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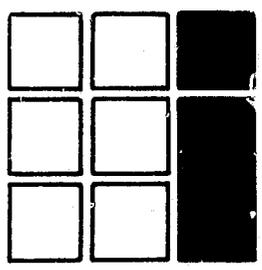
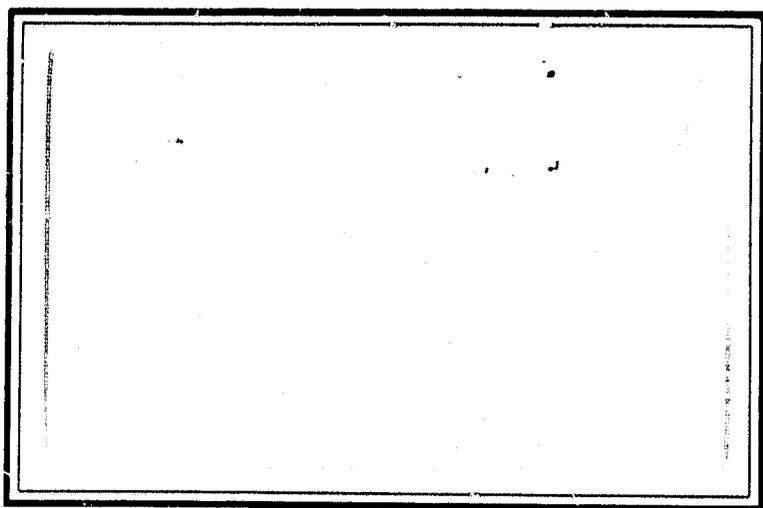
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(NASA-CR-170980) SEPAC: SPACELAB MISSION 1
REPORT (Intermetrics, Inc.) 41 p
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INTERMETRICS

INTERMETRICS, INC.

**SEPAC
SPACELAB MISSION 1
REPORT**

IR-AL-017

23 DECEMBER 1983

**Prepared For: National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, Alabama 35812**

**Prepared By: Intermetrics, Inc.
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Huntsville, Alabama 35801**

Preface

This document contains the SEPAC Spacelab Mission 1 report.

The document was prepared for the Information and Electronics Laboratory of the Marshall Space Flight Center under NASA Contract NAS8-34747. The report is based on the minutes maintained by J. R. Bounds and W. M. Womack of Intermetrics and J. R. Watkins of NASA/MSFC/EB42.

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NOTE

This report would be remiss without highlighting the excellent coordination of the SEPAC, POCC, and HOSC teams in trying to resolve the RAU 21 problem. The team members worked very hard and with tremendous cooperation. Particular thanks goes to the following:

Gene Canerossi (IBM)
Jim Christy (MSFC)
Kathy Hellman (MSFC)
Milt Herron (MSFC)
Geroge Lide (TRW)
Tom Lynch (MSFC)
Randy McClendon (MSFC)
Mac McCrory (IBM)
Bill Roberts (MSFC)
Sid Sexton (IBM)
Bob Stevens (MSFC)
Jimmy Watkins (MSFC)

SEPAC REPORT

1.0 General Overview

2.0 FO Summary

3.0 FO Details

4.0 Major Events

5.0 Software Lessons Learned

6.0 General Lessons Learned

7.0 Recommendations

1.0 GENERAL OVERVIEW

This document contains a detailed report of the SEPAC Spacelab Mission 1 activities relevant to software operations. Included also in this report are Spacelab events and problems that did not directly affect SEPAC but are of interest to experimenters.

Spacelab Mission 1 was launched from KSC on 28 November 1983 at 10:10 Huntsville time. .

The SEPAC POCC operations support was divided into two teams (Figure 1-1): the Rose team headed by William Taylor of TRW and the Cherry Blossom team headed by Roger Williamson of Stanford University. Each team worked a twelve hour shift - Rose shift was 4:00 AM until 4:00 PM; Cherry Blossom shift was 4:00 PM until 4:00 AM. Generally, there was a 30 minute overlap on team handovers.

A log was maintained by each position on the POCC teams. The contents of this report are mainly taken from the Software Engineering Manager (SEM) log.

In general, the Spacelab Mission met its objectives. As described later, there were two major problems associated with SEPAC: the loss of the EBA gun and the infamous RAU 21.

Figure 1-2 depicts the initial assessment of Dr. T. Obayashi of the SEPAC Spacelab Mission 1.

Based on preliminary analysis of SEPAC data, there are no problems that are directly attributable to SEPAC Flight Software.

Problems that should be analyzed are:

- SEPAC Gap problem,
- DEP READY NO problem, and
- System Stop problem.

These problems are characteristic of overall system problems and must be evaluated in coordination with the hardware people. Each of these has occurred in the laboratory but was never resolved. The area of concern is the interface between the IU and the NSSC-II. Prior to the reflight of SEPAC, the IU/DEP interface should be clean.

NUMBER	TITLE	FUNCTION	SL-1 SEPAC POCC OPERATIONS POSITIONS	14-SEP-83
1	PRINCIPAL INVESTIGATOR (PI)	ATTEND IMG/SOPS MEETINGS, WORK SIG PROBLEMS OFFLINE, MONITOR PLAN AND REPLAN TEAM MEMBER	CHERRY FLOSSOM TEAM TATSUZO OBAYASHI/ISAS	TATSUZO OBAYASHI/ISAS
2	PI REP #1 (PIR 1)	ATTEND IMG/SOPS MEETINGS, WORK SIG PROBLEMS OFFLINE, MONITOR LOOPS, PLAN AND REPLAN TEAM MEMBER	MOSUKI KAWASHIMA/ISAS	KYUICHI KOPKIN/ISAS
3	PI REP #2 (PIR 2)	ATTEND IMG/SOPS MEETINGS, WORK SIG PROBLEMS OFFLINE, MONITOR LOOPS, PLAN AND REPLAN TEAM LEADER	DAVID L. REASNER/MSFC	WILLIAM T. ROBERTS/MSFC JAMES L. BURCH/SWRI
4	POCC OPERATIONS MANAGER (PM)	MANAGE POCC OPERATIONS, MONITOR LOOPS, PRIMARY LOOP COMMUNICATOR	WILLIAM W. L. TAYLOR/TRW P.	ROGER WILLIAMSON/SU
5	ASSOCIATE PM (APM)	HELP MANAGE POCC OPERATIONS, OPERATE AND MONITOR POCC TERMINAL, MONITOR LOOPS, COMMAND, KEEP CONSOLE LOG	SUSUO SASAKI/ISAS	Y. YAMAGISHI/ISAS
6	POCC OPERATIONS ENGINEER (PE)	OPERATE AND MONITOR POCC TERMINAL, MONITOR SOFTWARE OPERATIONS, COMMAND	MILTON L. GIBSON/SWRI	JOHN W. BLACK/SWRI
7	CO-INVESTIGATORS (CO-IS)	ANALYZED REAL AND NEAR REAL TIME DATA, PLAN AND REPLAN TEAM MEMBER	DAVID W. BRACK/SU G. RICHARD CHADWELL/MSFC	JAMES L. BURCH/SWRI
8	SOCA OPERATOR (SOA)	OPERATE SOCA SYSTEM	REBECCA L. WATKINS/MSFC	REBECCA L. WATKINS/MSFC
9	SOFTWARE ENGINEERING MANAGER (SEM)	SCAIPR SOFTWARE OPERATIONS	WILLIAM W. POWELL INT. J.	BRUCE J. WATKINS/MSFC
10	HARDWARE ENGINEERING MANAGER (HEM)	MONITOR HARDWARE OPERATIONS	ILLIE J. BAKER/MSFC	YASUO NEGATOMO/ISAS
11	OPERATION ANALYST (OA)	ANALYZE OPERATION MONITOR DATA	YOSHIMASU TAKAHASHI/MSFC	YUKIYUKI YAMAGUCHI/MSFC
12	IU/DEP MONITOR	MONITOR INTERFACE UNIT	WILLIAM L. GIBSON/SWRI	RON K. BLACK/SWRI
13	ISA MONITOR	MONITOR ISA	YASUHI YOSHIZUMI/MSFC	RYOYUKI YAMAMOTO/MSFC
14	MONITOR MONITOR	MONITOR MDD/MCD	TAKASHI YOSHIDA/MSFC	KENJI IJICHI/MSFC
15	MIV MONITOR	MONITOR MIV	SHINJI FUJIMURA/MSFC	TERUJISA MORI/MSFC
16	PER MONITOR	MONITOR POWER SYSTEM	HIYOTEI YATSUBUCHI/MSFC	HIYOTEI YATSUBUCHI/MSFC
17	DDP MONITOR	MONITOR DDP	SHINJI FUJIMURA/MSFC	TERUJISA MORI/MSFC
18	LOGISTICS MANAGER (LM)	LOGISTICS	KEIKEN NINGIYA/ISAS	KIYOSHI MURATA/MSFC
19	DOCUMENTATION MANAGER (DM)	DOCUMENTATION	MATSUYOSHI YAMAMOTO/MSFC	SHINJI NISHIMURA/MSFC
20	ALL AROUND GUY (AAG)	ASSIST WHEN NEEDED	JAMES R. WATKINS/MSFC	JAMES R. WATKINS/MSFC

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FIGURE 1-1: SL-1 SEPAC POCC OPERATIONS POSITIONS

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Dec. 7, 1983

SEPAC / SPACELAB-1

T. OBAYASHI

SEPAC Science and Engineering Success Rates

1. Technical Rate (Hardware + Software)

- Spacelab Flight successful. +20%
- Battery charging +10
- CFD (EBA, MPD, NGP, MIV, DGP +20
IU, DEP, CP)
- MPD Firing Test MPD/NGP +10
- EBA Firing Test level I +20
- EBA Firing Test level II 0 ... EBA Failure -15%~20%
- CFR. (5)

80~85%
Acomplishment !!

2. Science Results

- 1) Vehicle Charge Neutralization by MPD Arcjet
- 2) Beam Plasma Discharge Phenomenon
- 3) Spreading of MPD Ar. Plasma Cloud
- 4) Interaction of N₂ Gas Plume with Electron Beam
- 5) Wave Emissions and Return Electron Spectra (High Energy)

Not Successful.

Artificial Aurora Generation

Neutralization by Neutral Gas Plume (partial)

A show was not successful!

FIGURE 1-2: INITIAL ASSESSMENT OF DR. T. OBAYASHI

2.0 FO SUMMARY

The SEPAC FO summary for Spacelab Mission 1 was:

2	DEP READY NO TYPE PROBLEMS
2	SYSTEM STOP
3	SHUTDOWNS FROM INSTRUMENTS
12	RAU 21 PROBLEMS (NOT RUN)
<u>21</u>	<u>FO's</u>
40	Total FO's ,

Figure 2-1 is a tabular summary of the FO's that were run. Section 3.0 contains details on these FO's.

Figure 2-2 is the initial FO crew timeline.

Figures 2-3 and 2-4 are graphic presentations of the initial and extended day mission for SEPAC operations.

	FO	M#	T=0	TYPE	NOTE
(1)	CF0	1	1/14:01:00	PASSIVE	FO RAN
(2)	F03	3	2/04:47:00	MPD+NGP	FO RAN
(3)	F013A/13A	27/17	2/07:30:00	PASS	FO RAN
			2/07:47:00		
(4)	F02	2	2/12:15:00	EBA	FO RAN
(5)	F05A/B/6	5/6/7	2/13:38:00	EBA/EBA/EBA	DEP READY NO PROB
			2/13:55:00		
			2/14:13:00		
(6)	F07/7	8/8	2/15:06:00	EBA+MPD	FO RAN
			2/15:24:00		
(7)	F08C	9	2/18:25:00	MPD	FO RAN
(8)	F04	4	3/03:13:00	EBA+NGP+MPD*	EBA STD
(9)	F06/5B	7/6	3/06:23:00	EBA/EBA*	RAN
			3/06:40:00		
(10)	F09A/B	10/11	3/07:30:00	EBA+NGP/*	RAN
			3/07:50:00	EBA+MPD*	MPD STD
(11)	F08A	9	3/09:00:00	MPD	RAN
(12)	F05A	5	3/23:26:00	EBA	RAU 21 FAIL
(13)	F014				CANCEL
(14)	FO 7/6	8/7	4/03:06:00		CANCEL
			4/03:14:00		
(15)	F08B	9	4/04:26:00		CANCEL
(16)	F06	7	4/06:10:00		CANCEL
(17)	F05A+13A	5/17	4/10:27:00		RAU SERIAL TEST
			4/10:34:00		FAIL
(18)	F09C		4/23:15:00		CANCEL
(19)	F010/12		4/23:45:00		CANCEL
			5/00:04:00		CANCEL
(20)	F07	8	5/07:35:00	EBA+MPD	FO RAN 3HVC'S ->
					EBA STD - ALL STD
(21)	F08	9	5/16:23:00	MPD	SCHEDULING PROBLEM
					FO RAN
(22)	F09A	11	5/23:38:00	EBA+MPD*	FO RAN
(23)	F09B	11	6/02:48:00	EBA+MPD*	FO RAN , RAU SKIPPED
(24)	F09A	10	6/07:12:00	EBA+NGP*	FO RAN
(25)	F011	14	6/08:43:00	EBA+MPD*	FO RAN
(26)	F013A	17	6/09:19:00	PASSIVE	FO RAN
			6/09:36:00		
(27)	F06	7	6/10:11:00	NGP	FO RAN, BEAM NOT ON MTV
(28)	F013A	17	6/11:35:00	PASSIVE	FO RAN, NO RT MTV
(29)	F01	1	7/15:35:00	HOT TEST CHECK	CANCELED - RAU 21 PROBLEMS
(30)	F013A	17	7/16:15:00	PASS	CANCELED OCR
(31)	13A	17	8/02:15:00	PASS	CANCELED RAU 21
(32)	F013A/13A	17	8/07:37:00	PASSIVE	NOT RUN
			8/09:54:00		
(33)	F013A	17	8/09:50:00	PASSIVE	FO RAN
(34)	F08A	9	8/10:22:00	EBA+MPD*	FO RAN
(35)	F08A	9	8/10:52:00	EBA+MPD*	T + 7 SECONDS DEP READY NO
(36)	F08A	9	8/11:22:00	EBA+MPD*	FO RAN
(37)	F08A	9	8/11:37:00	EBA+MPD*	FO RAN
(38)	F013A	17	8/13:50:00	PASSIVE	FO RAN
(39)	F013A	17	8/16:20:00	PASSIVE	HUNG
(40)	FO 1	1	8/18:40:00	PASSIVE	HUNG

*No EBA firings

FIGURE 2-1: TABULAR SUMMARY OF FO'S

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OF POOR QUALITY

T=0 (NET)	T=0 (GMT)	MODEL NAME	M #	STL	EMTL	ENERGY
0/18:43:00	333/10:43:00	BATT CHG ON				2850
1/13:45:00	334/05:45:00	BATT CHG OFF				
1/14:01:00	334/06:01:00	N2C/QF01	1	S02A00	S02E00	0079
2/04:47:00	334/20:47:00	N2MFD3*	3	S02A02	S02E05	0161
2/04:59:00	334/20:59:00	BATT CHG ON				0930
2/11:12:00	335/03:12:00	BATT CHG OFF				
2/07:30:00	334/23:30:00	N2F013A RUN1	17	S02K00	S02E06	0122
2/07:47:00	334/23:47:00	N2F013A RUN1	17	S02K00	S02E06	0122
2/12:15:00	335/04:15:00	N2EB1F02	2	S02A01	S02E01	0662
2/13:38:00	335/05:38:00	N2F50B/6	5	S02C04	S02E01	0179
2/13:55:00	335/05:55:00	N2F50B/6	7	S02C04	S02E01	0179
2/14:13:00	335/06:13:00	N2F50B/6	6	S02C04	S02E01	0179
2/15:06:00	335/07:06:00	N2F07/7	8	S02B05	S02E00	0194
2/15:24:00	335/07:24:00	N2F07/7	8	S02B05	S02E00	0194
2/18:25:00	335/10:25:00	N2F8C	9	S02C02	S02E05	0145
2/18:34:00	335/10:34:00	BATT CHG ON				1260
3/02:52:00	335/18:52:00	BATT CHG OFF				
3/03:13:00	335/19:13:00	N2EB2F04	4	S02A03	S02E00	0328
3/03:33:00	335/19:33:00	BATT CHG ON				0375
3/06:03:00	335/22:03:00	BATT CHG OFF				
3/06:23:00	335/22:23:00	N2F06/5B	7	S02B03	S02E01	0179
3/06:40:00	335/22:40:00	N2F06/5B	6	S02B03	S02E01	0179
3/07:30:00	335/23:30:00	N2F9AB/M	10	S02D05	S02E01	0181
3/07:50:00	335/23:50:00	N2F9AB/M	11	S02D05	S02E01	0192
3/09:00:00	336/01:00:00	N2F8A	9	S02C00	S02E05	0145
3/12:00:00	336/04:00:00	BATT CHG ON				1080
3/19:10:00	336/11:10:00	BATT CHG OFF				
3/23:26:00	336/15:26:00	N2SUNF5A	5	S02B02	S02E01	0179
3/23:34:00	336/15:34:00	N2SUNF5A	5M0	S02B02	S02E01	0179
3/23:56:00	336/15:56:00	N2F014	18	S02K04	S02E06	0122
4/03:06:00	336/19:06:00	N2F09A/B	10	S02D04	S02E01	0181
4/03:14:00	336/19:14:00	N2F09A/B	11	S02D04	S02E01	0192
4/04:26:00	336/20:26:00	N2F8B	9	S02C01	S02E05	0145
4/06:10:00	336/22:10:00	N2F09C	12	S02F00	S02E01	0184
4/10:17:00	337/02:17:00	N2F013A	17	S02K01	S02E06	0122
4/10:34:00	337/02:34:00	N2F013A	17	S02K01	S02E06	0122

FIGURE 2-2: FO CREW TIMELINE

4/22:30:00	337/04:30:00	BATT CHG ON					15
4/22:45:00	337/14:45:00	BATT CHG OFF					
4/23:15:00	337/15:15:00	N2SUNF9C	12	S02F02	S02E01	01	
4/23:23:00	337/15:33:00	N2SUNF9C	SHD	S02F02	S02E01	01	
4/23:45:00	337/15:45:00	N2F10/12	13	S02G00	S02E00	01	
5/00:04:00	337/16:00:00	N2F10/12	15	S02G00	S02E00	01	
5/01:24:00	337/17:24:00	N2F09B	11	S02D01	S02E00	01	
5/02:58:00	337/18:58:00	N2F05A	25	S02B00	S02E01	01	
5/03:18:00	337/19:18:00	BATT CHG ON					20
5/15:59:00	338/08:59:00	BATT CHG OFF					
5/16:23:00	338/08:23:00	N2F09C	12	S02F01	S02E01	01E	
5/16:32:00	338/08:32:00	BATT CHG ON					123
6/00:48:00	338/16:48:00	BATT CHG OFF					
6/02:48:00	338/18:48:00	N2F09A	10	S02D00	S02E01	01B	
6/07:14:00	338/23:14:00	N2F011	14	S02G01	S02E00	019	
6/08:43:00	339/00:43:00	N2F011	14	S02G03	S02E00	019	
6/09:12:00	339/01:12:00	BATT CHG ON					132
6/18:00:00	339/10:00:00	BATT CHG OFF					
6/09:19:00	339/01:19:00	N2F013A	17	S02K02	S02E06	012	
6/09:36:00	339/01:36:00	N2F013A	17	S02K02	S02E06	012	
7/11:41:00	340/03:41:00	BATT CHG ON					166
7/22:58:00	340/14:58:00	BATT CHG OFF					
8/07:37:00	340/23:37:00	N2F013A	17	S02K03	S02E06	012	
8/07:54:00	340/23:54:00	N2F013A	17	S02K03	S02E06	012	
8/08:13:00	341/00:13:00	N2CFRF15		CONF. FOR RETURN			
9/00:00:00		LANDING					

DUMMY TIMELINES S02K04, S02K05, S02K06, S02K07, S02K08

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FIGURE 2-2: FO CREW TIMELINE
(CONTINUED)

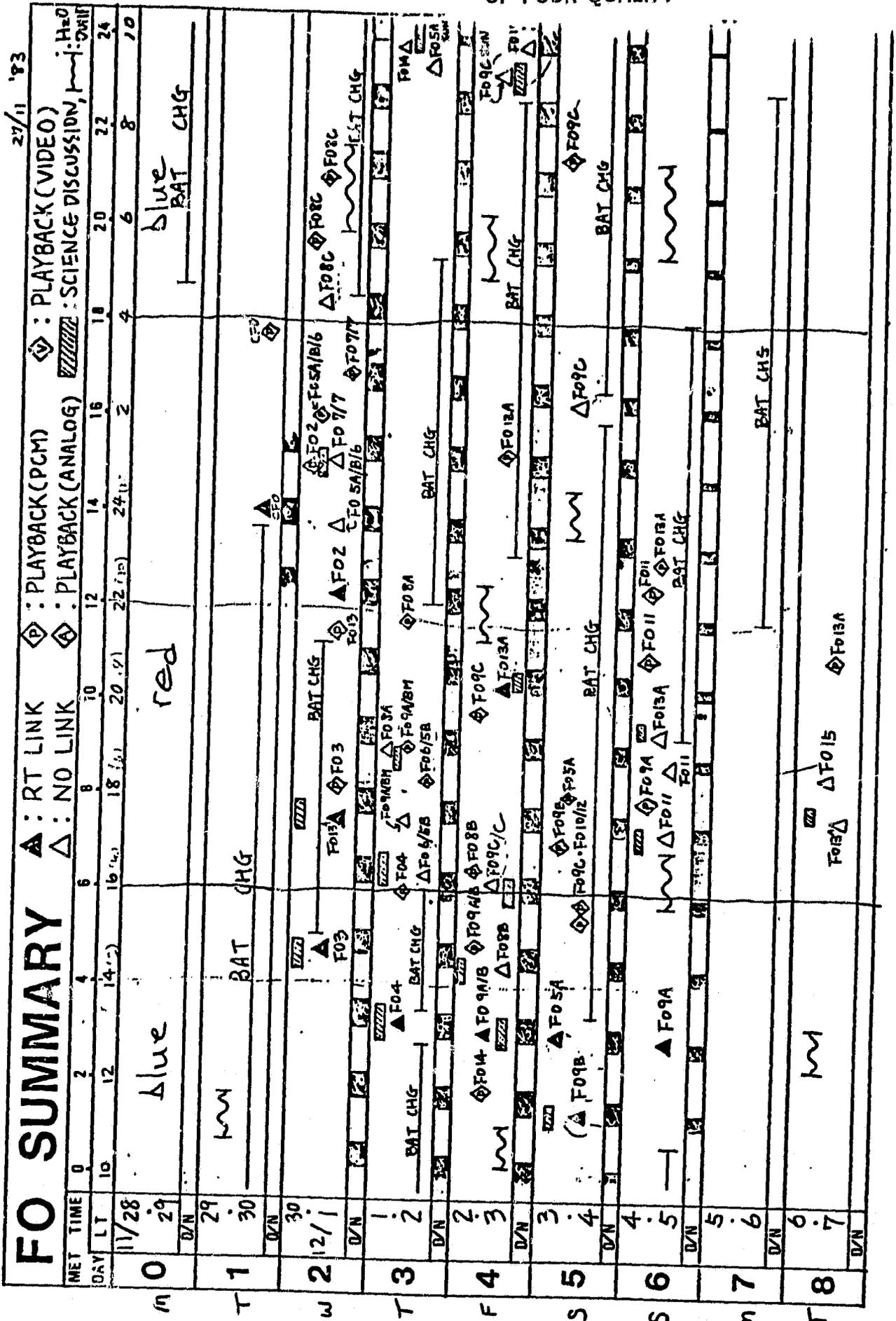


FIGURE 2-3: GRAPHIC PRESENTATION OF INITIAL SEPAC MISSION

3.0 FO DETAILS

The following details are provided for each FO.

As part of the description, the statement "the FO timeline was normal" is used to mean that the FO sequence (FO PREP, SMO, FO, FO OFF) operated in the expected timeframe. This does not imply that the SEPAC instruments worked properly.

Similarly, when the crew reported that an FO ran, that is only an indication that the FO timeline sequence was proper.

Confirmation that the EBA, MPD, or NGP fired successfully must be based on analysis of HRM data by the Japanese with support from observations made by MTV.

(1) FO #1 (SEPAC System Checkout)

On first attempt to run CFO there were two error messages: "DEP 12 - ECAS CANNOT SEND MESSAGE TO DEP" and "DEP 17 - ECAS UNABLE TO QUEUE MESSAGE FROM DEP".

Parker re OP'ed the DEP then reran FO 1 timeline.

A software gap of 10 - 15 seconds was noted on HRM around FO OFF SEQ + 25 seconds.

(2) FO #3 (MPD Test)

The FO #3 timeline was normal.

First NGP gas release may not have been good. Dr. Kuriki thinks cold soak may have caused NGP valve to stick. After warmup, NGP worked correctly. The same problem was seen in Japan.

(3) FO 13A/13A (Passive Experiment)

Owen enabled battery chargers for FO.

1st FO 13A	OFF SEQ Comp	334/23:45:02
2nd FO 13A	OFF SEQ Comp	Not seen by crew

Crew waited about 7 minutes after OFF SEQ Comp message should have been seen and turned IU/DEP off. This problem has been seen on ground before. FO 13A was run with PCF#69=1. Change of PCF#69=0 was not voiced to crew in time for implementation.

Owen enabled MTV around T + 5 minutes (1st FO 13A). During 2nd FO 13A, Owen put MTV in manual to look at joint beam firings. MTV was returned to auto prior to OFF SEQ START.

Two gaps were noted during 2nd FO 13A.

(4) FO #2 (EBA Low Power Test)

FO #2 timeline was normal.

Parker made PCF#69=0 entry then started FO PREP with proceed approximately 7 minutes early.

A gap was noted during node #2.

In general, the crew and ground could not see a well defined beam; however, one firing produced a faint pencil beam while the other firings were diffuse.

**(5) FO 5A/5B/6 (Electron Beam Experiment 1 - Long Pulse)
 (Electron Beam Experiment 1 - Short Pulse)
 (Electron Beam Experiment 2 - NGP)**

This multiple FO sequence was performed LOS. FO PREP for FO 5A was scheduled and performed. Around T=0, the DEP READY NO message occurred.

During FO PREP, Parker saw incorrect data (?), noticed chargers in INH, and turned chargers to ENA.

The DEP READY NO condition can arise when the IU and NSSC-II lose communication. Firmware in the IU sends the DEP READY NO when communication has been lost for 15 seconds. It has not been determined whether this condition did arise.

On playback of this data, there was also HRM data dropout raising the possibility there may have been a momentary transient in the Spacelab system.

Japanese data shows FO began to go abnormal at approximately 3 minutes into operation. At T=2 minutes, EBA firing pulse was not regular and the beam voltage increased abnormally.

(6) FO 7/7 (Electron Beam Experiment 3-MPD)

Because of confusion and uncertainty with prior FO, FO 7 was started early to allow ground to monitor HRM. Ground acquisition was lost prior to FO PREP START. Data looked good up to there.

Parker reported that multiple FO 7 ran correctly. Crew left MTV in manual; therefore, there was no MTV for FO 7.

Japanese reported that EBA and heater worked normally.

(7) FO 8C (Plasma Beam Propagation - Rotation)

FO 8C was run in LOS.

Crew reported FO 8C ran correctly.

(8) FO 4 (EBA High Power Test)

FO 4 had EBA shutdown just after T=0. Three HVC resets were seen within one minute causing the DEP to perform the EBA shutdown.

ECAS program continued to send HVC resets until manually removed by ground request.

Owen reported seeing EBA (heater) glowing during FO PREP.

Japanese reported the following:

- When data available, there was heater overload condition
- At T - 3.5 minutes, HVC reset pulse (delayed by ECAS until T=0?)

- At T + 12 seconds HVC reset pulse
- At T + 25 seconds HVC reset pulse
- At T + 1 minute EBA shutdown
- After EBA shutdown still detected, heater overload until end of FO

**(9) FO 6/5B (Electron Beam Experiment 2-NGP)
(Electron Beam Experiment 1 - Short Pulse)**

Performed voice link to crew to set PCF#34=7.0 (heater current) for this FO.

Owen thinks FO ran correctly; however, he did not see any beam firing.

Japanese reported no heater current, no overload, and no heater outputs.

**(10) FO 9A/9B (Artificial Aurora - EBA/NGP)
(Artificial Aurora - EBA/MPD)**

Performed voice link to crew to set PCF#32=0.6 (beam voltage factor) and PCF#34=12.0 (heater Current). Also set for the FO was PCF#45=1 via crew procedures.

FO PREP was started early by PROCEED.

Owen attempted to run SMO; however, since he was not in contingency mode SMO's did not work.

FO 9A timeline was normal.

Owen reported that he did not see any EBA firing. During FO 9B an MPD shutdown command was sent by ECAS and performed by DEP.

An ALL STD was issued by crew.

Japanese reported:

- High voltage system ok
- Some Current detected in heater circuit
- Wave produced

(11) FO 8A (Plasma Beam Propagation //B)

FO 8A timeline was normal.

Owen reported seeing MPD firing at window and on MTV.

(12) FO 5A (Electron Beam Experiment 1 - Long Pulse)

FO 5A did not run because of RAU 21 failure. IU/DEP was turned on, but the DEP READY YES indicator never appeared.

(13) FO 14 (Support 1 ES020)

FO 14 canceled because of RAU 21.

**(14) FO 7/6 (Electron Beam Experiment 3 - MPD)
(Electron Beam Experiment 2 -NGP)**

FO 7/6 canceled because of RAU 21.

(15) FO 8B (Plasma Beam Experiment 2 B)

FO 8B canceled because of RAU 21.

MTV was operated manually to observe ES020.

Owen saw no indication of ES020 firing.

(16) FO 6 (Electron Beam Experiment 1 - Short Pulse)

FO 6 canceled because of RAU 21.

**(17) FO 5A + FO 13A (Electron Beam Experiment 1 - Long Pulse)
(Passive Experiment)**

The following sequence was attempted twice:

- IU/DEP ON
- CK SUM OK

- 10 Second countdown
- Received GMT & GNC
- No DEP READY YES message

HOSC reported IU sending INITIALIZE LINKS, some received but others caused Manchester code errors on RAU - FAU 21 problem.

(18) FO 9C (Artificial Aurora - EBA)

FO 9C canceled because of RAU 21.

**(19) FO 10/12 (Equatorial Aeronomy)
(E//B - EBA/MPD)**

FO 10/12 canceled because of RAU 21.

(20) FO 7 (Electron Beam Experiment 3-MPD)

During FO PREP, the heater current was alternately set to 0.0A and 16.0A in an attempt to shock EBA heater.

At TO + 1:40, there was an EBA shutdown because of 3 HVC resets in 1 minute.

Crew performed a HOLD then ALL STD.

In FO setup all O2A INH's were to have been set; however, ground forgot to include HVC INH.

From this point on in the mission, the crew was instructed to set HVC and EBA inhibits on page 02A.

No EBA firings were noted by the crew nor were they confirmed on HRM data. The EBA was not working.

(21) FO 8 (Plasma Beam Propagation - //B)

Parker may have gotten FO 8 counting with incorrect (old) time.

According to SL printouts, Parker stopped first FO (don't know how) then reran FO.

FO timeline ran normally.

(22) FO 9A (Artificial Aurora - EBA/NGP)

FO 9A timeline ran normally.

(23) FO 9B (Artificial Aurora - EBA/MPD)

FO 9B timeline ran normally.

There were RAU skip error messages during FO. No adverse affect noted.

(24) FO 9A (Artificial Aurora - EBA/NGP)

FO 9A timeline ran normally.

(25) FO 11 (Electron Echo - EBA/MPD)

FO 11 timeline ran normally.

(26) FO 13A/13A (Passive Experiment)

Both FO 13A's timeline ran normally.

Crew thought that recorders were to be started automatically (ground command) and they were not. The crew turned on recorders manually. Only the last 5 minutes of data were recorded.

(27) FO 6 (Electron Beam Experiment 2-NGP)

FO 6 timeline ran normally.

PCF #01 was not entered in time by crew.

(28) FO 13A (Passive Experiment)

FO 13A timeline ran normally.

Because wrong HRM format (#11) was loaded, unable to get HRM data.

The TV was turned on 8 minutes late by ground.

(29) FO 1 (SEPAC System Checkout)

FO 1 canceled because of RAU 21 problems.

(30) FO 13A (Passive Experiment)

FO 13A canceled because of RAU 21 problem.

(31) FO 13A (Passive Experiment)

FO 13A canceled because of RAU 21.

(32) FO 13A/13A (Passive Experiment)

FO 13A canceled because of RAU 21.

(33) FO 13A (Passive Experiment)

FO 13A timeline ran normally.

(34) FO 8A (Plasma Beam Propagation - //B)

PCF #61=5 and PCF #71=0 were entered by crew.

FO PREP was started early by PROCEED.

Owen reported FO 8 ran normally.

(35) FO 8A (Plasma Beam Propagation - //B)

FO 8A ran normally until T0 + 7 seconds, then the DEP counters quit. Eventually (1 minute), the DEP READY NO status occurred on DDU.

(36) FO 8A (Plasma Beam Propagation - //B)

FO 8A timeline ran normally.

PCF #71=1 was entered by crew.

MPD firing was confirmed by Japanese EGSE. A gap occurred around FO OFF SEQ + 1 Minute 50 Seconds.

(37) FO 8A (Plasma Beam Propagation - //B)

FO 8A timeline ran normally.

(38) FO 13A (Passive Experiment)

The objective of this operation was to run FO 13A for an extended time. The method was to issue a HOLD at T + 14 minutes then issue a RESTART. This was to continue for 1 hour.

Crew performed HOLD/RESTART only once.

FO 13A's timeline ran normally.

(39) FO 13A (Passive Experiment)

The objective of this operation was the same as the previous FO 13A's. Instead, Parker scheduled two FO's.

A system stop occurred after T=0. DEP quit receiving 1HZ interrupt but continued at approximately 1/7 speed. A RAU 21 communication problem was assumed to be the problem.

(40) FO 1 (SEPAC System Checkout)

A system stop occurred after T=0. A RAU 21 communication problem was assumed to be the problem.

4.0 MAJOR EVENTS

(1) MTV Stow

The first major event for SEPAC was the discovery that the MTV was not in stow position when the pallet TV was used to view the payloads. This was not a problem for SEPAC. The Japanese seem to think that the MTV was left in that position at level IV/III/II.

(2) EMSTL Change

Replanning Request 002-001 changed the Exception Monitor Subordinate Timelines S02E01, S02E02, and S02E05 to delete enable of SID's 3021, 3045, 3046, and 3048. This was a permanent change to MMU.

(3) RAU 21

The first RAU 21 skip error message was reported at MET = 0/9:16:30 or GMT = 333/01:10:12. The RAU 21 problem was a major problem for SEPAC. When RAU 21 was in a fail mode, SEPAC was unable to perform any of its FO's as SEPAC requires the serial channels for operation. Based on the data reviewed at the POCC, the RAU problems seemed to be thermal related and manifested with the following characteristics:

- (1) Discrete Outputs worked,
- (2) Flexible Inputs (SI's or DI's) failed,
- (3) Serial Output messages worked,
- (4) Serial Input 1 word messages worked,
- (5) Serial Input multiple word messages failed.

The serial channel failures were Manchester code errors in the I/O coupler. During the course of the mission, several patches were implemented to get around or heal the RAU 21 problems. These included:

- (1) Patch to inhibit RAU 21 100HZ data sampling to reduce I/O activity and, therefore, help keep RAU cool.
 - (2) Patch to ignore I/O skip errors to keep ECOS from NOP'ing the RAU.
- There were several techniques used to keep the RAU cool. When the coolant lines registered a temperature greater than or equal 22° C the RAU quit. Below that temperature, the RAU worked normally. (The RAU should withstand temperatures up to 40° C.)
 - Many times throughout the mission, RAU 21 was NOP'ed by the ground for several minutes then OP'ed. When NOP'ed, ECOS does not sample RAU 21 I/O.
 - One of the two Spacelab DDU's was powered off when not needed by the crew.

RAU 21 interfaces included EXP 001, EXP 002, EXP 005, EXP 008, Horizon Sensor, and MSFC's EPDB.

At approximately 0/13:50, the I/O coupler was switched to coupler B. There was no improvement on RAU 21.

A procedure was developed with the ECOS/ECAS people that would patch the DEP's MMU load file for the DEP to not send serial output. The SEPAC ECAS would also be patched to not send serial output nor expect serial input. This procedure was never implemented because:

- (1) Patching ECOS to allow the SEPAC DEP to perform an MMU load was considered dangerous.
- (2) The implementation procedures were complex and there was a low probability of success.
- (3) The RAU 21 problem was intermittent and when operational there was no need for these patches.

(4) ECOS Crash

At approximately 0/11:20 there was an ECOS crash believed to have been related to a memory patch. Only 2/3 of the memory dump EC was completed. SEPAC was not in operation at the time of the crash.

(5) Playback

During the mission, the ground was unable to maintain the Playback schedule. This caused SEPAC problems during the time EBA trouble shooting was being performed. Since the Playback data was late, the SEPAC team had to perform FO's without benefit of having data to review.

(6) RAU 21-IU/DEP Tests

Throughout the mission, the SEPAC IU/DEP was used as a test point for RAU 21. By turning IU/DEP on, we were able to determine the health of RAU 21 Serial and FI channels. Sometimes there was a comedy of errors in trying this technique.

- 1/6:45 Crew turned IU/DEP on.
Lost HRM data transmission to ground - POCC problem.
- 1/8:03 Crew turned IU/DEP on.
White Sands network failure - no HRM data.
(White Sands down 40 minutes.)
- 1/11:15 Crew turned IU/DEP on.
HRM received, DEP loaded, never received GMT Serial from EC.
- 1/13:10 Crew turned IU/DEP on.
POCC did not receive HRM.
- 6/6:12 IU/DEP ON - RAU worked.

(7) Initial Activation

On first attempt to power up SEPAC IU/DEP, there was no ground indication of IU/DEP on. Ground requested crew to check panel feed. Crew had not turned rack on.

(8) IU/DEP ON

On several occasions, the crew left IU/DEP on after completion of FO operations.

1/8:48 IU/DEP left on for 50 minutes.

6/14:00 IU/DEP left on for over 2 hours.

There may have been other occasions where IU/DEP left on. Without real-time downlink, we could not determine all such instances.

(9) GN&C Time

There was a problem during day one when the GN&C data contained a GMT that was off by one day. This was not a problem to SEPAC. For experiments that used this GMT data, there was concern. Experiments 13 and 20 were unable to operate correctly until this problem was fixed.

(10) AEPI Locks

AEPI (a SEPAC joint experiment) encountered a problem putting its TV in the stow position after operations. According to flight rules, three redundant methods for stowing were required. One method would not work at all, the second method had one failure in three attempts, and the third method worked correctly. Because of this, AEPI had to operate without bringing its TV out of locks.

(11) HDRR Failure

The HDRR failed around 3/16:58 and was out until 4/03:04. The crew performed surgery with ground instructions.

(12) EBA Failure

A major disappointment of this SEPAC mission was the failure of the EBA. According to preliminary data, the EBA worked for FO #2 and FO 7/7. Then when FO 8C was run, there was an EBA shutdown (3 HVC resets).

Loss of the EBA changed the whole nature of SEPAC experiments for the mission.

(13) MPD Cylinder Expulsion

During the mission, there was an MPD cylinder expulsion. This was clearly captured on MTV. The exact time was recorded on MTV. According to the Japanese, this was no problem and the MPD was used thereafter.

There should be some analysis on the potential problem of the projectile from the MPD.

(14) Spacelab Power Surges

There was an activity during the mission to determine what was perceived as power surges on the primary bus. This resulted in the Spacelab DDU dropping offline.

SEPAC was requested to review the NRT data to determine if there was a correlation between SEPAC events (e.g., MPD, EBA, or NGP firing) and the current fluctuations shown on EPBD data. SEPAC did confirm that there were some activities occurring around the times in question; however, the frequency (15 minutes) raised questions as to whether this was related to SEPAC or something else.

The issue was later determined to not be SEPAC but there was no detailed explanation as to what the problem was.

5.0 SOFTWARE LESSONS LEARNED

SEPAC software performed without any attributable problems. There were some gaps and four total stops. These have not been analyzed to determine the conditions and causes.

There were several areas noted during the mission operation where SEPAC software could be improved. These software areas are described below.

- (1) The active PCF values should be placed in Scratch Pad Memory for ground observation. On several occasions, the POCC team was not sure whether the crew implemented PCF values. There is no easy way to determine if all PCF changes were made; and on several FO's, the crew did not get all PCF's entered before the FO PREP start.
- (2) The Intel PCM display station should be modified to have the capability to display the static data in its buffers. As currently designed, the system requires PCM sync to activate the display functions.
- (3) Additional status parameters should be included in HRM:
 - (a) Indicator for FO PREP start method (Proceed or Time)
 - (b) Status of control panel switches
 - (c) Receipt of shutdown commands
- (4) Provide a capability (via PCF) for an FO to automatically recycle to T=0 when FO operation is complete. The FO would continue this sequence until an "ALL STD" is received. This type operation would be meaningful when a long diagnostic run is required. An alternate method would be to have the software perform a "HOLD-RESTART" at a given node for a PCF defined time.

(5) Implement an auto start FO scheme. A potential scheme is:

```
IU/DEP ON
  DO UNTIL TIME =
  IF FO SCHEDULE RECEIVED
    THEN PERFORM FO
    ELSE PERFORM DEFAULT FO
  ENDIF
ENDDO
```

The auto start FO would allow SEPAC to perform an FO whether the RAU is operational or not.

6.0 GENERAL LESSONS LEARNED

Contained in this section are lessons learned that do not necessarily relate to software.

User Room 7 Accomodations

Probably the most discussed item was the accomodations provided in User Room 7 for SEPAC and AEPI. Stated simply - the room was extremely overcrowded. The SEPAC area could accomodate 6 - 7 people on a reasonable basis. During FO scheduled times, as many as 21 people were in the SEPAC area with an average of 12 - 15. This caused several things to happen:

1. There were insufficient jacks for everyone to monitor the loops.
2. There was a continuous closelining or rabbit trapping with headset cords as people moved around.
3. The temperature in the room was very warm because of the number of people and the amount of GSE.

These conditions caused a general confusion among team members. It was hard to communicate, leading to misunderstanding on what was happening and to the relaying of incorrect information to the POCC. Generally, these situations were corrected, but there was some agitation from the POCC with SEPAC.

Handover's

Initially the handover from one shift to another was treated as a major production. As the mission progressed and team members became tired, the handovers were much less formal and were done on a team position basis (i.e., each offgoing team member communicated with his oncoming counterpart). There should have been only one log book with each team member submitting a copy of his log at handover. Keeping log activities by each team function is ok as long as they are eventually merged into one log book.

I strongly recommend the use of the Flight Events/History/Briefing (Form #JSC 1441) for all future missions.

A suggestion made during one of the handovers was to have the handover meetings tape recorded and then transmitted. That is a good idea.

POCC Paperwork

The POCC paperwork went generally smooth. One experiment went overboard on OCR's inputting almost 700 OCR's. That type flow caused a bottleneck and hurt other experimenters. Within the SEPAC team, the biggest problem was the dissemination of information on OCR's and RR's to the team members. Part of this was definitely attributable to the language barriers with the Japanese. Japanese held both positions of APOM and were, therefore, responsible for writing OCR's and RR's. I believe the system could be simplified by assigning that function on the next mission to Americans.

For SEPAC, there were 55 OCR's and 10 RR's generated.

The use of a Personal Computer (PC) should also be seriously considered. The PC would perform the following functions:

- OCR & RR Status
- SEPAC Timeline
- GMT/MET/Local Time Coorelation
- Beam deflection calculations

For the investment (\$1800), the payoff would be the simplification of the POCC operations for SEPAC.

During POCC simulation, the sim team should hold a skull session and go over the OCR and RR forms. Each item should be discussed so the experimenter knows what those fields mean and how they are used by POCC cadre.

Also during POCC simulation, the sim team should hold a skull session on Timelines: how they are created, how they are used, how they can be modified, and how they can be created.

Playback

Throughout the mission, the playback schedule was consistently behind. To catch up, the Data Coordinator would have to skip playbacks. This required the experimenters to submit a PDRF requesting the playback data. SEPAC did not have tremendous success in obtaining playback data. Reasons include the lack of a person designated for the prime responsibility of obtaining playback and the general confusion in trying to get the SEPAC POCC team coordinated for real-time of playback data.

Data Tapes

There was no plan for obtaining copies of the HRM data recorded on SODA for analysis by NASA, SWRI, or Intermetrics. An impromptu plan was devised to have the SODA tapes copied at the Intermetrics Houston facility. SWRI was to take these tapes to their facilities to make copies for distribution to MSFC and SWRI.

Since SODA was Japanese, a log of playback/real-time data did not exist. This was requested from the Japanese but was not made available.

Whether the data is ever analyzed or not, it would be prudent for NASA/MSFC to have a copy of all data files resident on SODA.

NRT

The NRT system as currently implemented is both slow and limited. The NRT procedures are not crystal clear and it was several days before the SEPAC team got the hang of running NRT. NRT was not of any benefit to SEPAC.

7.0 RECOMMENDATIONS

Recommendations for SEPAC reflight are divided into short term recommendations and those of long term nature.

Short Term Recommendations

1. Investigate the system gap, system stop, and DEP READY NO problems.
2. Analyze each of the software items in section 5.0 for feasibility and costs; develop a plan for what software changes should be made.
3. Acquire and database the SEPAC HRM SODA tapes.
4. Analyze the HRM data to help determine the conditions associated with EBA failure.
5. Investigate the possibility of moving the Burst Mode Logic display calculations from the DEP to the IU. This would remove the need for the DMA channel for the NSSC-II. As currently designed, the IU sends BML data to the NSSC-II via the DMA channel. The DEP then computes the BML display parameters which are sent to the EC in a DEP user's message.
6. Prepare a shopping list of changes that could be implemented for SEPAC reflight both on short term and long term.

Long Term Recommendations

1. Develop a Personal Computer workstation that could be general purpose for all experimenters. The potential for using the PC for log records should also be considered.
2. Analyze the possibility of having control panel switch settings downlinked.
3. Analyze the possibility of having a manual EBA fire mode.