A SYNOPSIS OF THE EVA TRAINING CONDUCTED ON EASE/ACCESS FOR STS - 61-B

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I. EASE/ACCESS Training Problems

A. Large 3-dimensional structures

- Could not be accomodated in the JSC Weightless Environment Training Facility (WETF) since pool is only 33 feet wide, 78 feet long, and 25 feet deep

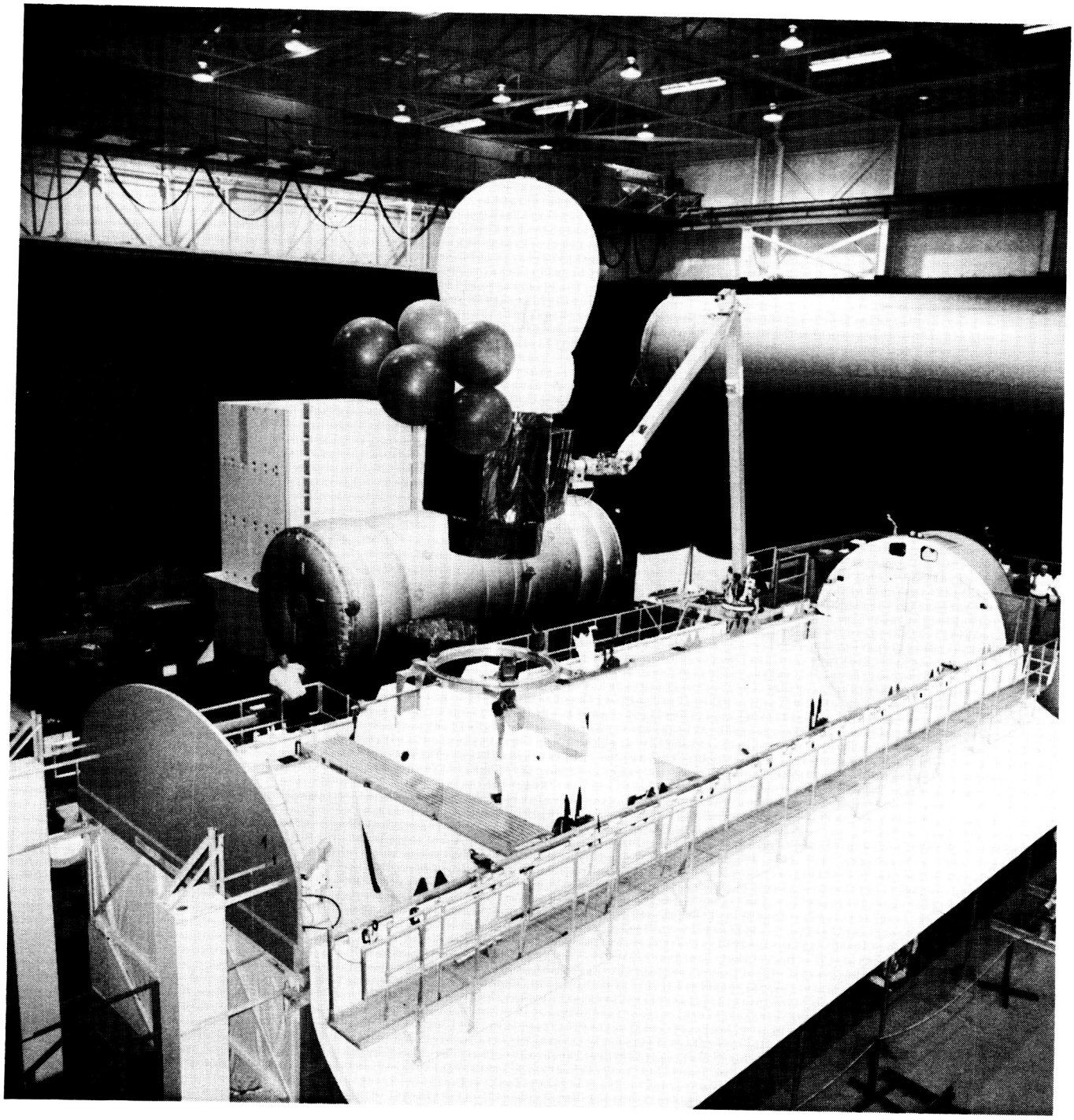
- Could be accomplished in the MSFC Neutral Buoyancy Tank (NBT) since pool is 40 feet deep and 75 feet in diameter

B. Training required extensive integration with the Remote Manipulator System (RMS) and Photo/TV plans

- No functional RMS existed at the JSC WETF at that time
- MSFC NBT did have a working RMS although the controls are not "flight-like"
  - Considered negative training for the RMS operator due to work station separation and non-flight-like controls
- The Manipulator Development Facility (MDF) at JSC used a "cardboard crewman" and an MPESS mockup to provide RMS operator training

C. Extensive PHOTO/TV coverage

- Could not provide the requested coverage due to limited locker stowage
- Required a very detailed plan which used a dedicated crewman to accomplish the plan
- Resulted in the most photographically documented EVA to date
- MDF used to provide best visual simulator of the required views for PHOTO/TV training



II. Training Plan

A. Normal EVA training plan

- Launch minus 6 to 8 months - Start with classroom or 1-g briefing and SCUBA familiarization of hardware (1 or 2 sessions)

- L-6 to L-3 months (biweekly) - In a tank, perform EMU suited runs of the basic tasks to provide the detailed training and development of procedures

- L-3 months to L-2 weeks (weekly) - Perform end-to-end timeline runs with EMU suited crewmen to build familiarity with timelines and work on contingency plans

NOTE: Anything prior to official assignment of the crew is supported by the EVA representative from the astronaut office

Crewmen who participated in development runs on the EASE/ACCESS hardware include

John Blaha
Gordon Fullerton
Ron McNair
Bryan O'Connor
Ellison Onizuka
Robert Springer
Jerry Ross, Sherwood Spring } Majority of development work
George Nelson

B. EASE/ACCESS training philosophy

- Early portion of training would be done at MSFC
- The assigned crew cannot be away from JSC during the final 3 months of preparation due to integrated simulations and flying schedules
- Thus the early training would be done at MSFC in August prior to a November launch
- Development of the EVA timeline was difficult because the principal investigators (PI's) had 9 hours of activity to pack into 6 hours of EVA timeline.

C. Actual EASE/ACCESS training

- L-7 months (April 9,10) - Ross, Spring - Early familiarization runs performed at MSFC

  - Hardware already there for continuing development runs

- L-4 months - At MSFC performed end-to-end timeline runs using proposed but too-long timelines

  - Proved to PI's that the amount of activity had to be cut down

  - Reworked the timelines and provided integrated training with the RMS Operator and the crewman in the manipulator foot restraint (MFR)

August 7, 1985 - One run of baseline experiments
- EVA-1 timeline run

August 8, 1985 - One run of contingency procedures due to broken arm system

August 9,12,13 1985 - Three runs of the detailed test objectives or the EVA-2 timeline
- Used a shortened timeline for EVA-2

- L-3 months to L-2 weeks - Training hardware brought to JSC WETF and performed only the baseline experiments or EVA-1 timeline on a biweekly basis

  - Tried to do long runs at ~4.3 psid to closely simulate flight conditions
  - Included 2 EVA simulations, which were integrated with the mission control center
  - Included contingencies for EASE/ACCESS and the EMU

SUMMARY OF TRAINING FOR 61-B EASE/ACCESS

I. EXTRA-VEHICULAR ACTIVITY (EVA) TRAINING			
FACILITY	DATE	HOURS	DESCRIPTION
SL NBT	8/7/85	4.0	EVA-1 TIMELINE
SL NBT	8/8/85	3.5	CONTINGENCY RUNS
SL NBT	8/9/85	4.0	EVA-2 TIMELINE
SL NBT	8/12/85	4.0	EVA-2 TIMELINE
SL NBT	8/13/85	4.0	EVA-2 TIMELINE
		19.5	SUBTOTAL
WETF	9/17/85	4.5	EVA-1 & CONTINGENCIES
WETF	9/24/85	5.0	EVA-1 TIMELINE
WETF	10/11/85	4.0	EASE/ACCESS CONTINGENCIES
WETF	10/16/85	4.5	ACCESS DTO, EASE BASELINE
WETF	10/23/85	4.0	EVA INTEGRATED SIMULATION
WETF	10/29/85	4.0	EVA-1 TIMELINE
WETF	11/6/85	4.0	EVA-1 TIMELINE
WETF	11/21/85	5.75	EVA INTEGRATED SIMULATION
		35.75	SUBTOTAL
		55.25	TOTAL

SUMMARY OF TRAINING FOR 61-B
EASE/ACCESS - Continued

II. PHOTO/TV TRAINING

FACILITY	DATE	HOURS	DESCRIPTION
CLASSROOM	3/5/85	2.0	
CREW COMPARTMENT	4/8/85	3.0	
FULL FUSELAGE	9/26/85	2.0	
FULL FUSELAGE	10/30/85	2.0	
CLASSROOM	11/20/85	1.5	
		10.5	TOTAL

SUMMARY OF TRAINING FOR 61-B
EASE/ACCESS - Concluded

III. REMOTE MANIPULATOR SYSTEM (RMS) TRAINING			
FACILITY	DATE	HOURS	DESCRIPTION
SES	9/20/85	1.75	
SES	11/6/85	3.00	
		4.75	SUBTOTAL
MDF	8/2/85	3.0	
MDF	9/20/85	1.5	
MDF	9/27/85	4.0	
MDF	10/11/85	2.0	
MDF	10/16/85	2.75	
MDF	10/21/85	1.0	
MDF	10/25/85	3.0	
MDF	10/31/85	2.5	
MDF	11/4/85	2.0	
MDF	11/5/85	2.75	
MDF	11/15/85	4.0	
		28.5	SUBTOTAL
		33.25	TOTAL

D. Results of Training

- Fully defined the timelines for EVA-1 and EVA-2
- Defined the method of using the MFR as a remote work platform
- Resolved safety concerns on jettisoning hardware, strapdowns, and lost pieces
- Completely defined and simulated the intravehicular jobs and integrated these jobs with the EVA crewmen
  - PHOTO/TV documentor
  - Choreographer
  - RMS Operator

INITIAL CONDITIONS (EVA-2)

PET 00:00:00 = MET 04:20:30

✓Airlock stowage complete:
35mm camera (one)

Four wrist tethers
For each crewman:
(1) Wrist tether
(1) Adj wrist tether

IV IMAX STANDBY/SETUP
(PL OPS, IMAX)

IV ✓P/TV06 SETUP (EVA), 1-16
(PHOTO TV, P/TV SCENES)

IV ✓DAP A1,B8 AUTO/VERN
• If PRCS DAP: A6,B8 AUTO/NORM *

RMS POSITIONED FOR GRAPPLE

CRT [SM 94 PDRS CONTROL]
PL ID - ITEM 3 +4 EXEC
BRAKES - OFF (tb-OFF)
MODE - ORB UNL, ENTER
ITEM 24 +4 EXEC
Mnvr to grapple pos

-850, +82, -435, 270, 0, 270

SY	SP	EP	WP	WY	WR
-49	+66	-123	-48	+13	-20

EVA 2 - Summary Timeline

PET	TASK
0 + 00-0 + 15	depress, egress, and translate to MFR stowage
0 + 15-0 + 25	unstow/grapple MFR
0 + 25-0 + 35	configure ACCESS for build
0 + 35-1 + 00	EV1 - low man - nominally build bays 1 - 9
1 + 00-1 + 20	EV1 ingress MFR, install tool boards, load components on boards
1 + 20-1 + 35	EV1 in MFR - build bay 10 from MFR
1 + 35-1 + 55	EV1 in MFR - utility cable installation
1 + 55-2 + 10	EV1 in MFR - ACCESS truss manipulation
2 + 10-2 + 20	EV1 egress MFR, EV2 ingress MFR
2 + 20-2 + 30	EV2 in MFR - disassemble bay 10 from MFR
2 + 30-2 + 35	EV2 in MFR - maintenance/repair task on bay 8
2 + 35-2 + 40	EV2 in MFR - rebuild bay 10
2 + 40-2 + 55	EV2 in MFR - manipulate access truss
2 + 55-3 + 00	EV2 egress MFR
3 + 00-3 + 20	EV2 as low man - Nominally disassemble 10 bays
3 + 20-3 + 30	Stow ACCESS hardware and unstow EASE hardware
3 + 30-3 + 40	Unstow EASE cradle; EV2 ingress MFR
3 + 40-3 + 45	EV2 in MFR - build heat pipe
3 + 45-3 + 50	EV2 in MFR - manipulate heat pipe
3 + 50-4 + 15	EV2 in MFR - build EASE
4 + 15-4 + 30	EV2 in MFR - manipulate EASE
4 + 30-4 + 35	EV2 egress MFR, EV1 ingress MFR
4 + 35-4 + 50	EV1 in MFR - manipulate EASE
4 + 50-5 + 05	EV1 in MFR - disassemble EASE
5 + 05-5 + 10	EV1 in MFR - build heat pipe
5 + 10-5 + 20	EV1 in MFR - manipulate heat pipe
5 + 20-5 + 25	EV1 in MFR - stow heat pipe
5 + 25-5 + 35	Pass tool boards to EV2, EV1 egress MFR
5 + 35-5 + 45	Stow MFR, close EASE cradle
5 + 45-5 + 50	Stow peripheral equipment
5 + 50-6 + 00	Ingress airlock
6 + 00	Repress

FS 8-1 EVA/61-B/FIN

NOMINAL TIMELINE
EVA-2

III. Flight Data File (FDF) and Flight Rules Production

A. EVA timelines

- Written prior to training at MSFC but rewritten due to length of timelines
- Turned in to editors at L-3 months, which was late - should produce PRELIMINARY version at L-4 months
- Lingering problem of defining timeline with equal amounts of time for both EASE and ACCESS
- Produced the integrated EVA checklist containing detailed EVA, RMS, and PHOTO/TV procedures

INITIAL CONDITIONS (EVA-1)

PET 00:00:00 = MET 02/21:45

✓Airlock stowage complete:
35mm cameras (two)
AAPS target with two wrist tethers

IV ✓RMS in viewing position
✓P/TV06 SETUP (EVA), 1-16
(PHOTO TV, P/TV SCENES)

IV IMAX STANDBY/SETUP
(PL OPS, IMAX)
✓DAP A1,B8 AUTO VERN
*If PRCS: DAP A6/B8 AUTO/NORM •

MNVR RMS TO ACCESS VIEWING POSITION

PARAM sel - JOINT ANGLE
BRAKES - OFF (tb-OFF)
MODE - SINGLE, ENTER

SINGLE DR to:

	SY	SP	EP	WP	WY	WR
✓	0	+25	-25	+5	0	0
1	+20					
2			-8			
3		+8				
✓	+20	+8	-8	+5	0	0

NOTE
C/W SINGULAR lt - ON (MA) (EP = -7.6)

BRAKES - ON (tb-ON)

EVA-1 Summary Timeline

PET	TASK
0 + 00-0 + 30	depress and egress, translate to MPESS
0 + 30-0 + 45	configure ACCESS for build
0 + 45-1 + 05	EV1 - low man - build bays 1-5
1 + 05-1 + 20	EV2 - low man - build bays 6-10
1 + 20-1 + 40	EV2 - low man - disassemble bays 10-6
1 + 40-1 + 55	EV1 - low man - disassemble bays 5-1
1 + 55-2 • 15	stow ACCESS assembly fixture
2 + 15-2 + 25	unstow peripheral hardware and unlatch EASE cradle
2 • 25-2 + 40	EV1 - low man assemble EASE - 1
2 + 40-2 + 55	EV1 - low man disassemble EASE - 1
2 + 55-3 + 10	EV1 - low man assemble EASE - 2
3 + 10-3 + 25	EV1 - low man disassemble EASE - 2
3 + 25-3 + 40	EV1 - low man assemble EASE - 3
3 + 40-3 + 55	EV1 - low man disassemble EASE - 3
3 + 55-4 + 10	EV1 - low man assemble EASE - 4
4 + 10-4 + 25	EV1 - low man disassemble EASE - 4
4 + 25-4 + 30	EV2 - low position
4 + 30-4 + 45	EV2 - low man assemble EASE -5
4 + 45-5 + 00	EV2 - low man disassemble EASE - 5
5 + 00-5 + 15	EV2 - low man assemble EASE - 6
5 + 15-5 + 30	EV2 - low man disassemble EASE - 6
5 + 30-5 + 40	secure EASE hardware and stow peripheral equipment
5 + 40-5 + 45	EV2 - obtain AAPS target and deploy target
5 + 45-5 • 55	ingress airlock
5 + 55	repress

NOMINAL TIMELINE
EVA-1

INITIAL CONDITIONS (EVA-2)

PET 00:00:00 = MET 04:20:30

✓Airlock stowage complete:
35mm camera (one)

Four wrist tethers
For each crewman:
(1) Wrist tether
(1) Adj wrist tether

IV IMAX STANDBY/SETUP
(PL OPS, IMAX)

IV ✓P/TV06 SETUP (EVA), 1-16
(PHOTO TV, P/TV SCENES)

IV ✓DAP A1,B8 AUTO/VERN
• If PRCS DAP: A6,B8 AUTO/NORM •

RMS POSITIONED FOR GRAPPLE

CRT [SM 94 PDRS CONTROL]
PL ID - ITEM 3 +4 EXEC
BRAKES - OFF (tb-OFF)
MODE - ORB UNL, ENTER
ITEM 24 +4 EXEC
Mnvr to grapple pos

-850, +82, -435, 270, 0, 270

SY	SP	EP	WP	WY	WR
-49	+66	-123	-48	+13	-20

EVA-2 - Summary Timeline

PET	TASK
0 • 00-0 + 15	depress, egress, and translate to MFR stowage
0 + 15-0 + 25	unstow/grapple MFR
0 + 25-0 • 35	configure ACCESS for build
0 + 35-1 + 00	EV1 - low man - nominally build bays 1 - 9
1 + 00-1 + 20	EV1 ingress MFR,install tool boards, load components on boards
1 + 20-1 + 35	EV1 in MFR - build bay 10 from MFR
1 + 35-1 + 55	EV1 in MFR - utility cable installation
1 + 55-2 + 10	EV1 in MFR - ACCESS truss manipulation
2 + 10-2 + 20	EV1 egress MFR, EV2 ingress MFR
2 + 20-2 + 30	EV2 in MFR - disassemble bay 10 from MFR
2 + 30-2 + 35	EV2 in MFR - maintenance/repair task on bay 8
2 + 35-2 + 40	EV2 in MFR - rebuild bay 10
2 + 40-2 + 55	EV2 in MFR - manipulate access truss
2 + 55-3 + 00	EV2 egress MFR
3 + 00-3 + 20	EV2 as low man - Nominally disassemble 10 bays
3 + 20-3 + 30	Stow ACCESS hardware and unstow EASE hardware
3 • 30-3 + 40	Unstow EASE cradle; EV2 ingress MFR
3 + 40-3 + 45	EV2 in MFR - build heat pipe
3 + 45-3 + 50	EV2 in MFR - manipulate heat pipe
3 + 50-4 + 15	EV2 in MFR - build EASE
4 + 15-4 + 30	EV2 in MFR - manipulate EASE
4 + 30-4 + 35	EV2 egress MFR, EV1 ingress MFR
4 • 35-4 + 50	EV1 in MFR - manipulate EASE
4 + 50-5 + 05	EV1 in MFR - disassemble EASE
5 + 05-5 + 10	EV1 in MFR - build heat pipe
5 + 10-5 + 20	EV1 in MFR - manipulate heat pipe
5 + 20-5 + 25	EV1 in MFR - stow heat pipe
5 + 25-5 + 35	Pass tool boards to EV2, EV1 egress MFR
5 • 35-5 + 45	Stow MFR, close EASE cradle
5 + 45-5 + 50	Stow peripheral equipment
5 + 50-6 + 00	Ingress airlock
6 + 00	Repress

FS 8-1 EVA/61-B/FIN

NOMINAL TIMELINE
EVA-2

STOW ASSEMBLY FIXTURE [6] (0 + 05)

EV1 1) Slide guide rail bracket up into place Do not pin
EV1 2) Release positive lock on toggle clamp
EV1 3) Release toggle clamp - rotate handle down
BOTH 4) Stow assembly fixture
EV1 5) Secure locking bracket with yellow pip pin
EV2 6) Secure mast clamps
EV1 7) Close assembly fixture toggle clamp - rotate handle up
EV1 8) Close positive lock on toggle clamp

MNVR RMS TO EASE VIEWING POSITION [7]

PARAM sel - JOINT ANGLE
BRAKES - OFF (tb-OFF)
MODE - SINGLE, ENTER

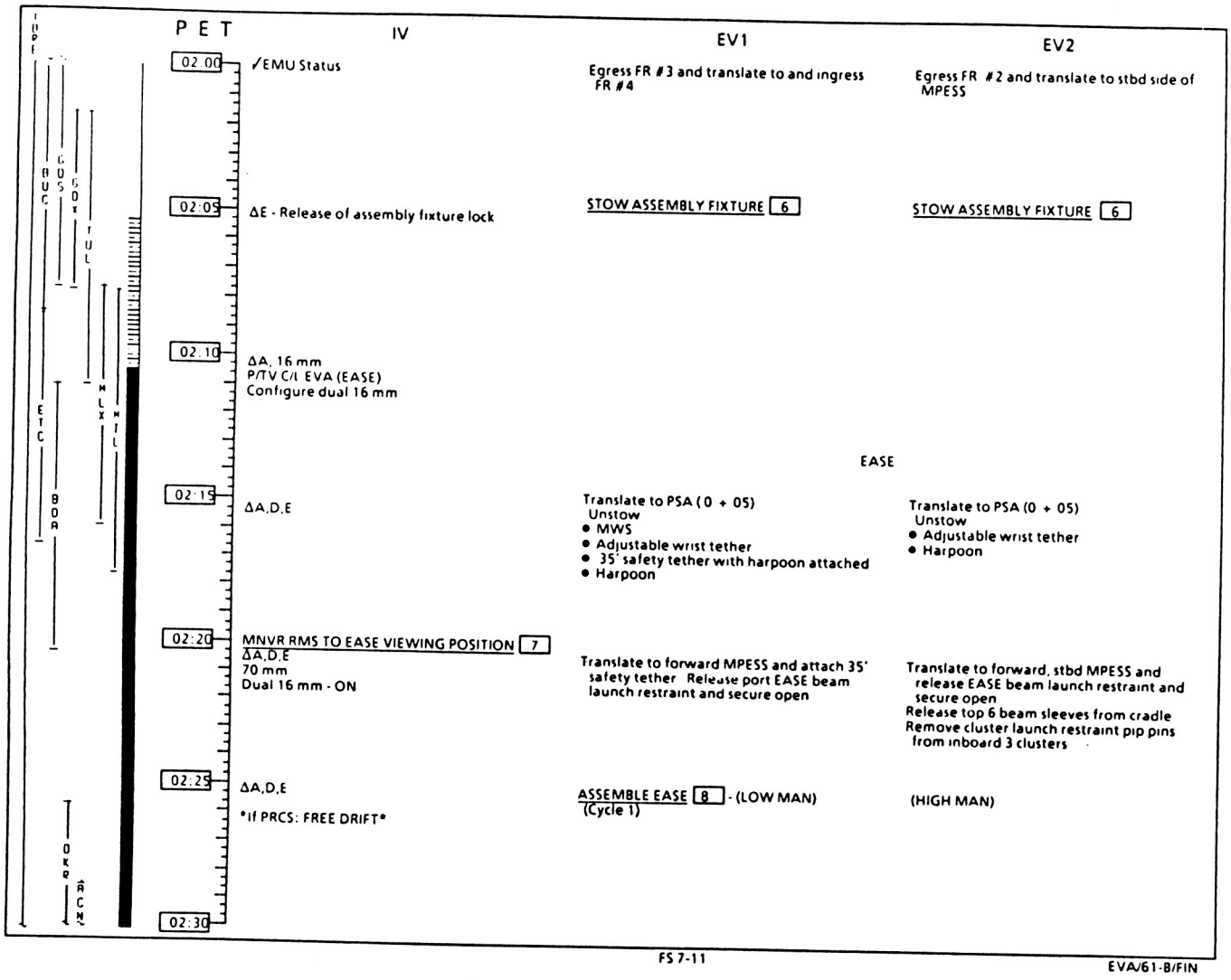
SINGLE DR to:

	SY	SP	EP	WP	WY	WR
1	+ 20	+ 8	-8	5	0	0
2		+ 15				
3			-15			
4	+ 20	+ 15	-15	5	0	0

BRAKES - ON (tb-ON)

ASSEMBLE EASE (0 + 15) [8]

IV	LOW MAN	HIGH MAN
ΔE - Pan to cluster top,stbd of MPESS	- Harpoon beam with 35' tether and position for cluster installation	
		- Harpoon cluster and attach to beam - Release cluster harpoon
	- Attach beam to aft, port position of base cluster and release harpoon	
	- Harpoon beam with 35' tether and position for cluster installation	
		- Harpoon cluster and attach to beam - Release cluster harpoon
	- Attach beam to aft, stbd position of base cluster and release harpoon	
	- Harpoon beam with 35' tether and pass free end to other crewman	- Translate up aft, stbd beam and receive end of beam
		- Attach beam to cluster
	- Translate up aft, port beam and attach beam to cluster	
	- Release harpoon	- Translate to aft, port cluster
	- Translate back to base	
	- Harpoon beam with 35' tether	
	- Harpoon cluster, attach to beam, release cluster harpoon	
	- Attach beam to fwd position of base cluster and release harpoon	
	- Harpoon beam with 35' tether and pass to high man	
	- Release harpoon	- Harpoon beam - Attach beam on aft, port cluster
	- Harpoon beam with 35' tether and pass free end to high man	- Translate to aft, stbd cluster and harpoon beam
	- Release harpoon	- Attach beam on aft, stbd cluster - Translate to fwd cluster and attach port, stbd beams



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EVA/61-B/FIN

CABLE RUN 12

BRAKES - OFF (tb OFF)
MODE - ORB LD, ENTER
Mnvr down to start position
+ Z (down) to Z = -805 and
- Y (right) to Y = -120

Adjust attitude to Pitch = 356
Yaw = 285
Roll = 265
with -Yaw (left) to 285
and coordinated
+ *Pitch (up) and -Roll (left)*
to P = 356 and R = 265
Mnvr + Z (down) and + Y (left) to start position

NOTE
Monitor W Y for Singularity at -75
(Alleviate with -Roll (left) crewman face down *if needed)*
Check clearance from sunshield

-836, -100, -427, 356, 285, 265

SY	SP	EP	WP	WY	WR
+ 23	+ 82	-135	-57	69	368

(or -8)

BRAKES - ON (tb-ON)

When loaded and ready to run cable,

BRAKES - OFF (tb OFF)

Mnvr -Z (up) stopping where required to attach cable

Above Z = -913, use + Roll (right) as required to remain clear of
EP singularity at -7 6

To return, reverse process, then

BRAKES - ON (tb-ON)

ACCESS TRUSS MANIPULATION 13

BRAKES - OFF (tb-OFF)
MODE - ORB LD, ENTER
Mnvr to ACCESS removal position:

-858, -93, -790, 0, 290, 0

SY	SP	EP	WP	WY	WR
-16	+ 121	-105	-43	-48	-186

(or + 174)

BRAKES - ON (tb-ON)

Remove ACCESS, then

BRAKES - OFF (tb-OFF)
MODE - ORB LD, ENTER
Mnvr -Z(up), -X(aft) and + Y(left) to:

-960, -93, -848, 0, 270, 0

SY	SP	EP	WP	WY	WR
-11	+ 86	-63	84	-68	-219

(or + 141)

BRAKES - ON (tb-ON)

To replace ACCESS, reverse process

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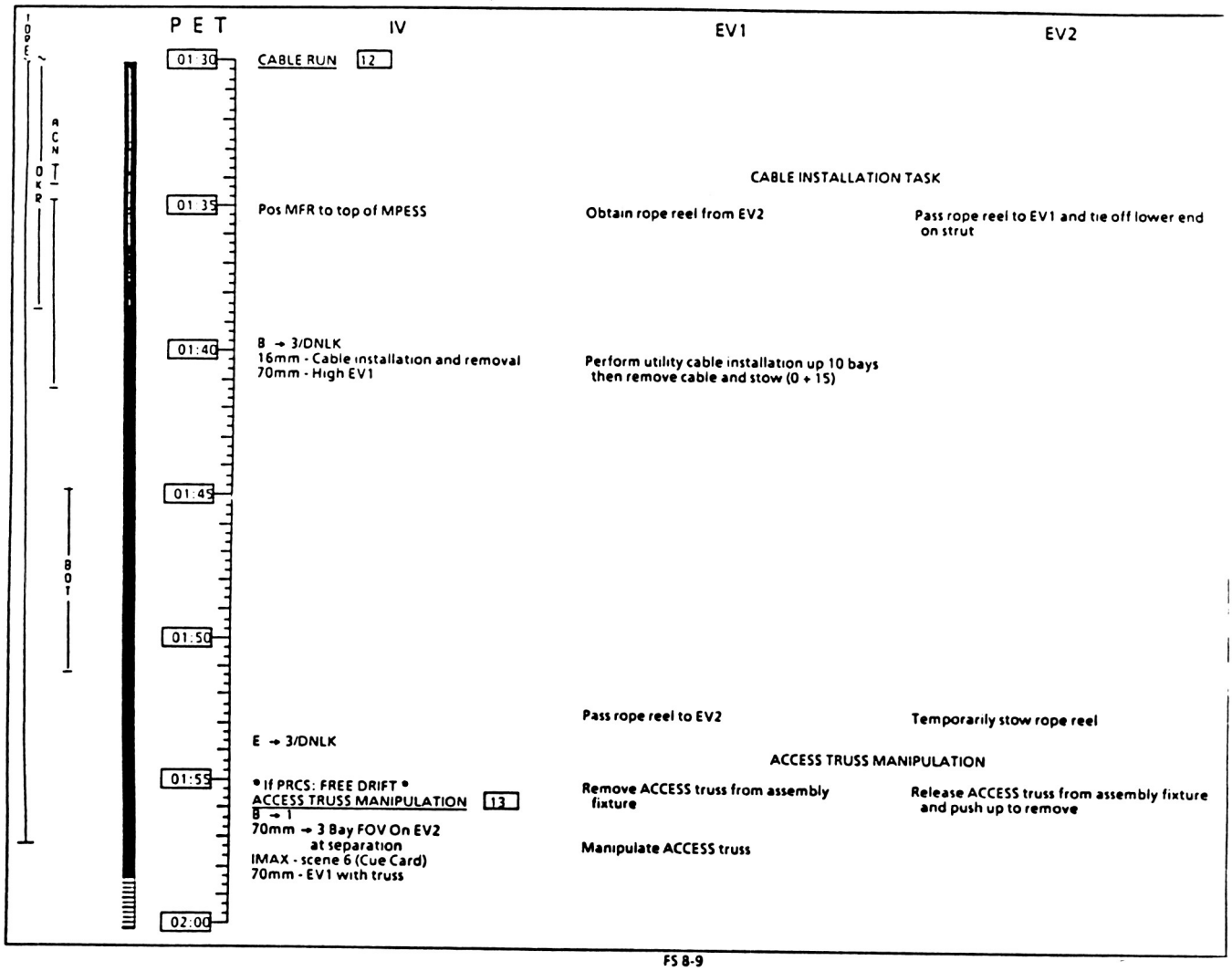
P E T
IV
EV1
EV2
01:30
CABLE RUN 12
CABLE INSTALLATION TASK
01:35
Pos MFR to top of MPESS
Obtain rope reel from EV2
Pass rope reel to EV1 and tie off lower end on strut
01:40
B → 3/DNLK
16mm - Cable installation and removal
70mm - High EV1
Perform utility cable installation up 10 bays then remove cable and stow (0 + 15)
01:45
01:50
Pass rope reel to EV2
Temporarily stow rope reel
E → 3/DNLK
ACCESS TRUSS MANIPULATION
01:55
• If PRCS: FREE DRIFT •
ACCESS TRUSS MANIPULATION 13
B → 1
70mm → 3 Bay FOV On EV2 at separation
IMAX - scene 6 (Cue Card)
70mm - EV1 with truss
Remove ACCESS truss from assembly fixture
Release ACCESS truss from assembly fixture and push up to remove
Manipulate ACCESS truss
02:00

FS 8-9

B. Other FDF products

- Payload Deployment and Retrieval System (PDRS) Checklist containing the detailed RMS procedures - developed at the Shuttle Engineering Simulator (SES) and MDF

- PHOTO/TV Checklist - initial requirements submitted after the training at MSFC but continually revised due to the ongoing MDF training

JSC-16987

Flight Data File
PDRS Operations Checklist

STS 61-B
Flight Supplement

Mission Operations Directorate
Systems Division

Final, Revision A
November 21, 1985

Flight Data File
Photo/TV Checklist
STS 61-B

Mission Operations Directorate
Operations Division

FINAL
November 15, 1985

NASA
National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

C. Flight Rules

- Effort made to think through all contingencies and plan for them
- Effort to document all agreements
  - PRELIMINARY FLIGHT RULES, published 10/1/85
  - FINAL FLIGHT RULES, published 10/30/85

SECTION A8 - EXPERIMENTAL ASSEMBLY OF STRUCTURES IN EVA/ASSEMBLY CONCEPT FOR CONSTRUCTION OF ERECTABLE SPACE STRUCTURES (EASE/ACCESS)

CONTENTS

IV. Use of the Remote Manipulator System (RMS) and the Manipulator Foot Restraint (MFR)

A. Concern about various failure modes of RMS

- Some failure modes cause the arm to move without command or move in the wrong direction

  - Could overload the structures
  - Could be avoided by procedure - the EVA crewman did not touch the structure until the operator had put the brakes on
  - This procedure also reduced the time when the system was susceptible to failure, ie. only when the MFR was being moved could a failure occur

- Using these procedures the loads were minimized to the brake-slip torque valves

B. Concern about training fidelity for the RMS

- The MSFC NBT arm had limited travel in some joints and too much travel in others
  - Caused procedures to be redeveloped at JSC on high fidelity simulators
  - Ultimately caused some delay in flight procedures

C - 3