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Mission Operation Report

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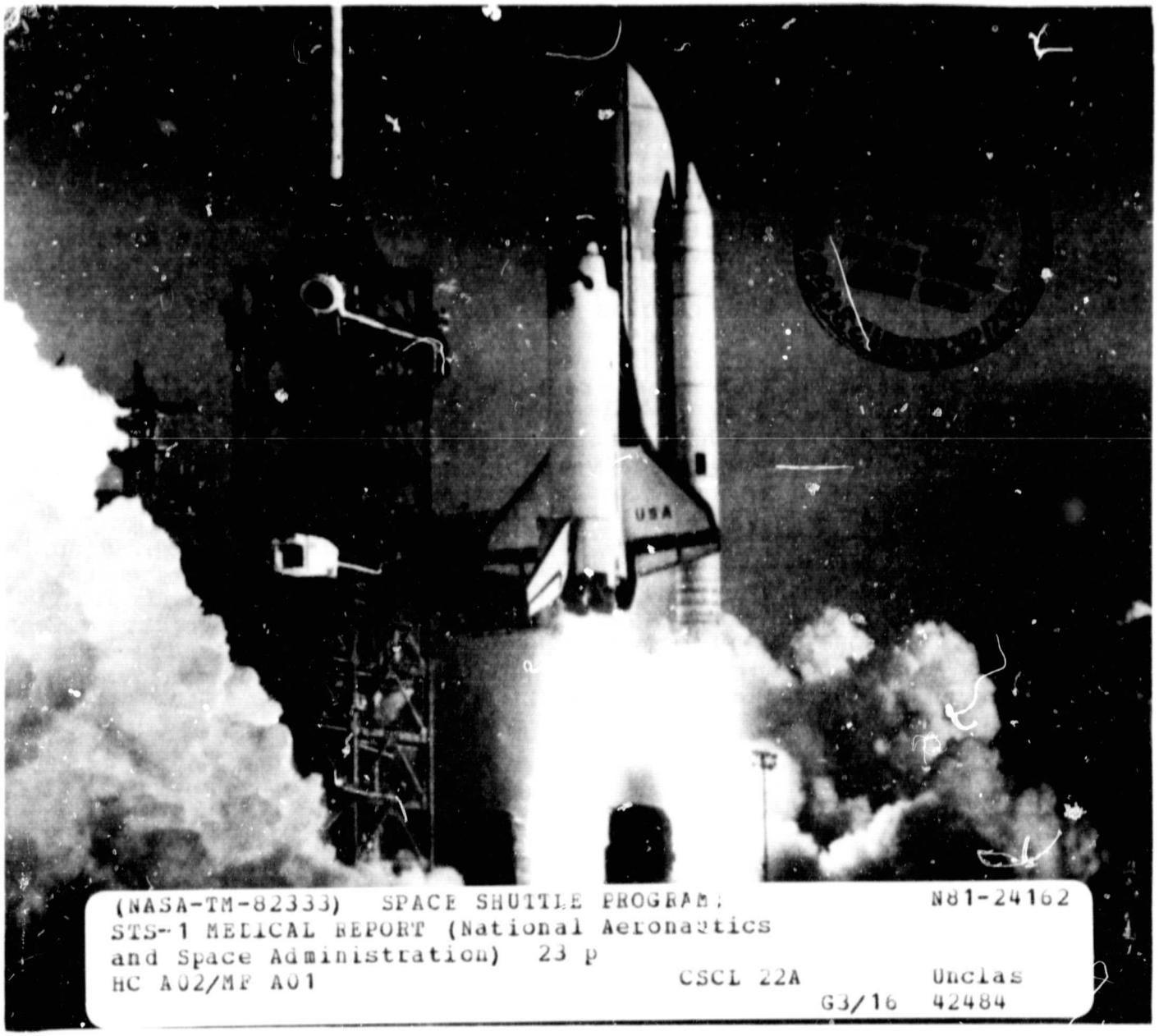

Spac Shuttle Program
STS-1 Medical Operation Report

CONTENTS

FIGURE

INTRODUCTION

The highly successful test of the first Shuttle orbital flight marks the beginning of a new era in space exploration. The U.S. return to manned spaceflight status provides both a continuity to the closing phase of the Apollo project and a potential for significantly increased space research capabilities.

For the first time in manned space flight a definitive separation of spacecrew duties has dictated the necessity for developing medical standards addressing individual classes of Shuttle crew positions. For the U.S. manned program the conclusion of the Apollo era also heralded the end of water recovery operations and the introduction of land-based medical operations. This procedural change marked a significant departure from the accepted postflight medical recovery and evaluation techniques. All phases of the missions required careful re-evaluation, identification of potential impact on preexisting medical operational techniques, and development of new methodologies which were then carefully evaluated and tested under simulated conditions. This required significant coordination between the different teams involved in medical operations. Additional dimensions have been added to the concepts of medical operations, by the introduction of different toxic substances utilized by the Space Transportation Systems especially during ground operations. The present report is intended to be a general medical assessment of the STS-1 mission and a more detailed report will be prepared by the medical operations personnel at Johnson Space Center(JSC).

MEDICAL OBJECTIVES

A critical ingredient for the Shuttle flight test program is medical operations. The primary medical objectives for these flights will be providing medical support, testing medical procedures and systems for the mature STS program, and initiating medical surveillance of STS crews. Specifically for STS-1, the two main objectives were to:

1) provide the routine and contingency medical support for the flight

2) evaluate crew health status throughout all mission phases

These medical objectives were accomplished, validating the months of thorough planning and subsequent successful implementation with only minor problems.

GENERAL CREW HEALTH ASSESSMENT

The assessment of crew health indicates that both the scheduled preflight isolation period (Health Stabilization Program) and medical evaluations were implemented flawlessly. Figure 1 shows the schedule for the evaluations as well as the general profile throughout all mission phases. The two F-0 examinations reflect the aborted launch on April 10, 1981 due to a computer problem and a repeat on April 12, 1981 - the day of the actual launch. The six-hour limit for the crew being in place in the Orbiter cabin before liftoff was a contributing factor to the launch postponement. This time limit ensures that the crew will not have too long of a workday on the first mission day when a high level of performance must be maintained for several hours after launch. Further details including durations of the medical evaluations are shown in Figure 2. The crew was returned to regular flight status on L+3 days after the last examination, certifying complete recovery from any effects of weightlessness.

SCHEDULE OF MEDICAL EVALUATIONS

MISSION PHASES

ACTIVITY	F-45	F-30	F-10	F-0	F+0	F+1	F+2	L+0	L+3
PHYSICAL EXAMINATION		X	X	X	EKG	PMC	EKG	X	X
AUDIOMETRY		X	X						X
VISION		X	X						X
MICROBIOLOGY		X	X					X	X
DENTAL		X	X						X
LABORATORY TESTS		X	X					X	X
EXERCISE STRESS TEST			X						X
ORTHOSTATIC TOLERANCE TEST			X					X	X
FTO	X				X	X	X		
DATES	2/15/81	3/3/81	4/1/81	4/10/81 4/12/81	4/12/81	4/13/81	4/14/81	4/14/81	4/17/81

Fig. 1

Shortly after launch, the Pilot Astronaut (who had not flown in space before) in accordance with the medical operations flight rules self-administered orally an anti-motion sickness medication (scopolamine-dexedrine). He did not experience any space motion sickness symptoms throughout the flight. Evidently either the medication was an effective countermeasure facilitating vestibular adapation to weightlessness or the Pilot Astronaut was not susceptible to space sickness.

PRE- AND POSTFLIGHT MEDICAL EVALUATIONS

DAYS / ITEM	F 30	F 10	F 2	F-0	L+0 L+1	L+3	L+3 TO L+7
LOCATION	JSC	JSC	JSC	KSC	DFRC	JSC	JSC
DURATION (HR MIN)	1 05	1 55	0 10	0 15	0 30	1 45	TBD
PURPOSE	LABORATORY EXAM URINALYSIS AUDIOMETRY	LABORATORY MICROBIOLOGY EXAMINATION URINALYSIS TREADMILL ORTHOSTATIC TOLERANCE DENTAL	LABORATORY URINALYSIS MICRO BIOLOGY	EXAMINATION	LABORATORY MICROBIOLOGY EXAMINATION URINALYSIS ORTHOSTATIC TOLERANCE	AUDIOMETRY ORTHOSTATIC TOLERANCE EXERCISE TOLERANCE TREADMILL RETURN TO FLIGHT DUTY	INSTRUCTOR PILOT CHECKOUT IN T 38

Fig. 2

During the flight excellent communications were maintained between Levels I, II, and III of management tor medical operations. The hierarchy for medical operations and communication flows are depicted in Figure 3. It should be noted that the flight surgeon was continuously available on both common and private communication lines from the Orbiter to the MCC, but no medical problems occurred and the crew maintained excellent health. In addition to medical communication, medical support inflight included the two medical kits (SOMS-A), shown in Figure 4.

Postflight evaluations indicated a mild weight loss in both crewmen. This was interpreted as due to fluid losses due to previously observed body's compensatory responses to the cephalad fluid shifts from the lower extremities. Photographs of the crew taken inflight, once more revealed facial puffiness which is invariably associated with fluid shifts.

It was noted during the scheduled postflight medical debriefings that the sleep periods were subject to some disruptions by minor acoustical stimuli (caution and warning alarms). It was noted however, that the crew elected to spend the rest period on the flight deck (flight seats). However in the mature STS some of the crews will spend rest periods in the mid deck. Further evaluations of the acoustical profiles of the flight and mid decks and Spacelab (pressurized module) are needed.

MEDICAL COMMUNICATIONS NETWORK

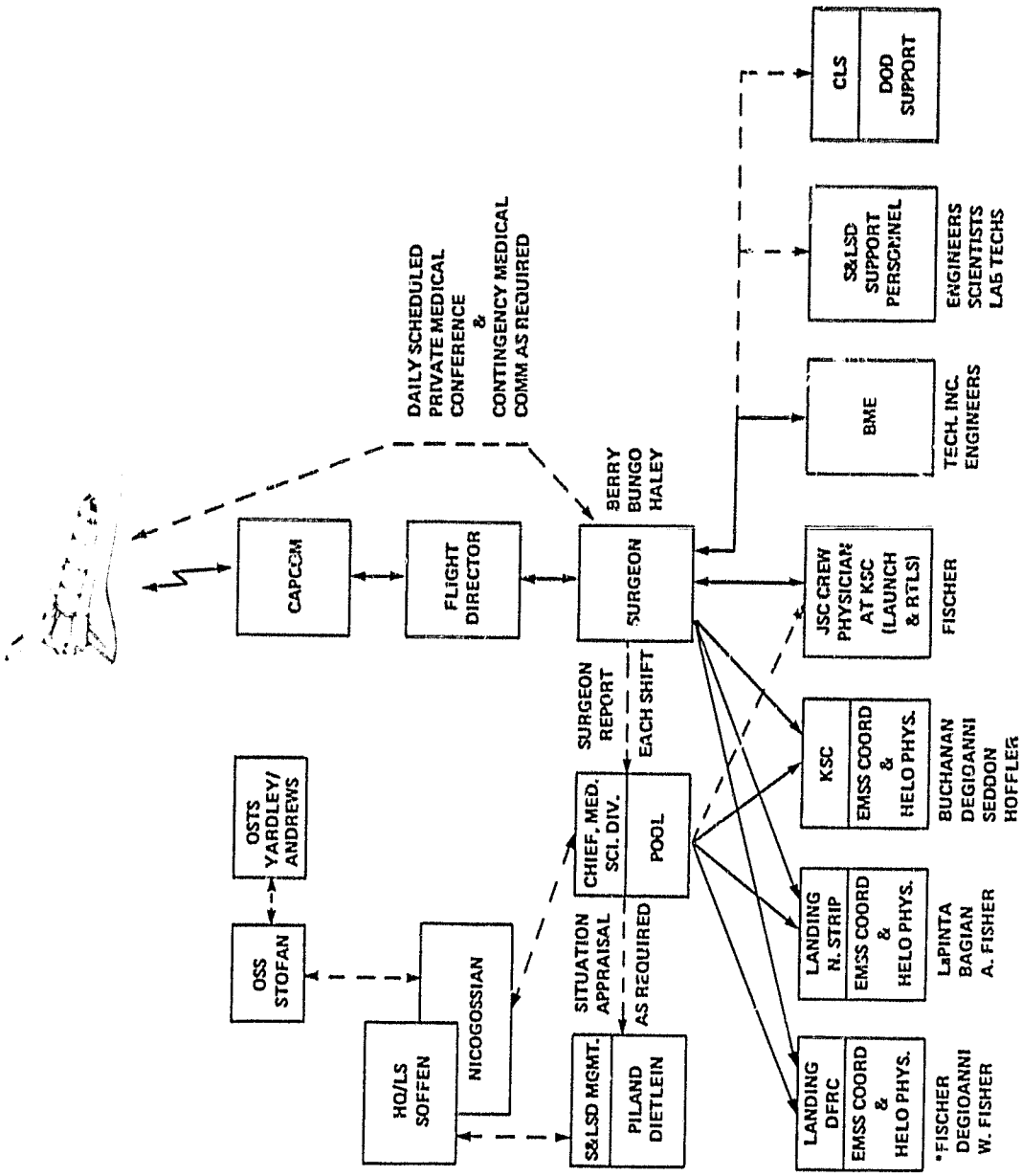

Fig. 3

SHUTTLE ORBITER MEDICAL SYSTEM A

Fig. 4

ENVIRONMENTAL MEDICINE

LAUNCH ENVIRONMENT

In contrast to previous launches the Orbiter cabin was at sea level standard atmospheric conditions (14.7 psia) and the crew was launched in pressure suits. The acceleration profile was typical of previous spacecraft launches (maximum was +3.4 g_x).

Flora within 3.5 to 4 miles of the launch pad were significantly damaged due to the hydrochloric acid cloud (pH=1) and deposition of aluminum oxide microspheres (3-30 microns). Recovery of the flora is being monitored. Repeated launches will continue to produce this local phenomenon, as previously estimated. Noise levels for launch were not greater than 100 dBA as predicted. The final impact analyses report is being prepared by Kennedy Space Center(KSC).

INFLIGHT ENVIRONMENT

Only minor problems occurred with the life support systems which are correctable. During the second mission day, the crew experienced some difficulty with the cabin temperature controller. It was reset and maintained the cabin temperature within comfortable limits. A few hours later the primary pressure control for the oxygen failed to maintain the appropriate pressure for the desired atmosphere mix and the oxygen pressure rose. The crew switched to the secondary system which performed normally. Another problem involved the waste management system in which the air flow rate continually decreased throughout the mission and did not adequately handle the input volume. The system failed by the end of the mission. These environmental perturbations have been flagged and are under examination for upgrading before the STS-2 mission.

NUTRITION

An intermediate system was used to provide food and water for the crew, as the galley is not yet an integral part of the STS operations. The food tray operations, shown in Figure 5, and the water dispenser, shown in Figures 6 and 7, worked well. The food tray is complemented by a food warmer, and chilled and cabin temperature water were available. Crew reports indicated that, in general, meals were very tasty. The food and water systems will continue to receive close attention because these items play an important part in the overall crew health maintenence in flight.

RADIATION ASSESSMENT

A solar flare was observed during the F-2 time frame, but no increase in radiation dosage for the crew was predicted at that time. On the fifth orbit the Orbiter passed through the South Atlantic anomaly and received nominal radiation levels, indicating that the ionizing particles from the sun were trapped in a

FOOD TRAY OPERATIONS - WITHOUT GALLEY

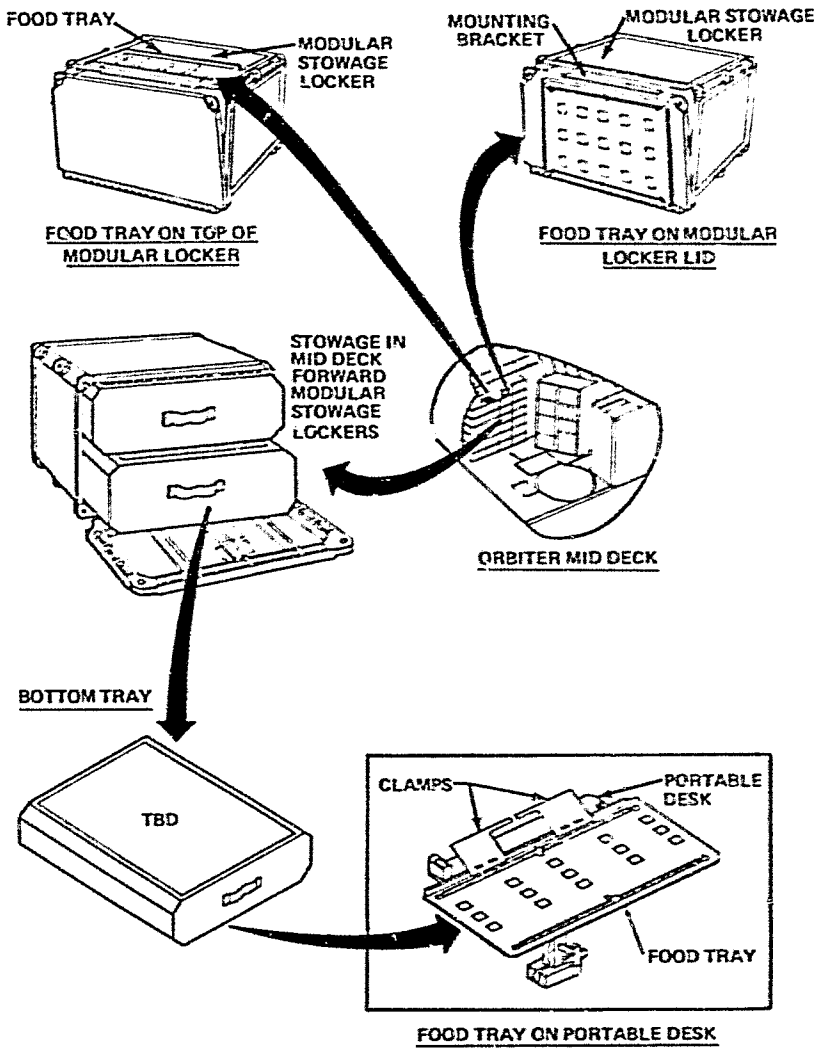

Fig. 5

WATER DISPENSER INSTALLATION

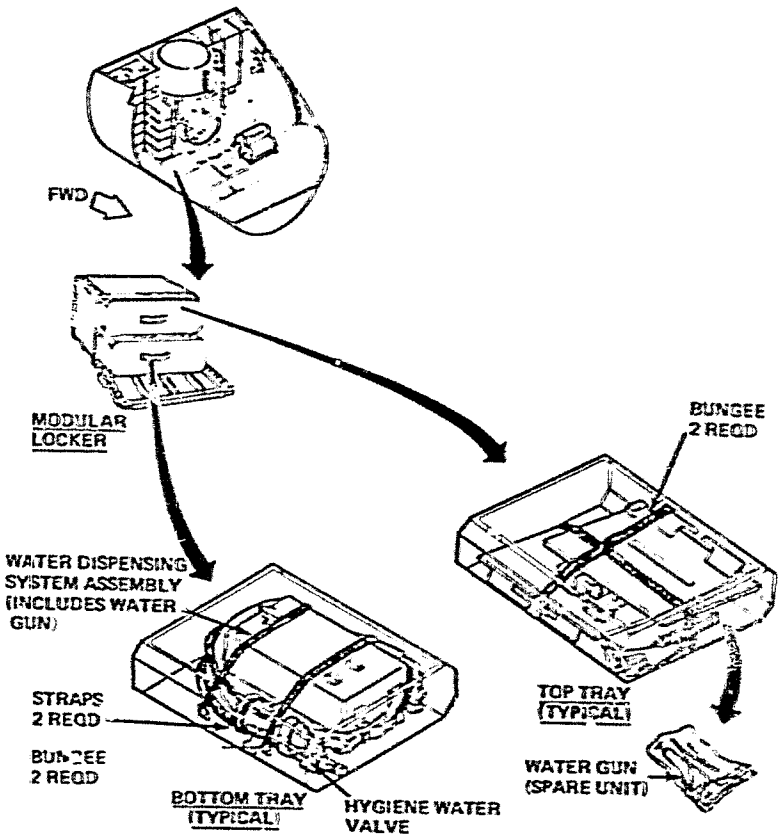

Fig. 6

OFT WATER DISPENSER

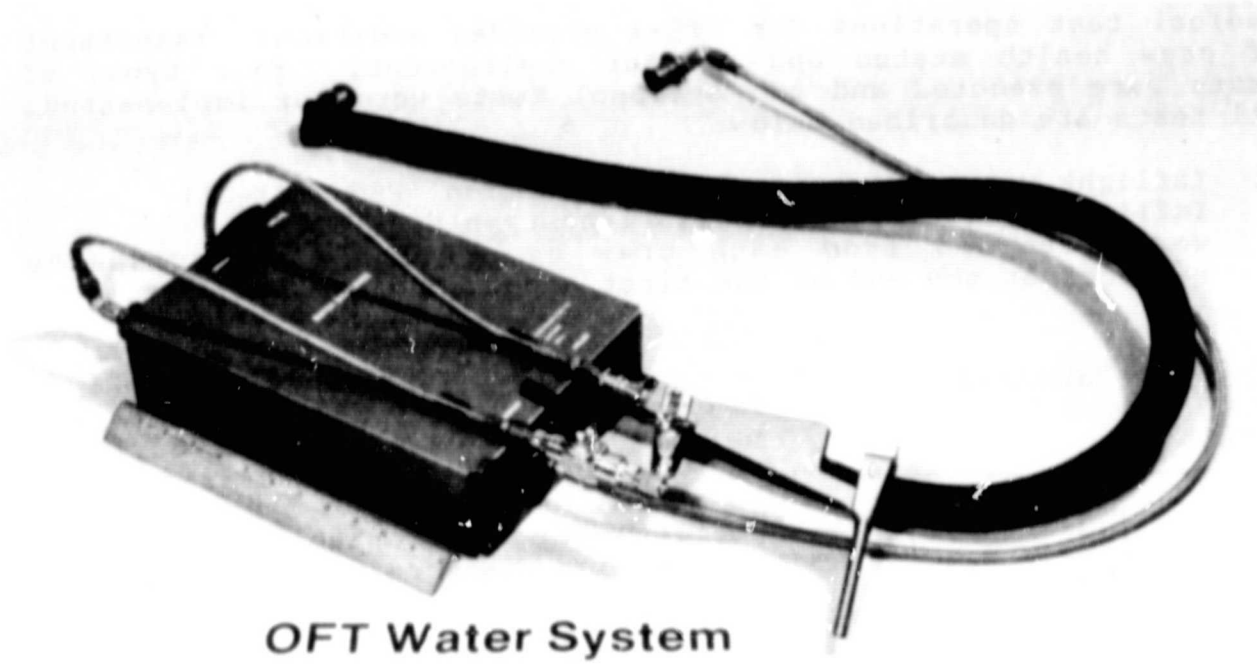

Fig. 7

geosynchronous orbit at a significant distance from the Shuttle orbit. Preliminary total estimated whole body estimated radiation exposure was 19 mrad.

LANDING AND EGRESS ENVIRONMENT

In this landing phase, the crew experienced nominal reentry forces (+1.2g_z) and did not activate their anti-g suits. These garments are worn to provide an added measure of safety in those flights in which orthostatic tolerance becomes significant (i.e., > 2 days and/or higher g_z) and the subsequent pooling of blood in the lower extremities during reentry may present potential decrements in performance.

Upon return and after toxicological scrub down (1 hr 8 min) the crew surgeon entered the Orbiter. After a brief evaluation and consultation with the crew, both crewmen exited the Orbiter and were transported by a specially outfitted van to the medical evaluation area, for a short L+0 medical health status assessment.

TEST OPERATIONS OVERVIEW

Medical test operations for STS-1 provided additional assessment of crew health status and Orbiter environment. Four types of tests were executed and two optional tests were not implemented. All tests are described below:

1. Inflight Motion Sickness Data Collection (FSO S141-01)
   Inflight motion sickness/disorientation debriefings were recorded from each crew member on a microcassette recorder at the end of the first and second mission days.

2. Cabin Acoustical Noise (FTO 161-01)
   Sound Level Meter, as depicted in Figure 8 was used to survey cabin noise at selected locations during the first mission day. Readings of 60-67 dBA indicated that the on-orbit environment was acceptable and typical of previous spacecraft, verifying noise suppression and muffling preparations.

3. Cabin Atmosphere Evaluation (FTO 162-01 & 162-02)
   Four whole gas samplers provided data on low molecular weight trace gases at 6 hr, 12 hr, and 28 hr after launch and 6 hr before deorbiting. A typical sampler is shown in the lower portion of Figure 9. A solid sorbent sampler, shown in the upper portion of Figure 9 was used to provide data on high molecular weight volatile compounds at 6 hr and 28 hr after launch. Analyses of the samples are in progress.

PRECISION SOUND LEVEL METER AND OCTAVE ANALYZER

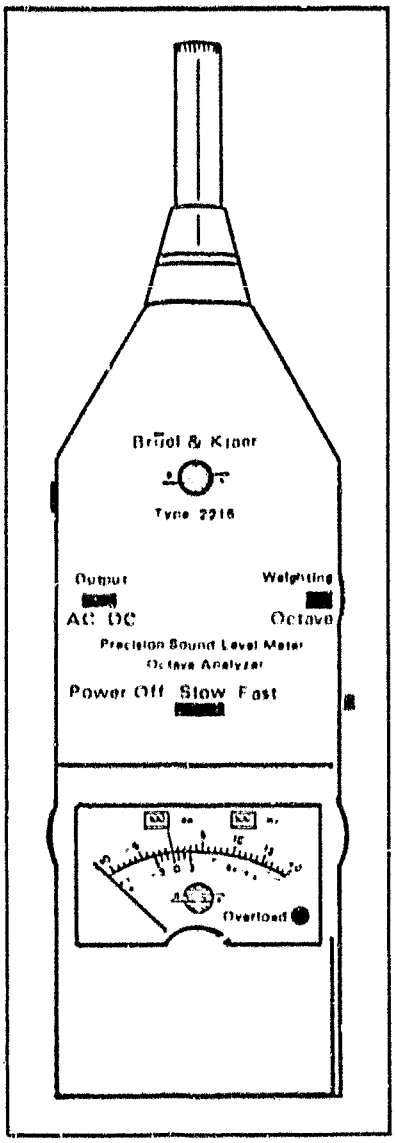

Fig. 8

AIR-SAMPLING SYSTEM

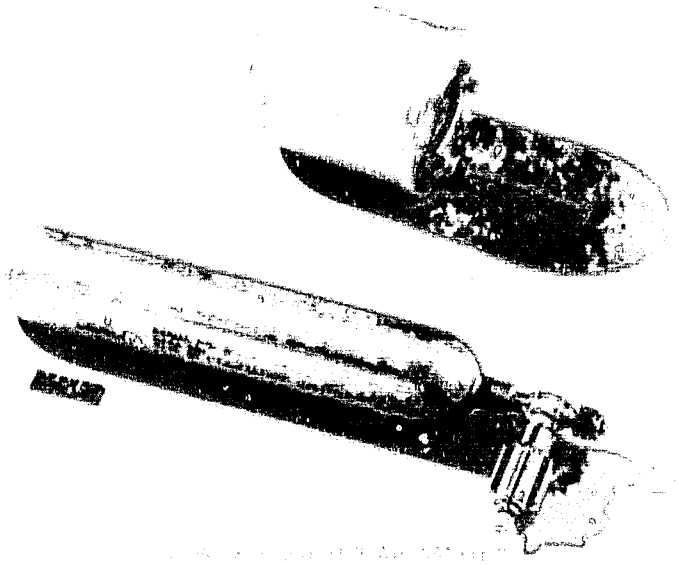

Fig. 9

4. Radiation Dosimetry (ISO S134-01)
Passive dosimeters were deployed at selected locations in the cabin and then stored to provide data on the ionizing radiation environment. Analyses of the dosimeters are in progress. Preliminary results indicate nominal levels typical of previous spacecraft in similar orbits. The array of dosimeters used by the crew are shown in Figure 10.

IONIZING RADIATION DOSIMETRY SYSTEM

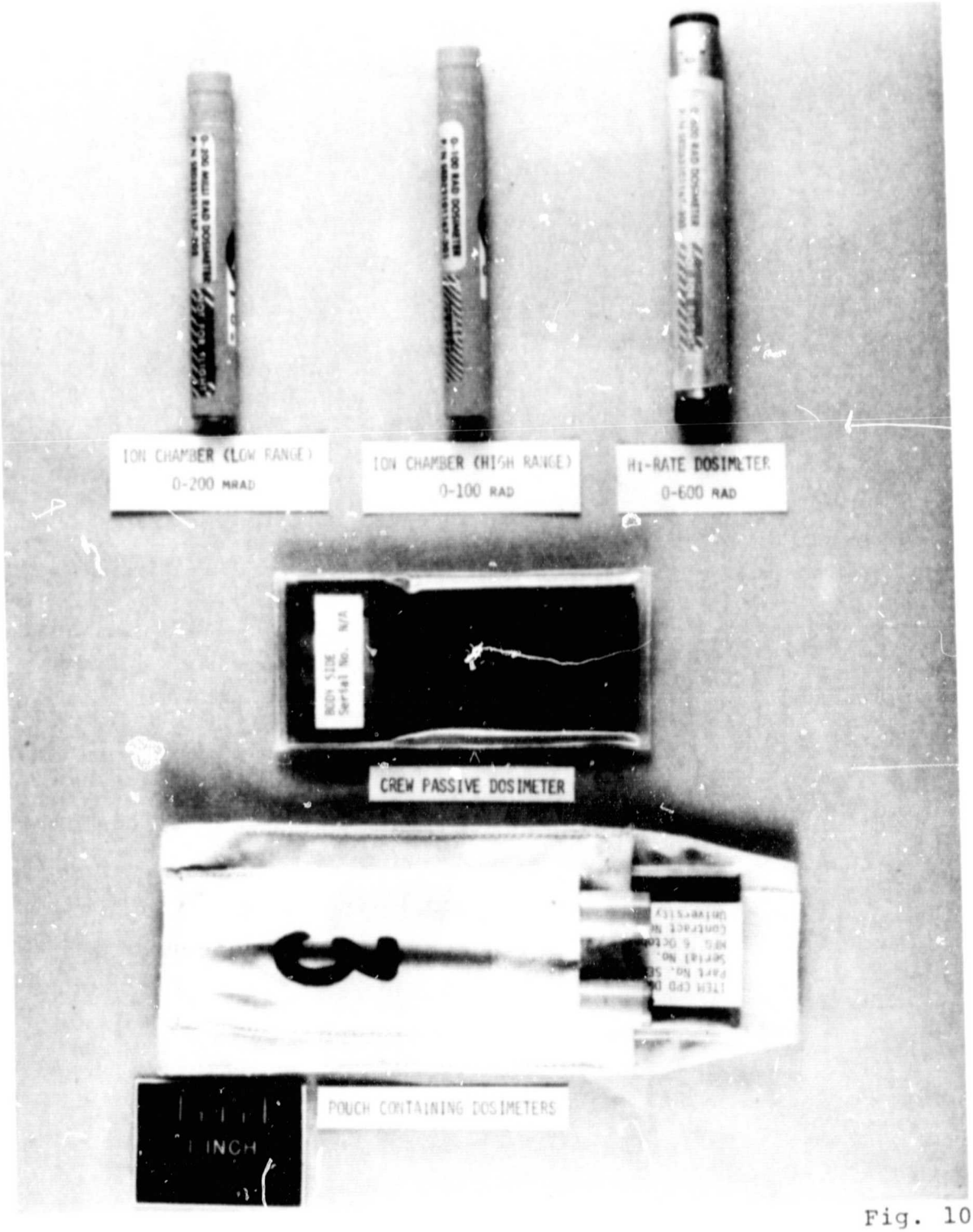

Fig. 10

5. Anti-G Effectiveness Verification (FTO TBD)
This test was planned to be activated at crew discretion. The anti-g garment, as shown in Figure 11, is designed to prevent blood pooling in lower extremities during the long duration (20 min) low level + 1.5gz environment of Shuttle reentry and landing. The garments were worn by the crew but were not activated.

ANTI-G GARMENT

Fig. 11

6. Crew Exercise Equipment Evaluation (FTO TBD)
This test was planned to be activated at crew discretion. As shown in the assembled configuration in Figure 12 this treadmill was on board the Shuttle and available for an inflight cardiovascular exercise regimen, but the crew did not activate it.

EXERCISER OPERATIONS

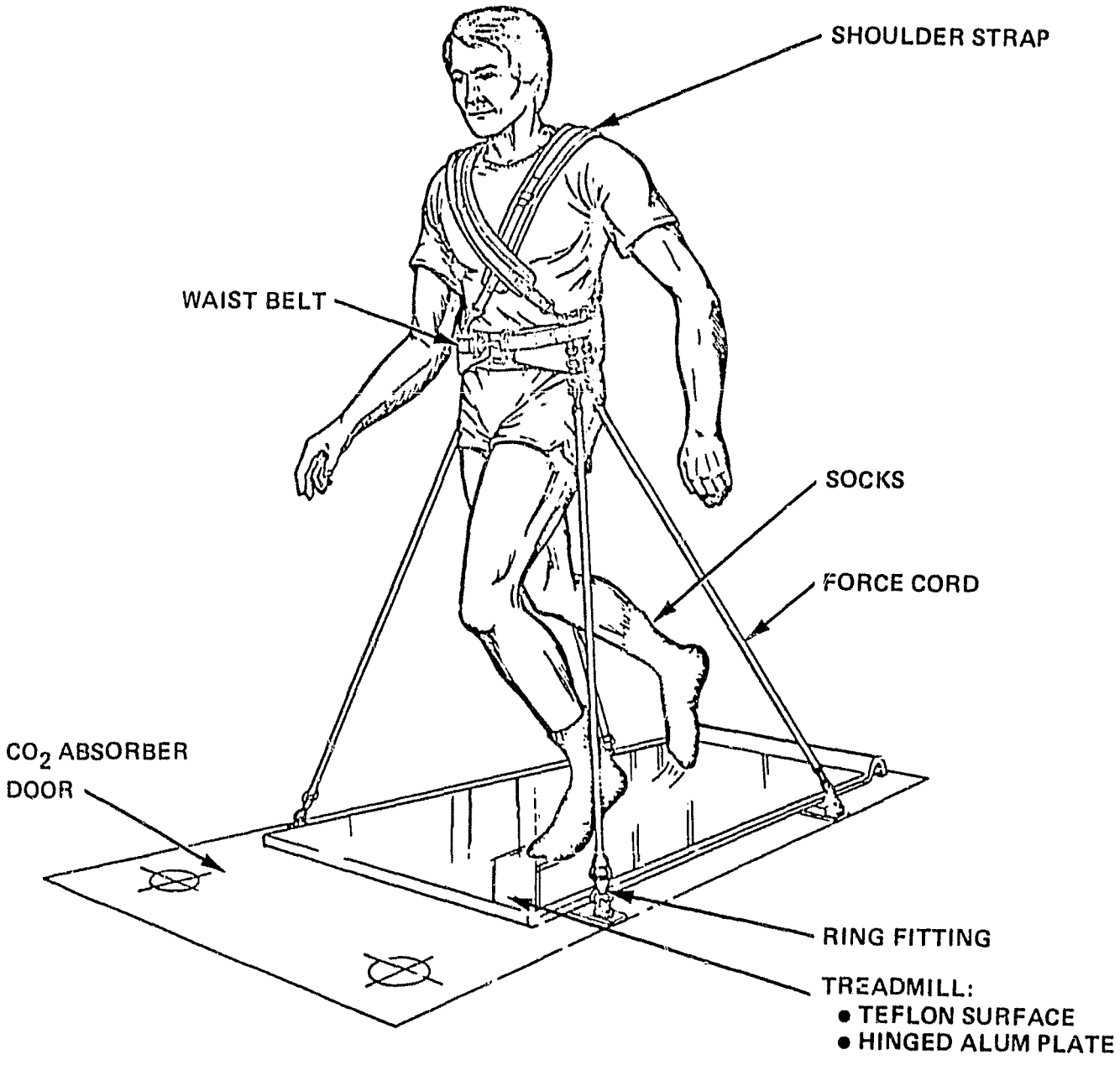

Fig. 12

GROUND SUPPORT SUMMARY

A NASA-contractor-DOD medical operations team self-imposed high work loads to plan, prepare, train, simulate, and implement routine and contingency medical operations in support of STS-1. A brief overview of significant milestones during these activities during the three months preceeding the STS-1 launch is illustrated in Figure 13. Numerous reviews as indicated in Figure 14 were accomplished to assure the success of medical activities at diverse locations.

OPERATIONAL MEDICINE STS-1 ACTIVITIES

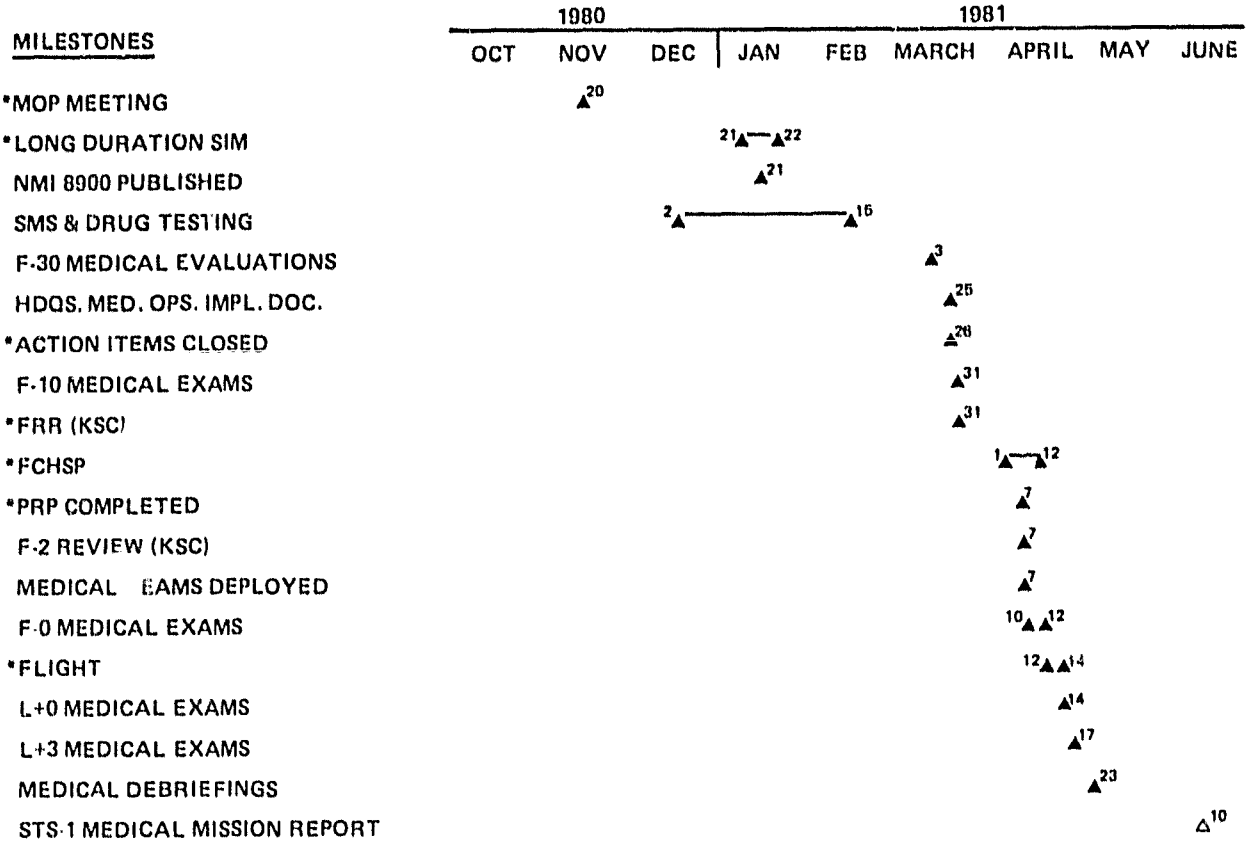

Fig. 13

Detailed evaluations will continue on performance, communication, and manpower devoted to STS-1 and future flights in order to provide the necessary feedback for fine-tuning support for the mature STS operations. These analyses will be supported by reports accessible through the developing JSC medical data management system which was functional for STS-1. Key features of this reporting system are listed in Figure 15.

STS-1 MEDICAL OPERATIONS SUPPORT CAPABILITIES

EVALUATED REVIEW AREAS	JSC	KSC	DFRC	N/S	HICKAM	KADENA	ROTA
MEDICAL EVALUATION OF CREW	X	X	X	X	X	X	X
HEALTH STABILIZATION	X	X	X	X	N/A	N/A	N/A
LABORATORY SUPPORT	X	X	X	X	N/A	N/A	N/A
CONTROL CENTERS SUPPORT	X	X	X	X	N/A	N/A	N/A
COMMUNICATIONS	X	X	X	X	X	X	X
EMERGENCY MEDICAL SERVICES	X	X	X	X	X	X	X
MEDICAL EQUIPMENT	X	X	X	X	X	X	X
TRAINING	X	X	X	X	X	X	X
DOCUMENTATION	X	X	X	X	X	X	X
PAO INTERFACES	X	X	X	X	X	X	X
CRASH AND RESCUE INTEGRATION	X	X	X	X	X	X	X
GROUND OPERATIONS INTEGRATION	X	X	X	X	X	X	X
FLIGHT OPERATIONS SUPPORT	X	X	X	X	X	X	X

Fig. 14

FEATURES OF THE MEDICAL OPERATIONS REPORTING SYSTEM

1. PREDEFINED REPORTS FOR NOMINAL MISSION
2. AREA ACTIVITY MANAGER HIGHLIGHTS RESULTS AND CATEGORIZES PROBLEM AREAS:
   - NO PROBLEM
   - MINOR PROBLEM
   - SIGNIFICANT PROBLEM IN WORKS
   - SIGNIFICANT PROBLEM NEEDING IMMEDIATE MANAGEMENT SUPPORT
3. AREA ACTIVITY MANAGER PROVIDED WITH PREDEFINED INPUT FORMS, DISPLAYS AND REPORTS, INCLUDING:
   - TABULATIONS, PLOTS
   - MILESTONES, SCHEDULES, STATUS
   - MISSION CHECKLIST
4. MEDICAL CLINICAL REVIEW TO PRODUCE BRIEF INTEGRATIVE PROSE REPORTS FOR MANAGEMENT
5. AUTOMATIC ACTION LIST AND OPEN PROBLEM TRACKING AT ALL LEVELS
6. STANDARDIZED PROSE ASSESSMENT FORMAT FOR WEEKLY OR DAILY MANAGEMENT REPORT INCLUDING RESULTS, PROBLEMS, AND OPEN ITEMS FOR:
   - CREW HEALTH ASSESSMENTS
   - ORBITER ASSESSMENTS
   - GROUND SUPPORT ASSESSMENTS

Fig. 15

Assessments of routine ground support for the flight indicate one area that needs refinement - the postflight egress timeline. The flight crew egressed the Orbiter about 1/2 hr later than planned due to a delay imposed for the ground crew to clear hazardous vapors near the Orbiter side hatch. Although the safety and health of the crew received its appropriate highest priority, the operational aspects for future missions - particularly removal of specimens from flight experiments - dictate that additional studies should be undertaken to minimize egress time for crew and time critical cargo.

Assessments of contingency ground support for the flight indicate that a continual readiness for various emergencies was maintained throughout flight. This included preparations for the flight surgeon to monitor nitrogen(N_2) washout procedures in the event of contingency EVA requiring a planned decompression to 9psia (already simulated under bedrest conditions). One minor communication problem developed in the voice link between the crew and the ground convoy during landing and postlanding phases. This will be examined to assure complete emergency support for future flights.

CONCLUSIONS AND RECOMMENDATIONS

1) The preliminary assessmen's of the STS-1 mission indicate that the medical support objectives were fulfilled with a high level of performance and on schedule.

2) Crew health statusing via evaluations and examinations were executed in a timely fashion throughout all mission phases. The associated medical reports were input to the data management system which proved to be an efficient functional and accessible depository of mission life sciences information.

3) Assessment of the Orbiter cabin environment indicated that all life support systems functioned adequately with few problems (such as thermal control) which should be corrected. The temperature, atmosphere mixture, and waste management controls all should be upgraded before STS-2. The Orbiter interior had a lower noise level than predicted. Based on preliminary assessments, further habitability studies considering larger crew complements is warranted.

4) The major portion of the preplanned inflight medical test procedures were completed on schedule. Further verification and refinement of the inflight health maintenance program should be accelerated, since the remarkable success of STS-1 implies a more rapid maturation of STS operations.

5) Significant workloads were imposed for medical flight support personnel during three months of sustained preflight activities. A large measure of the medical operations success can be attributed to the high degree of preparedness which was achieved through detailed training and simulations.

6) The safe but lengthy postflight egress timelines associated with reports of increased thermal load (not actually measured) on the crew while inside the orbiter should be examined for reduction. Future life sciences payloads may be impacted by the above timelines and warrant careful evaluation.

7) During this mission no space motion sickness was encountered. However, in light of previous space flight experience, a careful monitoring of inflight vestibular responses is recommended for future missions.

ACRONYMS AND ABBREVIATIONS

BME	Biomedical Engineer
CAPCOM	Capsule Communicator
CLS	Contingency Landing Site
CO_2	Carbon Dioxide
dBA	decibel, Absolute
DFRC	Dryden Flight Test Research Center
DOD	Department of Defense
EKG	Electrocardiogram
EMSS	Emergency Medical Services Systems
F	Flight
FRR	Flight Readiness Review
FCHSP	Flight Crew Health Stabilization Program
FSO	Functional Supplementary Objective
FTO	Functional Test Objective
g	gravity vector
HELO	Helicopter
JSC	Johnson Space Center, TX
KSC	Kennedy Space Center, FL
L	Landing
MCC	Mission Control Center
MOP	Medical Operations Panel
MOR	Mission Operation Report
mrad	millirad
N_2	Nitrogen
NMI	NASA Management Instruction

OFT	Orbital Flight Test
OSS	Office of Space Science
OSTS	Office of Space Transportation Systems
PAO	Public Affairs Office
PMC	Private Medical Communication
PRP	Personnel Reliability Program
psia	pounds per square inch, absolute
RTLS	Return to Launch Site
SOMS-A	Shuttle Orbiter Medical System A
SMS	Space Motion Sickness
STS	Space Transportation System
TBD	To Be Determined