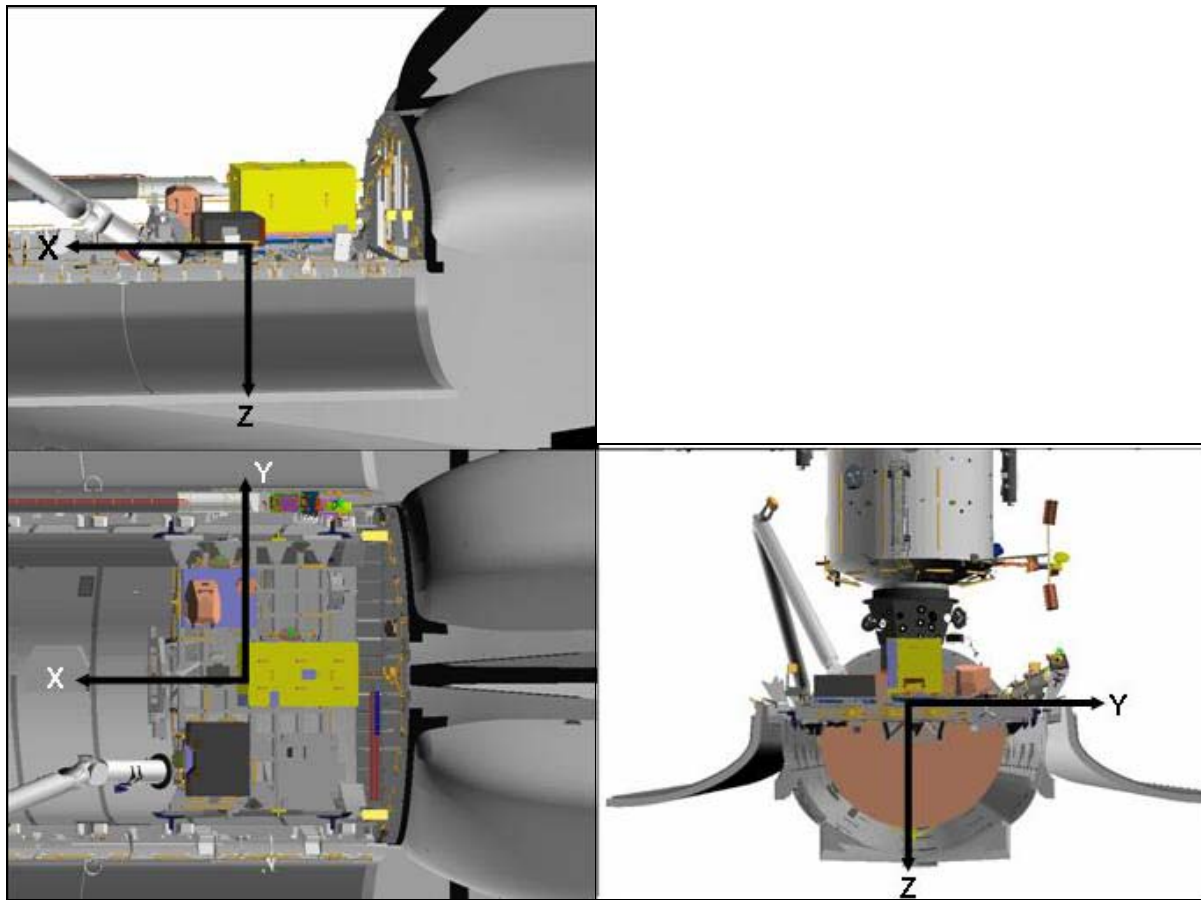
X	Y	Z	PITCH	YAW	ROLL	PL ID
-420	-353	-415	203	11	332	0
SY	SP	EP	WP	WY	WR	
+133.0	+76.1	-114.1	+18.6	+27.1	-154.9	

ESP-3 INSTALL VIEWING

X	Y	Z	PITCH	YAW	ROLL	PL ID
-506	-552	-399	116	33	21	0
SY	SP	EP	WP	WY	WR	
+110.0	+41.9	-69.8	+95.3	+14.8	-194.8	

ESP-3
REF DATA

ESP-3 COORDINATE SYSTEM – PL ID 5

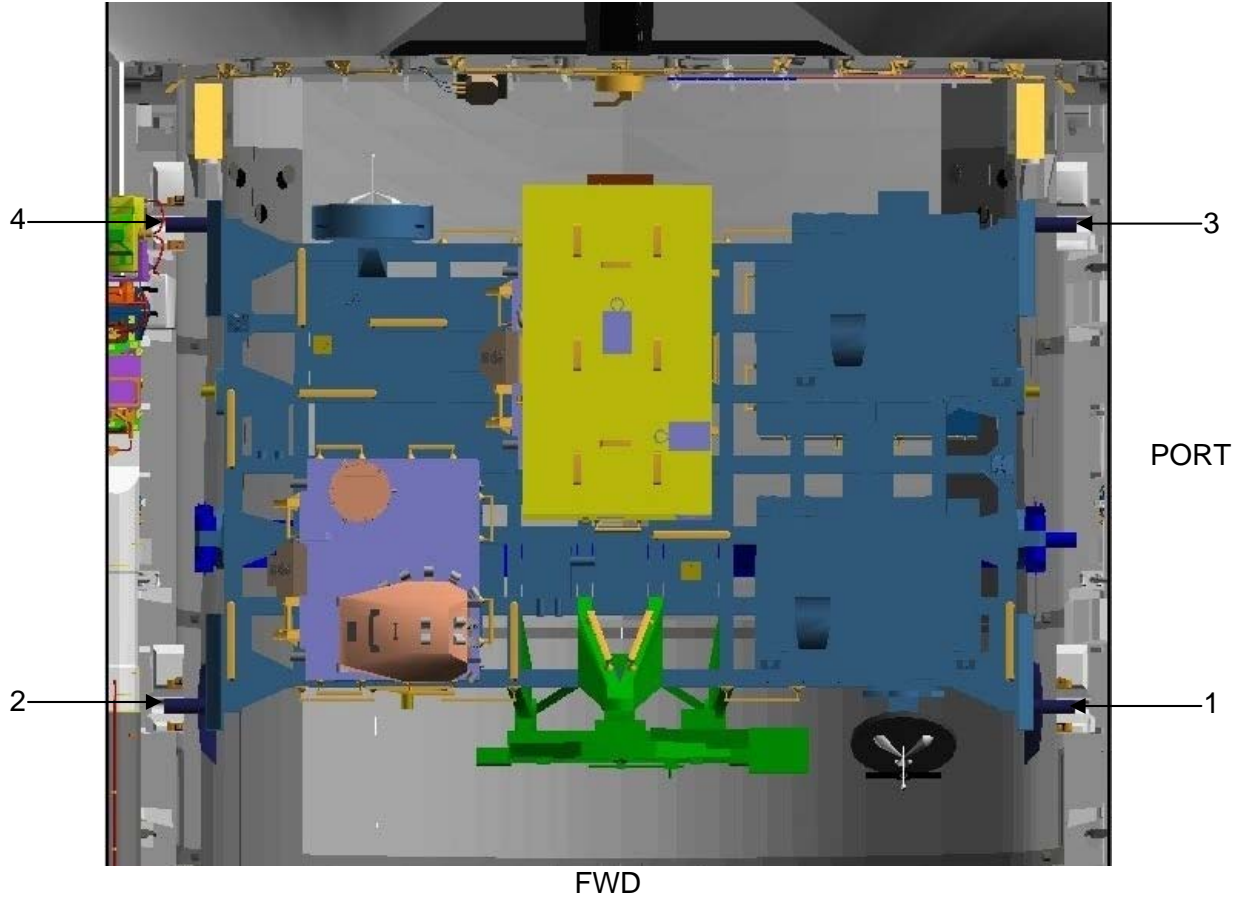


POR: At midpoint between forward and aft trunnions, at trunnion level

PURPOSE: ESP-3 Unberth and Maneuvering

RATES:	<u>COARSE</u>	<u>VERN</u>
TRANS LIM ft/sec	0.31	0.10
ROT LIM deg/sec	1.24	0.41

PRLA CONFIGURATION



LAT/REL SEQUENCE	PL SEL	LAT/REL
PRLA	3	1,4 (port fwd, stbd aft)
PRLA	3	2,3 (stbd fwd, port aft)

ESP-3 INSTALL CAMERA MATRIX

	Task	Shuttle				Station				
		MON 1	MON 2 (Orb Ch 1) (DCPL 92)	Downlink (Orb Ch 2) (DCPL 91)	DTV	Mon 1	Mon 2	Mon 3	To Orbiter	Downlink
P	ESP-3 Grapple	A	S 1 LOOB 03 (P1 LOOB 09)	Elbow (EE)	B (C)				03: S1 LOOB (09: P1 LOOB)	
P	ESP-3 Unberth	C	Lab 13 (P1 LOOB 09)	B (Elbow)	A				13: Lab (09: P1 LOOB)	
P	ESP-3 Port	Elbow	P1 LOOB 09	A	C (B)				09: P1 LOOB	
P	ESP-3 Intermediate	Elbow	P1 LOOB 09	A	B (C)				09: P1 LOOB	
P	ESP-3 Handoff	Elbow	P1 LOOB 09 (Mast 37)	A	B				09: P1 LOOB (37: Mast)	
R	SSRMS Grapple ESP-3			Elbow		91: SRMS Elbow	25: Tip LEE	37: MBS Mast (09: P1 LOOB)		
P	SRMS Ungrapple ESP-3	A	Mast 37 (P1 LOOB 09)	EE	B				37: Mast (09: P1 LOOB)	
P	ESP-3 Install View	Elbow	P1 LOOB 09	A	B				09: P1 LOOB	
R	Maneuver to ESP-3 Pre-Install		EE		B	91: SRMS Elbow (92: SRMS EE)	37: MBS Mast	24: Tip Elbow 22: Base Elbow		
R	ESP-3 Install		EE			92: SRMS EE (37: MBS Mast)	26: EBCS	24: Tip Elbow (22: Base Elbow)		
R	ESP-3 Release		EE			92: SRMS EE	25: Tip LEE	22: Base Elbow		
P	SRMS Pre-Cradle	A	C	Elbow	B					

Legend:

A, B, C, D: Orbiter Payload Bay Camera A, B, C, D

Elbow: SRMS Elbow

EE: SRMS End Effector

Base LEE: SSRMS Base LEE (DCP: 21, PCS: 40)

Base Elbow: SSRMS Base Elbow (DCP: 22, PCS: 43)

Tip Elbow: SSRMS TIP Elbow (DCP: 24, PCS: 48)

Tip LEE: SSRMS TIP LEE (DCP: 25, PCS: 51)

P1 LOOB: P1 Lower Outboard (DCP: 09, PCS: 19)

S1 LOOB: S1 Lower Outboard (DCP: 03, PCS: 4)

Lab Stbd Zenith: Lab Starboard Zenith (DCP: 13, PCS: 28)

R: ROBO Procedure

P: PDRS Procedure

1. Cameras in parentheses are backup camera options
2. If specific cameras are not identified, DCPL 91 and 92 are displayed to the ISS crew for situational awareness
3. Images displayed on monitors 1 and 2 are recorded on the Orbiter
4. ISS video comes to Orbiter on PL2. The desired source is routed to 11 – VTR 2
5. Camera numbers on Mon 1 (Station), Mon 2 (Station), and Mon 3 (Station) are camera numbers for RWS DCP routing. Camera numbers in To Orbiter (Station) and Downlink (Station) are for video routing via the PCS

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CUE CARD CONFIGURATION

S5 SJ GRAPPLE WRIST CCTV OVERLAY	FS CC 9-2
UNGRAPPLE WRIST CCTV OVERLAY	FS CC 9-3
ESP-3 SJ GRAPPLE WRIST CCTV OVERLAY	FS CC 9-4
UNGRAPPLE WRIST CCTV OVERLAY	FS CC 9-5
OBSS SJ GRAPPLE AT HANDOFF WRIST CCTV OVERLAY.....	FS CC 9-6
UNGRAPPLE AT HANDOFF WRIST CCTV OVERLAY	FS CC 9-7

CUE CARD
CONFIG

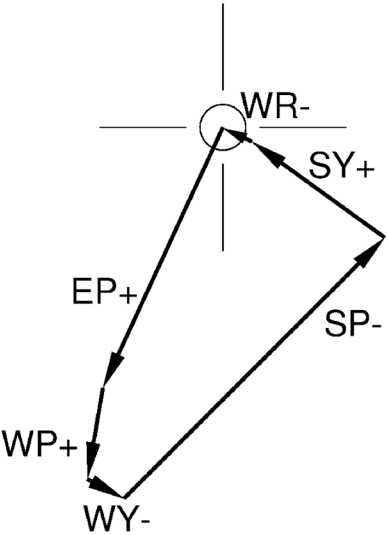
CUE CARD CONFIG

Fabricate as transparency

ZOOM 34.0 HFOV
FOCUS 5.0 FT
EYEPOINT APPROX 18 IN



WR-



S5 SJ GRAPPLE WRIST CCTV OVERLAY

PDRS-9a/118/O/B

I

(reduced copy)

FS CC 9-2

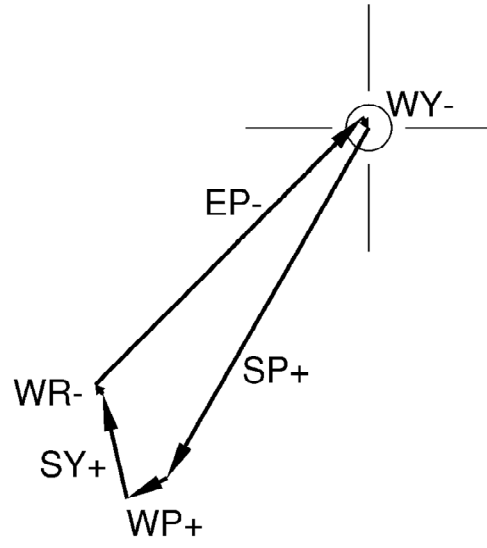
PDRS/118/FIN

Fabricate as transparency

ZOOM 34.0 HFOV
FOCUS 5.0 FT
EYEPOINT APPROX 18 IN



WR-



S5 SJ UNGRAPPLE WRIST CCTV OVERLAY

PDRS-10a/118/O/B

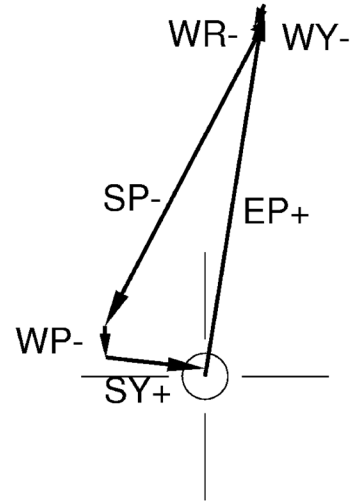
(reduced copy)

FS CC 9-3

PDRS/118/FIN

Fabricate as transparency

ZOOM 34.0 HFOV
FOCUS 5.0 FT
EYEPOINT APPROX 18 IN



ESP-3 SJ GRAPPLE WRIST CCTV OVERLAY

PDRS-11a/118/O/B

I

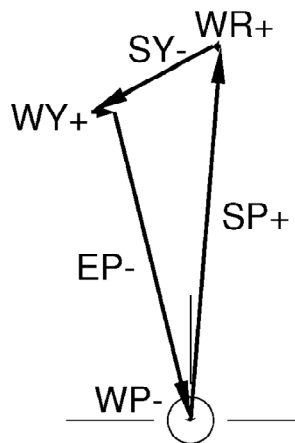
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FS CC 9-4

PDRS/118/FIN

Fabricate as transparency

ZOOM 34.0 HFOV
FOCUS 5.0 FT
EYEPOINT APPROX 18 IN



ESP-3 SJ UNGRAPPLE WRIST CCTV OVERLAY

PDRS-12a/118/O/A

I

(reduced copy)

FS CC 9-5

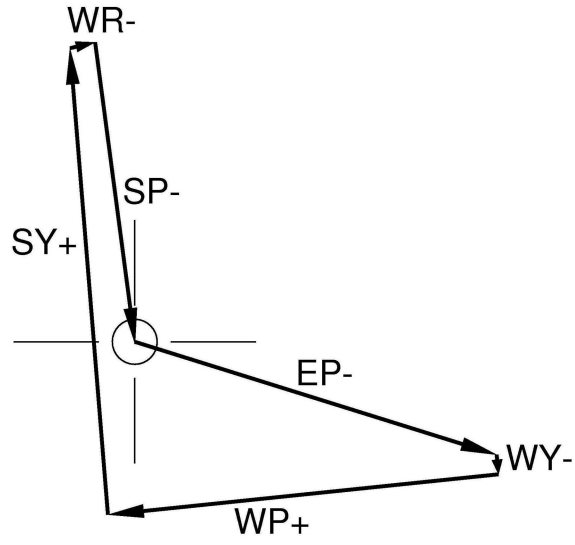
PDRS/118/FIN

Fabricate as transparency

ZOOM 34.0 HFOV
FOCUS 5.0 FT
EYEPOINT APPROX 18 IN



WR-



WR-

SY+

SP-

EP-

WY-

WP+

OBSS SJ GRAPPLE AT HANDOFF WRIST CCTV OVERLAY

PDRS-13a/118/O/B

I

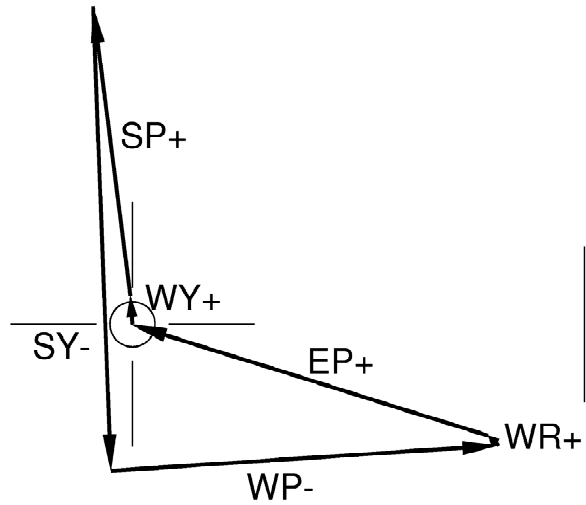
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FS CC 9-6

PDRS/118/FIN

Fabricate as transparency

ZOOM 34.0 HFOV
FOCUS 5.0 FT
EYEPOINT APPROX 18 IN



OBSS SJ UNGRAPPLE AT HANDOFF WRIST CCTV OVERLAY

PDRS-14a/118/O/B

I

(reduced copy)

FS CC 9-7

PDRS/118/FIN

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Space Shuttle Program
FLIGHT DATA FILE

JSC-48040-118
FINAL



PDRS OPS C/L

**STS
118**