NASA TM-58245

NASA-TM-58245 19820017875

NASA Technical Memorandum 58245

STS-2 Medical Report

May 1982

NASA

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

NASA Technical Memorandum 58245

STS-2 MEDICAL REPORT

Edited by
Sam L. Pool, M.D., Phillip C. Johnson, Jr., M.D.
and John A. Mason

Lyndon B. Johnson Space Center
Houston, Texas

N82-25751#

FOREWORD

The Space Transportation System Two (STS-2) was the second of the four planned manned orbital flight tests (OFT) of the Space Shuttle Program. This mission, though shorter than anticipated due to inflight fuel cell problems, was successfully completed on November 14, 1981, demonstrating for the first time in the history of space flight the reusable capabilities of a space vehicle.

The primary objective of the OFT program is to evaluate and demonstrate, under progressively demanding conditions, safe ascent, on-orbit operation, and return of the Orbiter and crew. In addition to the aerodynamic evaluations, a scientific payload (OSTA-1) and several individual experiments were included in medical support logistics involving concepts for a standardized program to be utilized during the mature STS operations.

The STS-2 mission presented the NASA medical team with a series of operational problems associated with the on-board potable water and altered work/rest cycles. The first problem was traced inflight to a malfunctioning fuel cell, while the second was attributed to modification of inflight crew timelines in order to maximize the scientific data acquisition. Shortened sleep periods, heavy work loads, inadequate time allocation for food preparation and consumption, and estimated low water intake, though tolerable for a 54-hour mission, would have been unacceptable for a longer mission. A contingency plan was developed to restructure inflight timelines and institute corrective health maintenance procedures in the event that the mission was extended beyond 54 hours. Minor losses of medical data occurred as a result of the shortened mission duration. All phases of the mission required real time re-evaluation, identification of potential impact on pre-existing medical constraints, and development of appropriate recommendations and solutions. These activities required significant coordination among the different teams involved in medical operations.

The role of Life Sciences continues to expand with each new orbital flight. While Medical Operations was the only discipline of Life Sciences involved in the first STS mission, the STS-2 included another element of the Life Sciences programs, a flight experiment dealing with plant biology.

A more detailed discussion of the medical problems encountered during this mission is presented in the various chapters of this report.

Arnauld E. Nicogossian, M.D.
Manager, Operational Medicine
Life Sciences Division

CONTENTS

Introduction

The Space Transportation System Two (STS-2) was launched on November 12, 1981, at 10:10 AM EST from the Kennedy Space Center (KSC) launch pad 39A. The launch was initially scheduled for November 4, 1981. However, a hold at T-minus 31 seconds for out-of-tolerance measurements could not be resolved in order to support the scheduled launch time. Subsequent evaluation of the lubrication oil pressure of the auxillary power units (APU) 1 and 3 resulted in a decision to delay the launch until the APU's 1 and 3 could be flushed and the filters replaced. On November 11, the revised flight schedule of November 12 was placed in some jeopardy by the malfunction of one of Columbia's multiplexer units. A unit from Challenger, scheduled for launch in late 1982, was flown to KSC; launch did occur at the revised schedule time.

The Commander of the mission was Joe Henry Engle, Colonel, United States Air Force, and the Pilot was Richard H. Truly, Captain, United States Navy.

The STS-2 Mission marked the beginning of the era of reusable Shuttle vehicles with the refurbished Columbia making its second space flight, carrying a space application payload and the remote manipulator. The Mission had a planned duration of approximately 5 days and 4 hours. However, fuel cell 1 failure resulted in a decision to shorten the mission to minimum mission guidelines of about 54-1/2 hours. The Columbia landed at the NASA's Dryden Flight Research Facility at Edwards Air Force Base Runway 23, 2 days, 6 hours, and 13 minutes into the mission. After a rollout of about 7,500 feet the spacecraft came to rest exactly on the centerline of the runway.

The primary objective of the OFT program is to evaluate and demonstrate, under progressively demanding conditions, the safe ascent, on-orbit operation, and return of the Orbiter and crew. During the STS-2 shortened mission over 90 percent of the high priority flight tests were sucessfully accomplished. The remote manipulator system tests were successful as was the Earth observation data collection by the OSTA-1 pallet experiments.

The STS-2 mission also demonstrated important designs in operational capabilities with the continuation of all major flight operations, including a successful return, in the presence of a significant subsystem failure. All other subsystems of the Orbiter operated satisfactorily.

The STS-2 mission presented the following medical problems:

- marginal on-board potable water caused by a malfunctioning fuel cell
- altered work/rest cycles by crew to maximize the scientific data acquisition
- inadequate time allocation for food preparation and consumption
- low water intake by crew members because of fuel cell problem.

This report will describe all medically related activities, ranging from preflight through postflight. This represents a detailed report, as a follow-on, supplementing and amplifying the general medical assessment of the STS-2 mission published by NASA Headquarters, January 29, 1982 (Postflight Mission Operations Report No. E-989-81-02). Also, for background, see STS-1 Medical Report, TM 58240 published December 1981.

EVALUATION OF CREW HEALTH

Charles K. LaPinta, M.D. and Craig L. Fischer, M.D.

As with STS-1, the basic philosophy for this mission was directed toward routine crew health maintenance and the implementation of a sophisticated Emergency Medical System. The preflight health of the crewmen, Commander Joe H. Engle and Pilot Richard H. Truly, was unremarkable. Inflight, the crew experienced several problems: lack of proper sleep; lack of desired food intake; and reduced fluid intake secondary to a failure in the potable water supply system. Despite these problems, the crewmen recovered rapidly postflight and have suffered no lasting untoward effects. They were returned to full duty including pilot in command of NASA high performance aircraft four days post landing.

The STS-2 Medical Program was designed to safeguard the health and well-being of all astronauts assigned to the mission as well as their families and co-workers who might have regular and close contact with the crewmen. This was accomplished, as in STS-1, by the same program elements, specifically:

Health Stabilization Program

Critical Personnel Reliability Program

Preflight and Postflight Medical Flight Crew Evaluation

Inflight Medical Consultation via Mission Control Center (MCC) Surgeons

Implementation of an Emergency Medical System at all Potential Launch and Landing Sites

Preflight examinations were accomplished on September 10, 1981 (F-30 exam), October 21, 1981 (F-10 exam), November 4, 1981 (day of aborted launch), and November 12, 1981 (launch day). Postflight exams were performed on November 4, 1981 (recovery day at the Dryden Flight Research Facility). The Crew Physician, Charles K. LaPinta, M.D. and Deputy Crew Physician, Craig L. Fischer, M.D., performed all preflight and postflight examinations.

In accordance with JSC medical policy, both crewmen used medication for space motion sickness prophylaxis. Commander Engle chose the combination scopolamine and dexedrine (0.4 mg and 5 mg respectively) capsule, and Pilot Truly chose the scopolamine patch which he applied in the crew quarters at KSC approximately 13 hours prior to lift-off and replaced once in flight. He removed the second scopolamine patch prior to reentry when he suspected some side effects from the medication.

About noon the day of recovery, word was sent from JSC that the crewmen might not be in optimal physical condition at landing time because of four problems: neither crewman had slept more than 2.5 hours (uninterrupted) during the mission (due to the many alarms and warnings received); and both crewmen did not consume a normal amount of fluids because the potable water supply failed to function properly. There seemed to be an inordinate amount of gas in the water, and it took an excessive length of time to obtain. Therefore, the crew drank less than they should have. This underhydration led to severe thirst near the end of the mission. It should also be noted that the crew never had time to eat a full meal and subsisted on snacks and "grabbing a sandwich or something" when time permitted.

The postflight physical examinations were performed in adjoining rooms with the Deputy Crew Physican doing Pilot Truly's physical and the Crew Physician doing Commander Engle's. The exam sequence was:

- Medical Debrief
- Microbiology
- Weight
- Stand Test
- Blood Draw
- Physical Exam

Just prior to the physical examination a formal medical debriefing was held. The questions asked were obtained from a list read by each examiner. The crew's replies were recorded on cassette recorders. The examinations were accomplished expeditiously and smoothly.

At the time of examination both crewmen appeared fatigued and underhydrated. After replenishment of their fluid deficit, they rapidly recovered and by two hours post landing were clinically normal. No residual effects of the mission were observed on the recovery plus three day examination and the crew was returned to full flight status.

INFLIGHT OBSERVATIONS

Michael W. Bungo, M.D.

The launch of STS-2, which was scheduled for November 4, 1981, was aborted at T-31 seconds because of difficulties with the auxillary power unit. Actual launch was postponed and occurred on Thursday, November 12, 1981, from the Kennedy Space Center (KSC). There was no resident fatigue or apprehension in the crew on launch day which might have been attributable to the prior delays.

The crew awoke at 5:10 a.m. EST (316:11:10:00 GMT).* The medical staffing of Mission Control began at approximately the same time with the Staff Support Room (SSR) establishing the communication lines to KSC. The Mission Operation Control Room (MOCR) Surgeon received a briefing on the crew health from the Crew Physician at 12:47. No problems were reported, and the crew had ingressed the Orbiter without difficulty (12:33). The pilot (PLT) was using a transdermal scopolomine patch for prophylactic therapy of vestibular space sickness and applied this preparation the night before. The commander (CDR) was to use an oral scopolomine/dexedrine combination and was to receive his first dose on orbit. This was in contrast to the aborted flight 8 days earlier when the CDR took a dosage at breakfast. The hatch was closed at 13:22 and lift-off occurred at 15:10.

At 16:40, the MOCR Surgeon and Biomedical Engineer (BME) were informed that a major solar flare was in progress. There was possible concern for the attendant implications. Projections, however, limited crew exposure to 50 millirad from the protons encountered in the South Atlantic Anomaly, and radiation was not of further concern for the remainder of the flight. By 17:36 (the Australia pass on the first orbit), it was evident that there were problems with one of the fuel cells. Over the next few hours this problem was to have impact in: 1) shortening the mission, and 2) causing re-routing of the potable water supply to lessen the possiblity to potassium hydroxide contamination.

Because they were busily working spacecraft related problems and test procedures, the crew hastily ate only sandwiches for lunch on launch day.

At 19:35, the crew reported on the open loop that although they both felt fullness in the head, they were otherwise well. Again at 20:49, the crew reported that in spite of the busy workload, they "both feel real well". The cabin temperature was reading in the mid-to-high 80's on the groundbased indicators, but because of previous cold problems on STS-1 and because the STS-2 crew felt comfortable, this indicator was not felt to represent conditions accurately, and no action was taken.

*Note: All subsequent times in this report will be in Greenwich Mean Time (day:hour:minute; or just, hour:minute). Launch was at 10:10 A.M. EST or 316:16:10:00 GMT.

Conferences were held off the loop combining the inputs of the Flight Director, EECOM, and the MOCR Surgeon to remedy the potassium hydroxide (KOH) spillage into the potable water system. EECOM estimated KOH concentration to be no greater than 2%. The surgeon constructed a plan to test the pH of the drinking water by using the urine test sticks that were packaged in the on-board medical kit. The Flight Director decided that the time course involved in the testing procedure, in spite of its simplicity, was too great a constraint on the minimum timeline. Water was drawn directly from the functional fuel cells, unless large quantities were needed, in which case, the potable water tank was to be used without testing.

The second day of the mission went without incident as the crew tested the remote manipulator system (RMS). They were feeling none the worse from their first day's ordeal, were able to eat, and appeared to be in reasonable condition as viewed on downlinked TV transmissions. It was during this day that they were informed of the decision to terminate the mission early.

The noise survey and whole gas sampling, which had been deleted from the timeline of day one were requested to be completed on this second day.

President Ronald Reagan visited the MOCR between 318:00:15 and 318:00:28 and communicated with the crew of STS-2. Crew sleep was again interrupted on the second night by multiple caution and warning alarms. It was estimated that no more than 2 3/4 hours of uninterrupted continuous sleep occurred. Total sleep may have been 6-7 hours.

On entry day, the timeline was extremely busy for the crew. No electrocardiographic (ECG) data was obtained from either crewmember as late as the last Australia pass. The BME verified that all ground systems and apparently all spacecraft systems were functioning normally. As a consequence, the Flight Director was asked to determine whether the crew had indeed donned and plugged in their biomedical harnesses. Soon thereafter, ECG data was downlinked on the CDR, but even after a second reminder to check the biomed cable connector, no data was obtained on the PLT. Since persistently elevated heart rates were noted and concern for the cardiovascular status of the CDR was in evidence, the Johnson Space Center Emergency Medical Services System (EMSS) coordinator, with the recognition of the MOCR Surgeon, called the Crew Physician at Edwards Air Force Base and advised that he be prepared for a fatigued, hypovolemic crew. The crew egressed the Orbiter at 22:05 looking somewhat fatigued.

The MOCR Surgeons were faced with several operational problems: 1) the use of additional medication by a crewmember for motion sickness prophylaxis; 2) the need for other flight controllers to be aware of crew medical/comfort concerns such as, potable water, cabin temperature, caution and warning alarms, and timeline workloads. None of the above precluded a successful mission, yet, the medical/human system will respond uniquely to changing events, and heightened awareness to these variables is in order.

CREW MEDICAL TRAINING AND SHUTTLE ORBITER MEDICAL SYSTEM

James M. Vanderploeg, M.D. and Arthur T. Hadley, III, M.D.

The objective of the crew medical training for STS-2 was to provide the prime and backup crews with the knowledge and skills necessary to respond to inflight illnesses and injuries in an appropriate and timely manner. This objective was met through both the general medical training which is part of each astronaut's initial training and mission specific training in the months prior to STS-2.

Each astronaut's initial medical training involved 16 hours of instruction during the first year following selection.

Included during the first year of training was the initial two-day course in altitude physiology. This course provided training in the following areas: composition of the atmosphere; the Gas Laws; signs, symptoms and treatment of hypoxia; operation of life support equipment; effects of increased G's; the L-1 and M-1 anti-G maneuvers; use of the anti-G suit; and an altitude chamber ride with demonstration of hypoxia. This material is reviewed every three years by means of a one-day refresher course. In addition to the above training, astronauts Engle and Mattingly received detailed medical briefings that had been a part of mission preparation during the Apollo program. These briefings were designed to acquaint the crewmembers with pre and postflight medical procedures; to discuss crew preventive medicine measures; to instruct the crew in the contents and uses of the medical kit; to demonstrate the configuration and operation of the biomedical harness; and to familiarize the crew with toxicological considerations.

The STS-2 premission medical training for astronauts Engle and Truly began in mid-1979 when they were designated as the backup crew for STS-1. The first training acomplished was the self study course entitled MED EQ 2102. This involved each crewmember working through the "Medical Equipment Workbook". The topics covered in this workbook were: (1) the Shuttle Orbiter Medical System (SOMS): contents, uses, location, and stowage; (2) the Operational Bioinstrumentation System (OBS): components, donned configuration and on-orbit contingency use; (3) the Anti-Gravity Suit (AGS): components and pressure controller operation; and (4) the Radiation Equipment: components, locations and on-orbit contingency use.

Following completion of MED EQ 2102 Engle and Truly were given 9 hours of medical procedures training in three courses entitled MED PROC 2102, 2201, and 2301.

The premission medical training for astronauts Mattingly and Hartsfield included the workbook self-study course MED EQ 2102 described above. This was followed with an intensive 3 1/2 hour training session on October 2, 1981.

The Shuttle Orbiter Medical System (SOMS-A) is an outgrowth of onboard medical kits which have been in use throughout the history of manned space flight.

The STS-1 Medical Report contains a brief summary of previous medical kits and training.

SOMS-A was designed for use during the Orbital Flight Tests to provide treatment capability for life-threatening emergencies and to permit diagnosis and treatment of many less severe illnesses and injuries. The inventory of the SOMS-A is intended to sustain the medical needs of a two-man crew for up to 14 days.

The following is a partial listing of the contents of the SOMS kit. A complete listing can be found in the STS-1 Medical Report, NASA Technical Memorandum 58240.

Deleted: (Drugs)
- Sudafed
- Periactin
- Phenergan/Dexedrine
- Erythromycin
- Pencillin V.K.
- Ampicillin
- Dulcolax
- Donnatal
- Valium
- Cepacol
- Robitussin
- Aminophylline Suppositories
- Aramine
- Pronestyl
- Vistaril
- Demerol
- 1 Atropine
- Halotex
- Neosporin
- Neocortef
- Pontoncaine
- Absorbtear

Added: (Drugs)
- Amoxicillin
- Terbutaline
- 1 Epinephrine
- 4 Bupivacaine
- 1 Isoproterenol
- 1 Heparin
- 1 Lidocaine
- 1 Morphine
- Polysporin
- Ophthocort
- Proparacaine
- Tears Naturale

Drug Concentration Changes:
- Lidocaine (20 mg/cc ▶ 40 mg/cc)
- Dalmane (15 mg ▶ 30 mg)
- Tylenol (#3 ▶ Plain)
- 3 Phenergan 25 mg/cc ▶ 2 Phenergan 50 mg/cc

Non-drug Additions:
- 2 Heparin Locks
- 1/2" Roll Dermicel tape
- 5 4x4 s
- 1 3" Ace Bandage
- 1 Nasostat
- 10 Telfa Pads
- 1 Needle (22 Ga; 1.5")
- 1 Magnifying glass

Non-drug Removals:
- 1 Surgical Mask
- 1 Binocular Loupe
- 1 Foley Catheter
- 2 IV Butterflies
- 4 ft. I.V. Tape
- 1 IV Tubing

Changes:
- All 2x2 Gauze pads ▶ 4x4 Gauze pads
- PVP Iodine wipes ▶ PVP Iodine swabs

HEALTH STABILIZATION PROGRAM

James K. Ferguson, Ph.D.

The Health Stabilization Program was altered for the STS-2 mission to a level I effort. Level I is an educational program which creates health awareness among the personnel entering crew work areas. The STS-2 mission was the first time a Level I Health Stabilization Program was conducted. Measures were taken that were designed to develop an increased health awareness among those persons working in crew areas. Posters, signs, and information sheets were placed in work areas. Information sheets were also distributed. Briefings were given to the flight crewmembers which recommended illness prevention measures. Since work areas were not restricted to primary contacts, special crew travel routes were established to prevent accidental exposures. All persons who were known to have to be within six feet of a crewmember during the seven days immediately prior to launch were identified as Primary Contacts and badged. Medical consultation was made available to all personnel who worked in crew areas. Security was not used in the work areas or for crew movement from place to place. Health protection for the crew was based on personnel compliance to program recommendations.

The STS-2 Health Stabilization Program was started at 0800 on October 28, 1981, and continued to November 12, 1981.

Table 1

Number, Type, and Location of Primary Contacts

Type	JSC	KSC	Headquarters	Subtotal
NASA	97	12	6	115
Contractor	33	7	0	40
Others	9	0	0	9
Subtotal	139	19	6	164 Grand Total

Only three illness reports were received from the 164 Primary Contacts during the 14 days of program operation. This is an illness rate of nine per 1000 per week compared to a rate of 28 illnesses reported per 1000 per week on the STS-1 mission. Each of the three illness reports was a different illness type.

VALIDATION OF PREDICTIVE TESTS AND COUNTERMEASURES FOR SPACE MOTION SICKNESS

Jerry L. Homick, Ph.D.

Experience from previous manned space flight indicates that if no corrective actions are taken up to 40% of Shuttle crewmembers could experience some degree of space sickness during the first few days of flight. Because of its complexity and uniqueness this biomedical problem cannot be resolved solely with ground based research. To obtain final and valid solutions it is essential that data be collected systematically on individuals who fly Space Shuttle missions.

A Detailed Supplemental Objective (DSO) was developed to initiate this data collection process with the STS-1 mission. A nearly identical DSO was implemented for the STS-2 mission. A primary objective of this DSO was to conduct inflight observations, supported by a series of pre and postflight data collection procedures, on STS-2 crewmembers in an effort to validate ground based tests which may be predictive of susceptibility to the space motion sickness syndrome. An additional objective was to implement crew testing procedures which would enable acquisition of data to be used in validating motion sickness countermeasures.

At approximately F-300 days each crewmember completed a questionnaire designed to elicit pertinent information regarding past experiences with the various types of motion environments and responses to those environments. The questionnaire indicated that both crewmembers had a minimal history of motion sickness susceptibility. During approximately the F-300 to F-270 period of time the crewmembers were tested for susceptibility to experimentally induced motion sickness in the JSC Neurophysiology Laboratory. The standard Coriolis Sickness Susceptibility Index (CSSI) test was used. The results indicated that they both had moderately high resistance to terrestrial motion sickness. Between approximately F-330 and F-270 days both crewmembers conferred with the STS-2 Crew Physician to select a preferred anti-motion sickness medication. The medication was administered to them under operational conditions e.g., Shuttle simulator training to determine any adverse reactions. The efficacy of the selected medication was confirmed by using the CSSI test.

In accordance with the NASA medical operations policy for the prophylaxis and treatment of space motion sickness, both crewmembers utilized anti-motion sickness medication during the early phase of the mission. One of the crewmen experienced what may have been moderate motion sickness symptomatology during the first day of flight only. Neither crewmen reported any vestibular disturbances during landing or postflight.

CREW CARDIOVASCULAR PROFILE

Michael W. Bungo, M.D.

As part of the Orbital Flight Test (OFT) program, STS-2, like its predecessor, STS-1, was designed to verify the operation of the Space Shuttle systems. Cardiovascular data were, therefore, collected in a manner which would have minimal impact on crew activities while still having some predictive value.

The two-man crew of Columbia consisted of the pilot (PLT) and the commander (CDR); data collection was identical for both. Heart rates were monitored during the ascent phase and during entry according to methods described in the STS-1 Medical Report (NASA Technical Memorandum 58240).

A "stand test" was performed on the 22nd day before flight (F-22) and within 1 hour after the crew egressed the Orbiter upon landing (L+0). This test was used as a clinical maneuver to elicit orthostatic intolerance. The heart rate was monitored continuously by ECG and the blood pressure obtained by sphygmomanometry each minute for a total of 15 minutes. During the first 5 minutes, the crewman was at supine rest; during the next 5 minutes, he was seated with his ankles, knees, and hips each flexed at 90°; and during the last 5 minutes, he was required to stand upright without other movement.

Maximum heart rates for both crewmen occurred during the period when the solid rocket boosters were ignited (launch through "SRB sep."). Other peaks occurred at external tank separation (just after main engine cutoff), during the Orbital Maneuvering System (OMS) 1 burn, and approximately 22 minutes into the timeline over the Madrid tracking station. These pychologically/physiologically stressful events correlate extremely well with what was seen during STS-1, even to the accelerated heart rates noted over Madrid at a time one would not have predicted this workload.

If the body weight decreases can be assumed to represent purely single compartment fluid losses, then the PLT lost 28% of his blood volume or 9% of his extracellular fluid. The CDR on the other hand, would have lost 58% of his blood volume or 19% of his extracellular fluid. In actuality, the functional intravascular volume deficit is likely between these extremes and indeed may even vary as "G" load varies.

The volume deficits for the PLT are very similar or only slightly greater than those seen in STS-1 (a flight of equal duration although less complicated). The data for the CDR must be considered with the individual case but also as a likely scenario in future medical operations.

BIOCHEMISTRY AND ENDOCRINOLOGY

Carolyn S. Leach

The biochemistry and endocrinology studies were conducted to provide data which, when integrated with information from other medical disciplines, permit an objective assessment of the individual crewman's health. Additionally, the data collected during the preflight phase of the Shuttle mission provided baseline information for the medical team in detecting and identifying postflight physiological changes which may have resulted from exposure to the space flight environment. The results of these tests not only helped in the clinical assessment of the crewmen but also provided data to compare to previously acquired results on men returning from 2 days in space.

The results show postflight decreases below preflight findings for triglycerides, Mg, Na, K, and AST for both crewman. Postflight increases above preflight values were observed in glucose, cholesterol, BUN, uric acid, bilirubin, calcium, osmolarity, alkaline phos., CPK, angiotensin I, aldosterone, insulin, T3, T4, HGH, ACTH, and LDH. The LDH increases in both crewmen were predominantly the LD4 and 5 bands which causes a pattern in which the first two bands are relatively lower than normal.

The postflight 24-hour urine results showed decreases in Na, K, Cl, Mg, and increases in excretion of cortisol, aldosterone, epinephrine, and norepinephrine when compared to preflight control values.

The test results of STS-2 crewmen were similar to the findings on recovery of previous space flight crews. Table I shows the percent differences of the STS-2 crew's postflight findings compared to preflight values, the percent difference of the post to preflight comparison for the STS-1 crew and the postflight findings on the Apollo crewmen who spent an average of 12 days in space compared to their preflight values. This comparison leads one to the conclusion that the Apollo crewmen probably underwent the most dramatic changes within the first two days of exposure to space flight. Furthermore, these findings on the Shuttle crewmen support the hypothesis that the changes in fluid and electrolyte metabolism probably occur within hours of reaching orbit as have been shown in ground simulation.

TABLE 1

Parameter	Apollo Immediate Postflight % from Preflight Mean	STS-1 Immediate Postflight % from Preflight Mean	STS-2 Immediate Postflight % from Preflight Mean
Osmolality	-0.7	-0.5	5.0
Na	-0.4	-1.0	-1.0
K	-7.3	-6.8	-12.8
C^1	-0.6	-1.0	3.0
Ca	1.0	1.8	6.8
Mg	-5.0	-2.5	-4.8
PO_4	0	12.5	1.9
BUN	11.9	25.5	1.7
Creatinine	8.3	9.3	10.7
Glucose	9.8	1.0	2.6
Triglycerides	-24.3	-31.0	-32.0
Cholesterol	-6.0	-3.0	17.0
Uric Acid	-14.8	-22.0	12.0
Total Bilirubin	12.5	-12.5	113.0
Alkaline Phosphatase	2.8	1.3	18.0
Lactic Acid Dehydrogenase	-10.1	5.3	27.0
SGOT (AST)	-4.2	-14.3	-55.0
Creatine Phosphokinase	-11.3	-6.0	61.0
Angiotensin I	488.0	80.0	275.0
Cortisol	-27.0	-11.0	92.0
Insulin	32.0	81.0	362.0
T_3	-1.0	3.3	-5.0
T_4	12.0	11.5	31.0
HGH	304.0	5.5	30.0
ACTH	-24.0	54.8	-24.0

HEMATOLOGICAL AND IMMUNOLOGICAL ANALYSIS

Gerald R. Taylor, Ph.D.

Hematological and immunological analyses were conducted on the primary and backup crewmembers of STS-2 so that body-function values necessary for the objective assessment of the health status of the crew before launch and immediately after flight could be evaluated by the medical staff. Blood samples were collected by venipuncture from the two prime and two backup crewmembers 62, 22, 10, and 2 days before flight (F-62, F-22, F-10, F-2, respectively). Additionally, blood samples were collected from the two prime crewmembers directly after landing and again 4 days later (L+0, L+4, respectively). Further specifications are given in "Clincial Laboratory Support Plan for Orbital Flight Test (OFT) Missions" (JSC-14374).

The results of analyses conducted on the cellular blood components of the primary and backup crewmembers demonstrate that for the one-month period preceding the flight, there were no unusual variations in the cellular blood components of the four crewmembers. However, there were important alterations in both primary crewmembers after the flight.

A marked postflight hemoconcentration, which reflects the overall body dehydration is illustrated by an increase in the erythrocyte count, increased hemoglobin concentration, and increased hematocrit. The postflight increase in erythrocyte count was 2 1/2 times greater than that which could be explained by the change in the hematocrit, suggesting that the increase in red blood cells was due to another mechanism in addition to simple loss of fluid from peripheral blood. The difference can be shown to be due to a decrease in erythrocyte size (MCV). This volume decrease is likely the result of a change in the dynamic osmotic balance which would cause loss of water into the more concentrated extracellular fluid. Explanatory calculations are outlined below:

- Within the population (n=2) there was a postflight mean increase of 11.8% in the erythrocyte count per unit volume (actually an 11.8% decrease in diluent)

- Simultaneously, there was a mean decrease of 5.4% in the average erythrocyte volume (MCV).

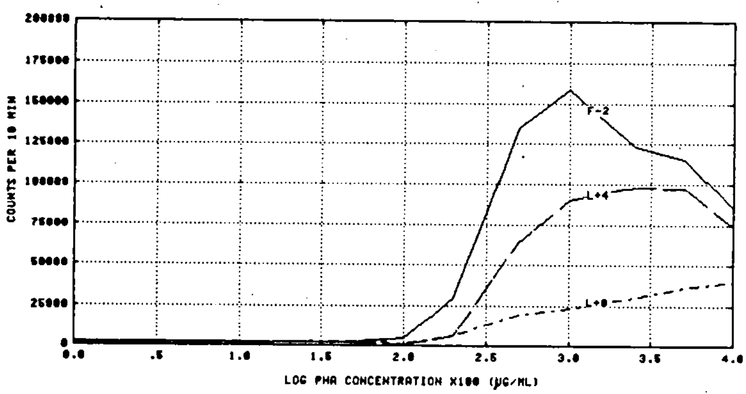
- Therefore if cell Number X cell size = Packed cell volume, 111.8% x 94.6% = 105.76%.

- Accordingly, we would expect the hematocrit to be 5.76% greater postflight. The actual mean postflight increase in hematocrit was 5.95% above the preflight mean. The proximity of these values verifies the analysis.

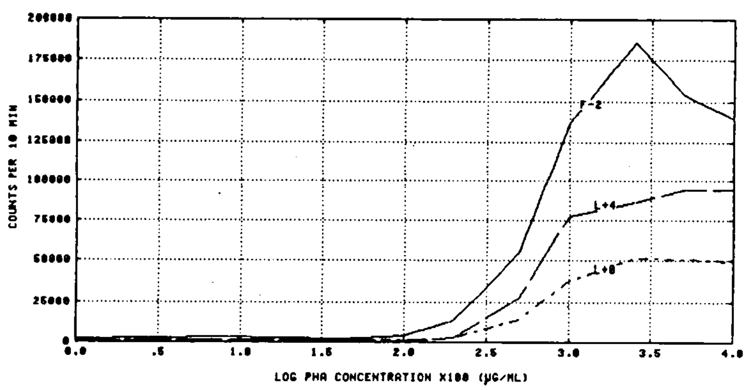
A second phenomenon which may or may not be related to the total body deydration is reflected in the postflight increase in peripheral leukocytes which when divided into its components illustrated a marked increase in neutrophils concurrent with a considerable decrease in lymphocytes and eosinophils.

Typically there is a diurnal increase in the number of neutrophils into the peripheral circulation as the work cycle progresses. However, increases of the magnitude shown here indicate an unusual demargination of neutrophils resulting in a major shift from the marginated granulocyte pool to the circulating granulocyte pool. Such shifts are generally associated with vigorous exercise, pain, stress, nausea, anxiety, anoxia, or unusual mental activity. These same affectors typically mediate a transient lymphocytopenia and eosinopenia. Both lymphocytes and eosinophils demonstrated a marked absolute decrease postflight.

Cell-Immunological Activity: Lymphocytes extracted from crew blood samples were reacted with the mitogen Phytohemagglutinin (PHA) to assess the competence of the *in vitro* immune response. After a suitable incubation period, the blastogenic response was measured by determining the incorporation of radioactive thymidine into newly formed DNA. The data show that there was a significant ($p \leq 0.01$) decrease in the ability of lymphocytes to respond to mitogenic assault postflight as shown in Figure 1. Further, the data show that the deviation was only partially recovered by 4 days after landing. It is possible that this effect is the result of selective margination of T-lymphocyte subsets which are selectively responding to the stress by altering their relative abundance within the circulating pool and the sequestered pool.



(a) Crewmember X



(b) Crewmember Y

Figure 1.- STS-2 maximum PHA response curves.

MEDICAL MICROBIOLOGY OF CREWMEMBERS AND SPACECRAFT

Duane L. Pierson, Ph.D.

The reuse of a spacecraft requires careful microbial monitoring of the vehicle to evaluate the effectiveness of the interim cleanup procedures. The Microbial Contamination Plan implemented for STS-1 was followed for STS-2. The plan consists of specimen collection and subsequent evaluation of the crewmembers and the Orbiter including the interior surfaces, air, potable water and foodstuffs.

Crew Microbiology

Staphylococcus aureus was the most prevalent potential pathogen isolated from the ears, nose, and throat specimens. The only other medically important bacteria isolated from these sites were the Gram negative rods, *Enterobacter aerogenes* and *Acinetobacter calcoaceticus*. The prime commander appeared to carry *Candida parapsilosis* in one or both ears during both pre and postflight examinations. *Candida albicans* was isolated from the backup pilot's throat on one occasion. No potentially pathogenic microbes were isolated from the backup commander. The microorganisms isolated from the ears, nose, and throat specimens of the crewmen were not particularly unusual, and the flight crew experienced no clinical symptoms associated with these microbes.

An alpha-hemolytic streptococci was isolated from the urine specimens of both the prime commander and the prime pilot during the F-10 and F-2 sampling periods. The total number of bacteria cultured from the urine specimens was within acceptable units. No ova or parasites were observed in the the fecal samples of both crews, and *C. albicans* and *Aspergillus terreus* were the only medically important microorganisms isolated.

No significant increases or changes in microbial flora were observed in the prime crewmen subsequent to landing. No detectable exchange of microbes between crewmen was observed.

Spacecraft Microbiology

Two different *S. aureus* strains were isolated from the interior surfaces of the Orbiter. One strain was phage type 79 and the other strain was untypable. These potentially pathogenic strains of S. *aureus* were important because of their isolation location. Type 79 was found on the water dispenser barrel. The food warmer was the site of the other staphylococcal strain. *Enterobacter agglomerans* was the only other medically important bacteria isolated from the surface sites. However, ten different species of the fungal genus, aspergillus, were isolated from the twenty surface sites. These fungi are probably best characterized as potential pathogens under compromising physiological conditions of the human host.

FOOD AND NUTRITION

Richard L. Sauer and Rita M. Rapp

The objective of the STS-2 food system was to provide a safe, nutritious food supply within the various biomedical, operational, and engineering constraints. The food system was designed to be in a convenient, acceptable form which would allow easy manipulation in the null-gravity environment and require a minimum amount of time and effort for both preparation and cleanup.

The standard menu of OFT flights is shown in Table 1. Food stowed aboard Columbia for STS-2 began with meal B on day 1 and continued through meal B on day 6. The pantry for STS-2 is listed in Table 2. The pantry is used on each flight to accommodate individual food preferences and also to function as a contingency food supply in case the mission is extended. On a nominal mission pantry items serve as extra beverages and snacks. Pantry items may also be exchanged for menu items.

Food types and packages used on STS-2 were the same as those used on STS-1 (1). Frozen corned beef sandwiches were prepared in the Johnson Space Center (JSC) Food Facility and transported to the Kennedy Space Center (KSC). Water was placed in two flight beverage packages the day before launch and refrigerated. On launch morning the beverage packages and frozen sandwiches were placed in each astronaut's space suit pocket for their first inflight snack.

Preflight food service was provided for the STS-2 prime and backup crews during Countdown Demonstration Test (CDDT) and the Health Stabilization Period. Meals were prepared and served at both the JSC Preflight Food Facility and the KSC crew quarters. The preflight food service was extended one week due to the launch delay and transferred back to JSC from KSC when the crews returned to Houston.

Inflight nutrient intake was estimated from an inventory of the returned used and unused packages of food. Food packages that were used were all returned together in a trash bag. Packages were not labeled in any way according to crewman use. Visual estimates were made of any food residues. Missing food packages were assumed not to have been used and were not included in the nutrient calculations. Estimated STS-2 Inflight Nutrient Intake is presented in Table 3. The mean daily nutrient calculations presume that food consumption was equally distributed between the two crewmembers; however, there is no evidence to indicate that this was the case.

TABLE 1

SHUTTLE - STANDARD OFT MENU

MEAL	DAY 1[1], 5		DAY 2, 6		DAY 3, 7		DAY 4, 8	
A	Peaches	(T)	Applesauce	(T)	Dried Peaches	(IM)	Dried Apricots	(IM)
	Beef Pattie	(R)	Dried Beef	(NF)	Sausage	(R)	Breakfast Roll	(I)(NF)
	Scrambled Eggs	(R)	Granola	(R)	Scrambled Eggs	(R)	Granola w/Blueberries	(R)
	Bran Flakes	(R)	Breakfast Roll	(I)(NF)	Cornflakes	(R)	Vanilla Inst. Brkfst	(B)
	Cocoa	(B)	Choc. Inst. Brkfst	(B)	Cocoa	(B)	Grapefruit Drink	(B)
	Orange Drink	(B)	Orange-Grapefruit Drk	(B)	Orange-Pineapple Drink	(B)		
B	Frankfurters	(T)	Corned Beef	(T)(I)	Ham	(T)	Ground Beef w/ Pickle Sauce	(T)
	Turkey Tetrazzini	(R)	Asparagus	(R)	Cheese Spread	(T)	Noodles & Chicken	(R)
	Bread (2X)	(I)(NF)	Bread (2X)	(I)(NF)	Bread (2X)	(I)(NF)	Stewed Tomatoes	(T)
	Bananas	(FD)	Pears	(T)	Gr. Beans & Broccoli	(R)	Pears	(FD)
	Almond Crunch Bar	(NF)	Peanuts	(NF)	Crushed Pineapple	(T)	Almonds	(NF)
	Apple Drink (2X)	(B)	Lemonade (2X)	(B)	Shortbread Cookies	(NF)	Strawberry Drink	(B)
					Cashews	(NF)		
					Tea w/Lemon & Sugar (2X)	(B)		
C	Shrimp Cocktail	(R)	Beef w/BBQ Sauce	(T)	Cr. Mushroom Soup	(R)	Tuna	(T)
	Beef Steak	(I)	Cauliflower w/Cheese	(R)	Smoked Turkey	(T)(IM)	Macaroni & Cheese	(R)
	Rice Pilaf	(R)	Gr. Beans w/Mushrooms	(R)	Mixed Italian Vegetables	(R)	Peas w/Butter Sauce	(R)
	Broccoli au Gratin	(R)	Lemon Pudding	(T)	Vanilla Pudding	(T)	Peach Ambrosia	(R)
	Fruit Cocktail	(T)	Pecan Cookies	(NF)	Strawberries	(R)	Chocolate Pudding	(T)
	Butterscotch pudding	(T)	Cocoa	(B)	Tropical Punch	(B)	Lemonade	(B)
	Grape Drink	(B)						

NOTE: [1] Day 1 (launch day) consists of Meal B and C only

Abbreviations

T --- Thermostabilized
IM --- Intermediate Moisture
R --- Rehydratable
I --- Irradiated
FD --- Freeze-Dried
NF --- Natural Form
B --- Beverage (Rehydratable)

Table 2: Pantry for Shuttle Transport System-2 (STS-2)

Rehydratable Beverages	No.	Thermostabilized Food	No.
apple drink	8	beef steak (I)	8
coffee, black	10	corned beef (I)	4
coffee, cream, and sugar	10	ham	4
grapefruit drink	6	salmon	2
lemonade	8	smoked turkey (I)	2
orange drink	8		
tea	10		

Ready-to-eat Snacks	No.	Rehydratable Food	No.
apricots	4	asparagus	2
dried beef	4	beef patty	2
bread	4	green beans with broccoli	2
cookies, shortbread	4	green beans with mushrooms	2
food bar, granola/raisin	4	Italian vegetables	3
peaches, dried	2	peach ambrosia	2
nuts, almonds	4	potato patty	2
nuts, cashews	4	sausage patty	2
nuts, peanuts	4	strawberries	2
peanut butter	4		
crackers	4		

TABLE 3: Estimated STS-2 Inflight Nutrient Intake

nutrient	Units	Total Intake for 2 Men during STS-2 (2 days)	Mean per Man per Day	Recommended per Man per Day
kcalories	g	4399.0	1100.0	3000.0
Protein	g	234.0	58.5	56.0
Carbohydrate	g	608.2	152.0	
Fat	g	112.1	28.0	
Water of Rehydration	ml	4530.0	1134.0	
Moisture in Food	g	353.7	88.4	
Calcium	mg	2749.0	687.0	800.0
Phosphorus	mg	3663.0	916.0	800.0
Sodium	mg	7130.0	1782.0	3450.0
Magnesium	mg	615.0	154.0	350.0
Iron	mg	49.4	12.4	18.0
Zn	mg	37.6	9.4	
Potassium	mg	5449.0	1362.0	2737.0

Water intake was estimated by assuming that the recommended amount of water was used to reconstitute rehydratable food items. Since there is no metering device on the water dispenser, the crew cannot accurately determine the amount of water used to rehydrate foods. In addition, it is not known how much of the water volume was actually displaced by gas in the system. Ignoring these factors, water associated with the food consumed was estimated to include 4500 ml as water of rehydration and 350 ml as moisture naturally occurring in the food, giving a total of 4850 ml water consumed inflight. The water from the container in the crewmen's suit pocket is included in the water of rehydration calculations, but this does not include any other drinking water they may have consumed inflight. Under ordinary circumstances a reasonable water allowance is 1 ml/kcal for adults (2). This allowance appears to have been met during the STS-2 flight since it was estimated that a total of 4400 kcal and 4850 ml water were consumed inflight.

The problems associated with the food system during STS-2 included excessive gas in the water supply and insufficient time to prepare and consume the food due to technical and mechanical problems with the spacecraft.

References

(1) NASA Technical Memorandum 58240, December 1981.

(2) National Research Council, <u>Recommended Dietary Allowances</u> National Academy of Sciences, Washington, D.C., 1980, p. 160.

POTABLE WATER

Richard L. Sauer

To verify that the Shuttle Potable Water System provides water that is potable, samples of water are obtained periodically from the system during its preflight servicing, as well as postflight. These samples are analyzed to determine the continuing chemical and microbiological acceptability of the water. With the exception of a small amount of the Ground Support Equipment (GSE) load water, the bulk of the water consumed inflight comes from the operation of the fuel cells.

A major impact to the STS-2 mission was the failure of one of the fuel cells. Because of the potential of contamination of the potable water tank with water from the failed fuel cell, the potable water tank was isolated and not used for the remainder of the flight. The result was that the water dispense rate was limited to the fuel cell production rate of approximately 12 pounds per hour. This is equivalent to requiring about five minutes to reconstitute a beverage container. The excessive time for beverage and food reconstitution impacted the crew timeline. In addition, excessive gas was found to be present in the water when it was dispensed.

A total of sixteen preflight and four postflight samples of water were taken from the potable water system for STS-2. These consisted of both chemical and microbiological samples. The specific parameters monitored are those listed in NASA Specification SE-S-0073-C "Space Shuttle Fluid Procurement and Use Control".

- Taste and Odor - A slight odor and taste of iodine was detected in several preflight samples. The levels were of no medical consequence.

- Dissolved Gas - One preflight sample drawn from the ambient and chilled quick disconnects indicated the presence of dissolved gas.

- Total Bacteria - Total bacteria exceeded the specification limit of zero up to a maximum of 400 colony forming units per 100 ml (CFU/100 ml) and 250 CFU/100 ml in the initial chilled and ambient water samples, respectively. While exceeding the limit, these levels are not considered significant. The organisms were identified as *Pseudomonas fluorescens* and *Pseudomonas denitrificans*, both being common contaminants of water. Subsequent preflight sampling had negative bacteriological results.

- Yeast and Mold - The ambient water sample taken immediately after loading the potable water tank with GSE water, which had been iodinated 3.5 hours earlier to a level of 4.75 mg/l, indicated 1 CFU/100 ml of yeast and mold. The GSE water initially contained a quantity of yeast and mold which, in time, was destroyed by the iodine. All subsequent samples proved free from yeast and mold.

SHUTTLE TOXICOLOGY

Wayland J. Rippstein

All of the nonmetallic materials used in the interior of the Orbiter crew compartment are known to outgas contaminant compounds. Early in the Shuttle program, a materials testing program was established for determining the kinds and amount of contaminant compounds outgassed. A record of the results of this testing was maintained. From this record, it was learned that a significant number of different compounds (about 400 in number) would be outgassed. Some of these compounds could attain concentration levels above the spacecraft maximum allowable concentration (SMAC) levels allowed by NASA Headquarters document NHB 8060.1B, "Flammability, Odor, and Offgassing Requirements and Test Procedures for Materials in Environments that Support Combustion". No corrective measure for outgassing control was necessary since the environmental control life support system (ECLSS) removed significant amounts of gaseous atmospheric contaminants from the Orbiter spacecraft cabin. The exact removal capability for all the contaminant compounds, determined in the outgassing testing of the candidate spacecraft materials, is not known.

By conducting a series of outgassing tests on the Orbiter crew cabin, the atmospheric contaminant situation of the vehicle was reliably established. This evaluation involved the use of two devices for collecting atmospheric samples. The samples collected were to permit the determination of the kinds and amounts of contaminant compounds in the crew compartment. These samplings were accomplished under Flight Test Objectives (FTO's) 264-01 and 264-02.

This information was finally to be used to extrapolate contaminant gas buildup for up to seven days. The main goal in these activities was to ensure that the cabin atmosphere would be safe for future space crew operations.

Whole Gas Sample Results

Three cylinders containing atmospheric samples were returned to JSC. The sequence in which the sampling cylinders were opened for sample acquisition was not recorded. A total of 99 compounds were identified and quantitated from the three cylinders used for sampling.

Absorbed Gas Sample Results

Although the air sampler assembly was only placed in Day 1 (position "1"), compounds were detected in all seven positions of the device. A total of 86 compounds were identified in the analyses of the air sampler assembly contents.

RADIOLOGICAL HEALTH

Robert G. Richmond

It has been shown that manned space flight results in exposure of astronauts to a radiation environment that is significantly more complex than that normally associated with the radiological health environment for industrial workers. In space, the radiation environment can be considered to be composed of three components: (1) particles trapped by the Earth's magnetic field (the Van Allen radiation belts); (2) particles of solar origin (those particles customarily associated with solar flare activity); and (3) galactic cosmic rays and their secondary components. Historically the radiation dose received by crew members has been minimal. Carefully conceived operational procedures and the selection of judicious flight profiles have played a major role in minimizing radiation exposures to the crews.

A record of all radiation exposure received by the astronauts is maintained as part of the astronaut's medical record. The measured dose of radiation encountered by the space crew during each mission is added to the individual crewman's medical record.

As in the case of the STS-1 dosimetry, the measurements obtained in the STS-2 mission (See Table 1) indicate a very small radiation exposure. This is not an unexpected situation because of the low inclination and altitude of the flight profile and the short duration of the mission.

TABLE 1 SUMMARY OF RADIATION MEASUREMENTS FOR STS-2

DOSIMETER S/N	LOCATION	TLD** DOSE (MRad)	POCKET DOSIMETER DOSE (mR)
0201	COMMANDER	7.5 ± 2.0	NONE WORN
0202	PILOT	9.2 ∓ 2.1	NONE WORN
0205	POUCH 1*	12.5 ∓ 2.2	16 2.0
0206	POUCH 2*	12.1 ∓ 2.2	12 1.7
0207	POUCH 3*	11.0 2.1	10 1.4
0208	POUCH 4*	15.0 2.3	13 1.7
0209	POUCH 5*	10.5 2.1	13 1.7
0210	POUCH 6*	10.9 2.1	11 1.5

NOTE: These values have been corrected for background

NOTE: TLD doses in mRAD, pocket dosimeters in mroentgen

* Pouches not deployed.

** Avg. value of 1 CaF_2 (TLD-200) and 1 LiF (TLD 700), Benton, et al., Ref. 1.

CABIN ACOUSTICAL NOISE

Jerry L. Homick, Ph.D.

All of the noise levels measured on STS-2 were considerably in excess of the level (55 dBA) specified by JSC Standard 145. Noise levels at several locations (e.g., forward avionics bay, WCS operation, ARS servicing housing and aft air outlet) exceeded the level (76 dBA) beyond which permanent physiological damage to the crewmen's auditory system may be expected to occur. It should be noted, however, that these high readings were obtained with the sound level meter microphone in very close proximity to the noise source or in an air flow. Such measurement conditions would lead to artificial results which would not be representative of the real noise at the crewman's ear.

	Octave Band SPL								
Hz	63	125	250	500	1K	2K	4K	8K	dBA
JSC Standard 145 (NC50)	73	66	60	55	52.5	50	48	47.5	55
Flight Deck (aft overhead window)	65	64	58	59	66	62	62	48	67*
F5 Air Outlet (Flt. Deck)									76
Aft Air Outlet (Flt. Deck)									77
Sleep Location (Flt. Deck, Seats)									61
Sleep Location (Flt. Deck, Floor behind Seats)	59	60	63	57	61	56	51	44	64
Mid-Deck Center (Mid-deck)									68*
IMU Inlet (Mid-deck)	64	63	66	57	62	62	61	55	68
Ceiling Air Outlet (Mid-deck)									71
FWD Avionics Bay (Mid-deck)									80
WCS Air Inlet (Mid-deck)									75
WCS Operation (Mid-deck)									87
ARS Servicing Housing (Mid-deck)									77

Two measurement locations (those marked with an * in the above Table) were common to STS-1. The noise levels measured at these locations were very similar on both flights.

From a physiological point of view the noise levels measured on STS-2 were not hazardous to the crewmen's hearing. Continuous exposure to the measured mid-deck noise spectrum for periods up to 7 days in duration would not cause permanent hearing damage. However, some temporary hearing threshold shifts could be expected. These temporary shifts could have subtle effects on speech communications and auditory signal detection. It was for this reason that JSC earlier developed a guideline which recommended that in spacecraft noise environments between 65 dBA and 75 dBA hearing protection devices be worn during sleep to permit recovery from noise induced temporary threshold shifts.

During postflight crew debriefings the STS-2 crew stated that noise did not appear to interfere with sleep, nor did noise interfere with communications.

ENVIRONMENTAL EFFECTS OF SHUTTLE

Andrew Potter, Ph.D.

The environmental effects of the exhaust cloud produced by the launch of STS-2 were monitored at the Kennedy Space Center (KSC), Florida. Sonic booms were measured during STS-2 Orbiter reentry and landing at Edwards Air Force Base (EAFB), California the measurement stations were clustered around the maximum overpressure zone near EAFB.

Launch Exhaust Cloud Measurements

The launch generated a cloud of exhaust products, averaging about 1000 meters in diameter, which moved southward along the Banana River at an altitude of about 1500 meters. The cloud was composed of aluminum oxide dust, liquid HCl aerosol, and gaseous HCl, plus small amounts of fine particulates swept up from the launch pad area.

TABLE 1

METEOROLOGICAL CONDITIONS FOR STS-2 LAUNCH

PARAMETER	ALTITUDE SURFACE	1047 m Cloud Bottom	3048 m Cloud Top
Dry Temp.(^{o}C)	22.4	11.7	5.6
Wind Speed (m/sec)	7.7	8.8	8.8
Wind Direction (deg)	338	28	354
Relative Humidity(&)	67	100	17
Barometric Pressure (mb)	1016.0	900.0	707.0

The launch exhaust cloud produced a fallout of acidic dust and mist similar to STS-1. The fallout did not produce significant harm to personnel, vegetation, or automobiles. It now seems likely that the fallout is associated with the deluge water, and will occur for most, if not all, future launches. Surface concentrations of gaseous HCl were negligibly small in both STS-1 and STS-2 launches. Airborne concentrations of HCl were similar in both launches to values previously observed in a Titan cloud.

Sonic boom levels produced by Orbiter reentry were about 10-20% less than expected, possibly due to the strong cross-winds, which may have blown the maximum overpressure region away from the measurement stations.

MEDICAL INFORMATION MANAGEMENT

Edward C. Moseley, Ph.D.

The STS-1 Medical Report (December 1981) indicated the need for increased automation of Medical Operations. Further, the report documented progress made by STS-1 toward completing some major automation objectives including progress in hardware, software, security, data organization, input formats, and standardized reporting. These same resources were utilized in STS-2.

All hardware, software, data organization, and input formats used for both STS-1 and STS-2 worked well. New access codes were issued for STS-2 and a formal approval procedure for data access was established and followed. Better security training was provided to all medical personnel and each were instructed on how to change their own password at any time. In addition, steps were taken to protect the physical integrity of the data by periodically storing the latest disk file in a vault located in another part of the building. In general, the improved STS-2 security systems worked well although additional improvements were identified and are currently in work.

Training in utilization of the system by Flight Surgeons as well as Biomedical Engineers was more timely and complete.

Information systems installed for STS-1 and reused for STS-2 worked well. Prior to STS-2, a variety of new features were added to the Medical Information Management System. Among these were the capability for electronic mail, blood/urine trend displays, family and medical history, previous physical examinations, a program to aid in generating and distributing shift reports, and menus to aid in selecting the desired information. A new graphics terminal and hardcopy unit were added to the Medical Staff Support Room in MCC. Finally, improved security measures were implemented. All of these additions appeared to work well.

MANAGEMENT, PLANNING, AND IMPLEMENTATION OF MEDICAL OPERATIONS

Norman Belasco

Section I

Management of Medical Operations

The Medical Operations Management Objectives for STS-2 were organization, implementation, and direction of a Medical Operations team that would effectively and efficiently provide for:

- Assuring the health of flight personnel during all segments of the Shuttle missions as well as providing medical management, analysis, treatment, and expertise throughout the Shuttle OFT Program planning from preflight through postflight phases.

- Required medical participation in program management, and for medical and bioengineering expertise. Such tasks encompass the planning and implementation of incremental flight activities, procedures, training, and testing as well as all other areas or specific items that have a direct or indirect relationship to crew health, including Emergency Medical Services.

- Acquisition of data as an addition to the medical information base for enhancing future manned flights, initiating as well as verifying selected transitional changes in the Shuttle health care services (and procedures) in preparation for the STS mature operation phase of the Space Shuttle.

In summary, all elements of the Medical Operations system functioned as intended throughout the mission preparation, preflight, inflight, landing and postlanding phases.

Section II

Medical Operations Planning

The Medical Operations planning objectives were to provide coordinated, accurate, comprehensive plans and planning activities, that would be the "roadmap" for Medical Operations conduct and integration with the other Shuttle operations facets.

The success of the readiness reviews, mission verification exercises, and STS-2 mission support attest to the high quality of management, planning, coordination, and implementation achieved in support of this second STS flight. It is estimated that changes and improvements to the existing Medical Operations system for STS-3 will be in the order of 3 percent, at most.

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TM-58245		

4. Title and Subtitle	5. Report Date
STS-2 Medical Report	May 1982
	6. Performing Organization Code
7. Editors Sam L. Pool, M.D., Philip C. Johnson, Jr., M.D. and John A. Mason	8. Performing Organization Report No. S-514
9. Performing Organization Name and Address Lyndon B. Johnson Space Center Houston, TX 77058	10. Work Unit No. 199-89-00-00-72
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546	13. Type of Report and Period Covered Technical Memorandum
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The medical operations report for STS-2, which includes a review of the health of the crew before, during, and immediately after the second Shuttle orbital flight (November 12-14, 1981) is presented. Areas reviewed include: health evaluation; medical debriefing of crewmembers; health stabilization program; medical training; medical "kit" carried in flight; tests and countermeasures for space motion sickness; cardiovascular profile; biochemistry and endocrinology results; hematology and immunology analyses; medical microbiology; food and nutrition; potable water; Shuttle toxicology; radiological health; cabin acoustical noise. Also included is information on: environmental effects of Shuttle launch and landing, medical information management; and management, planning, and implementation of the medical program.

17. Key Words (Suggested by Author(s)

Toxicology	Radiation Hazards
Acoustic Noise	Environmental Effects
Medical Science	Nutrition
Management, Planning	Crews (Health)
Medicine	Motion Sickness
Cardiovascular System	Water
Training Simulators	Hematology/Immunology
Biochemistry/Endocrinology	Microbiology
Food	

18. Distribution Statement

Unclassified - Unlimited
Subject Category: 51

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	31	

*For sale by the National Technical Information Service, Springfield, Virginia 22161

JSC Form 1424 (Rev Nov 75) NASA — JSC