MEDICAL/BEHAVIORAL EXPERIMENTS

BIOMEDICAL AND BEHAVIORAL EXPERIMENTS

I. GENERAL PROGRAM DESCRIPTION

OBJECTIVES

The objectives of the medical/behavioral experiments program are:

A. To extend man's capabilities in manned space flight by determining:

1. The effects of space flight on man, and the time course of these effects.
2. The specific etiologies and mechanisms by which these effects are mediated.
3. The means of predicting the onset and severity of undesirable effects.
4. The most effective means of prevention or correction of undesirable effects.

B. To obtain scientific information of value to conventional medical research and practice.

The objectives outlined for this study will be obtained by means of individual measurements to explore each of the eight areas of body function toward which the medical/behavioral program effort has been directed. In pursuing these objectives, basic principles apply which relate clearly to flight program planning.

1. The key variable in the evaluation of man in space is duration of flight. Thus, medical/behavioral measurements of flight crew members will, as a general rule, be required more frequently during the extended portion of an incremental mission than earlier in that mission, although they will, in general, be qualitatively the same. An exception to this general principle will be measurement of initial changes (first 48 hours).
2. It is important to obtain as great a redundancy of pertinent measurements of individual crew members as is practicable in any given flight configuration to establish statistical validity.
3. A major practical aim of this effort is to utilize these observations to be prepared with appropriate preventive or remedial techniques such as lower body negative pressure, special exercises, and other conditioning methods for maintaining man in a satisfactory condition during future long-duration missions. This will include the evaluation of the long term effects of zero-G to determine the desirability or need for artificial gravity i.e., to conduct the observations required in order to make the so-called "g decision."

The eight areas of study include: (1) neurophysiology; (2) cardiovascular function; (3) pulmonary function and energy metabolism;

(4) nutrition and musculoskeletal function; (5) endocrinology; (6) hematology and immunology; (7) microbiology; and (8) behavioral response.

PROGRAM

The medical/behavioral experiments program is functionally organized in the following manner:

I. Medical/Behavioral Experiments

A. Determination of requirements and maintaining relationships, support, and participation of the scientific community.

B. Review of experiment proposals for scientific merit.

C. Support of experiments in definition.

D. Selection, conversion, and support of experiments for development phase.

E. Support and guidance during operational data gathering, and post-mission data reduction and reporting phases.

F. Application of data to the medical/behavioral experiments program, manned space flight, and the civilian community, as indicated.

II. R&D Support of Medical/Behavioral Experiments Program

A. IMBLMS (Integrated Medical and Behavioral Laboratory Measurement System)

B. Parallel development efforts to advance states-of-the-art in measurement techniques and equipment to enhance the capabilities of IMBLMS and proposed experiments.

C. Simulations and ground-based data, i.e., the support of ground-based simulation and other studies in order to obtain a body of pertinent data as a normative or control base to permit the extraction of valid conclusions from flight data.

The experimental package proposed for Skylab I, SL 1 through 4, presently consists of sixteen individual experiments which serve six of the eight areas of medical investigation now defined. These are: (1) nutrition and musculoskeletal function; (2) cardiovascular function; (3) hematology and immunology; (4) neurophysiology; (5) behavioral effects; and (6) pulmonary function and energy metabolism. In addition to these 16 MSFEB-approved experiments, four more are currently in the definition phase. One of these is in the hematology area, two are in nutrition and musculoskeletal function, and one in endocrinology. Appendix A is a list of the presently approved Skylab medical/behavioral experiments with areas, personnel, and designators identified. All of these and all of the medical/behavioral experiments now in definition will be completely accommodated by the IMBLMS. Appendix B lists the measurement capability of the IMBLMS.

Since the duration of crew exposure to the space flight environment is the major variable of this investigational area, all or most experiments will be repeated on missions of increasing durations irrespective of the particular flight programs which are able to carry them. It is anticipated, therefore, that Skylab I experiments will be repeated on Skylab II, and these on the Space Station, etc. By and large, this will hold true until experimental hypotheses can be sufficiently well established or disproved. At the same time, new experiments will be added as they become ready for development and are evaluated and approved for manned space flight programs.

II. IMBLMS - DESCRIPTION & INTERFACE REQUIREMENTS

A. The Integrated Medical and Behavioral Laboratory Measurement Systems (IMBLMS) is a highly flexible and sophisticated laboratory system designed to accommodate the medical and behavioral measurements required for existing experiments as well as those anticipated for the future. Its two basic aims are: (a) the accommodation of medical and behavioral investigations in accordance with the full objectives of the program; and (b) the provision of maximum flexibility. It is basically a rack and module system which can be assembled into working consoles according to the requirements of the medical/behavioral experiments program and the spacecraft for any particular mission. As a design goal it will employ maximum commonality of measurement techniques as well as functional and structural elements. Hardware modules and submodules for specific experiments can be developed to fit specifications of the IMBLMS and utilized on an "as needed" basis for any particular mission. The flexibility afforded by the modular approach will thus significantly reduce lead-time requirements, enhance inflight maintenance, and enable the relatively inexpensive introduction of updated techniques and equipment. The IMBLMS will consist of five functional elements: (1) physiological; (2) behavioral; (3) biochemical; (4) microbiological; and (5) data management. Together they will accommodate required measurements of all eight areas of investigation to which the medical/behavioral experiments program is directed.

For Skylab II and the Space Station, the IMBLMS will be composed of two or three consoles plus five or six pieces of peripheral equipment hard-mounted to the spacecraft. Presently identified peripheral equipment includes the bicycle ergometer, rotating litter chair, lower body negative pressure device, body mass measurement device, and the specimen mass measurement device. Figure 1 is a rough sketch of the general concept of IMBLMS.

The following IMBLMS specifications are presently foreseen estimates. The values given below are only rough approximations and must be treated as such. It should be carefully noted that these provisional specifications will be subject to alteration as the development effort continues.

<u>Weight</u>	- Ascent	1200-1500 lbs.	(~ 500 lbs. of peripheral requirement included)
	- Return	150-200 lbs.	(per resupply)
<u>Volume</u>	- Ascent	265-350 $ft.^3$	(including ~ 62 $ft.^3$ for peripheral equipment)

<u>Dimensions</u> - Consoles:

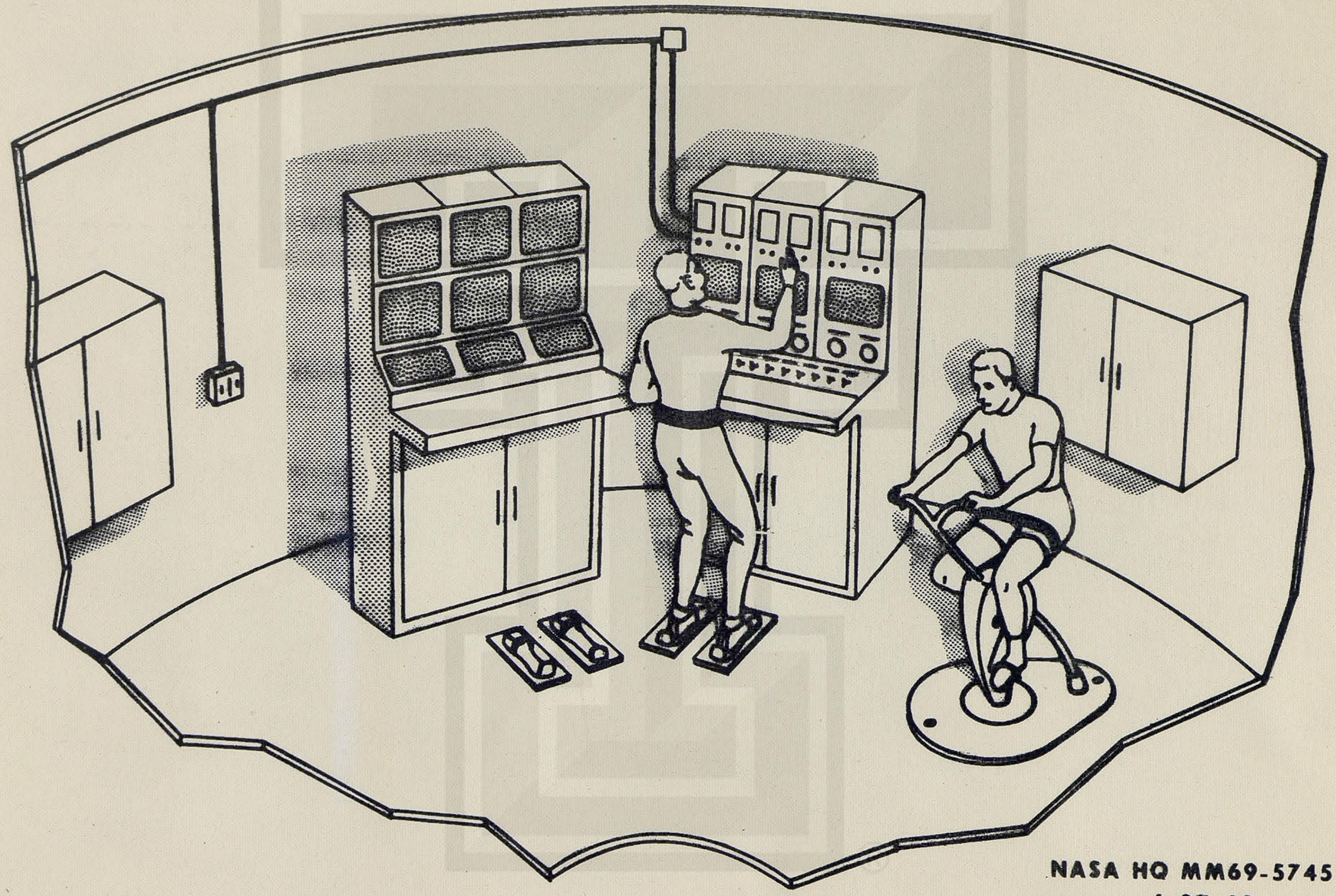
If two consoles, of the order of 5x5.5x2 ft. each
If three consoles, of the order of 5x3.5x2 ft. each

Peripheral Equipment: (See descriptions of each)

<u>Power</u> -	Average -	~ 700w
	Peak -	~ 1800w
	Standby -	~ 50w
	TOTAL -	Dependent upon mission
<u>Data</u> -	Analog -	Includes TV
	Digital -	Max. rate 256 KBS
	Film -	For use with Skylab or Space Station developed camera
	Tape -	For both analog (including video) and digital data
<u>Thermal</u> (BTU/hr)	-	Standby - ~ 170 BTU/hr
		Operate - ~ 2000 BTU/hr

IMBLMS

INTEGRATED MEDICAL / BEHAVIORAL LABORATORY MEASUREMENT SYSTEM



NASA HQ MM69-5745
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Mode of Operation

Cabin temperature control of 75°F ± 5°F required. Nominal zero g required when evaluating the effects of weightlessness; artificial gravity when evaluating comparative effects of artificial g. No attitude requirements.

Role of Man

IMBLMS is a system of laboratory equipment operated by man to evaluate man. Therefore, man is an absolute requirement. Crew time requirements:

(a) For performance, approximately 12-15 hours per man per week estimated requirement

(b) Maintenance time: Unknown at present

Crew Skills

Specially trained M. D. mandatory. Additional specially trained physiologist desirable. IMBLMS maintenance technician essential. This can be a crew member trained in electronic maintenance for other Space Station equipment as well. He should be thoroughly familiar with the systems aspects of IMBLMS.

Operation

IMBLMS will be in operation an estimated 6 to 8 hours/day, 6 days a week. The medical astronaut will be the primary operator. The physiologist (if one is aboard) will be his secondary operator. At least one of them will be in attendance whenever IMBLMS is being used for flight crew evaluation. Primary responsibility for medical experiments, IMBLMS and its use will rest with the medical astronaut at all times. It is envisioned that IMBLMS will be operated much like a physician operates his office. The operator will see and run specific studies on a succession of crew members each day according to a predetermined plan. Long term missions will require a formal flight plan prior to launch, but the medical astronaut must retain a degree of latitude to change the schedule and procedures with the concurrence of Earth-based P.I.'s.

Anticipated frequency of operation of peripheral equipment in Skylab is given on the data sheets in Section II.B. It should be noted that these estimates apply only to Skylab I. They are only rough estimates which are likely to change. They are included only to provide very general guidance to the experiments module, Space Station, and Skylab II contractors and planners.

Waste Management

There is a spacecraft interface requirement between IMBLMS and Waste Management. The obtaining of urine and fecal samples is not a part of IMBLMS; nor does IMBLMS provide a specific urine volume measurement technique. These are the Space Station contractors' responsibilities; however, they are of the highest order of importance to the attainment of the medical and behavioral experiments program objectives. Disposal of urine samples, feces, and other waste materials must also be provided by the Space Station contractors. Although the specific volumes of waste materials are presently unknown, it is envisioned that they will consist of such items as blood specimens, disposable syringes, radioisotopes, lancets, needles, fibrous materials (viz. cotton), plastic or glass slides and reaction containers, chemicals, and electrode jellies and paste.

Consoles

The consoles will require mounting to the structure of the Space Station for operation. The location and orientation of the consoles are not critical except that they should be all located in the same general laboratory area. The console and subject should be in the viewing cone of the experimenter. The interfaces between the consoles and Space Station will require provision for structural mounting, electrical power, waste management, vacuum, and thermal control. Pressurizing gas may be an interface requirement, but it may be included in the IMBLMS.

Note: In the case of suited IVA experiments, interfaces between suit and spacecraft are not a part of IMBLMS considerations.

Peripheral Equipment

* (1) Body Mass Measurement Device

* (2) Bicycle Ergometer

* (3) Specimen Mass Measurement Device

* (4) Rotating Litter Chair

* (5) Lower Body Negative Pressure Device

(* See attached pages. These data were taken from approved EIP's for Skylab I medical experiments and changes may be made for Skylab II and Space Station experiments. All weights, sizes, and power for peripheral equipment are included in the overall IMBLMS estimates.)

Data System

The data management system of IMBLMS is a building block type of system. It will accept, compress, handle, process, display, and condition for transmission to the ground data from measurements performed with IMBLMS. The system provides for computer operation to fulfill its normal requirements, but it has the additional capability of a limited backup non-computer mode. The building block concept of the IMBLMS data management system provides a range of options from complete self-containment to varying degrees of reliance on the spacecraft data management system. The extent of this reliance will depend upon the capability and availability (timing as well as time) of the spacecraft data system to meet the somewhat heavy IMBLMS requirements. In any case, an interface will be required between the IMBLMS data management system and the Space Station transmitter and receiver, since IMBLMS has no transmitting or receiving capabilities other than through the spacecraft.

II. B. IMBLMS PERIPHERAL EQUIPMENT COMPONENTS

BODY MASS MEASUREMENT DEVICE (BMMD)

Characteristics:

Weight - 38 lbs. Launch (25# BMMD 13# Stowage Box)

Size - 14 cu. ft. Launch - 28 cu. ft. Operational
0 Return

Power - 2 watts, 28 VDC (supplied through IMBLMS)

Spacecraft Interface

Mounting brackets are required in the Space Station for operation. These should be braced for maximum rigidity. Location and orientation of the BMMD should be in the area of the support console and in the viewing cone of the experimenter.

Environmental Constraints

Thermal (Stored and Operational)		-51 to +70°C
Atmospheric Pressure		25 psia to 1 x 10^{-6} mm Hg
Relative Humidity		0%- 100%
Acceleration	Storage	0 - 7g
	Operation	0 - 1g
Vibration (Storage) Random		20 to 100 cps - linear increase (log by log plot) from 1.001g^2/cps to 0.075 g^2/cps
		100 to 500 cps- constant at 0.075g^2/cps
		500 to 1000 cps-linear decrease (log by log plot) from 0.075g^2/cps to 0.015g^2/cps
Shock		30g
Dimensions:	Stored:	28 x 22 x 24 inches
	Operational:	36 x 22 x 48 inches

Time Requirements: Calibration once/week, 1 man, 25 minutes.
Test: Each astronaut once/day - 5 minutes.

Body Mass Measurement Device & Specimen Mass Measurement Device

BICYCLE ERGOMETER

Characteristics:

Weight - 150# Launch
0 Return

Size - 12 ft^3 Launch
0 Return

Power - 48 watts (supplied through IMBLMS)

Spacecraft Interface

The bicycle ergometer will interface structurally with the Space Station. The mounting rails of the Space Station must be strong enough to withstand any torque applied by the astronaut during exercise.

Environmental Constraints - None

Subsystem Support

All power and recording requirements will be obtained from IMBLMS.

General Operational Requirements

There are no spacecraft orientation requirements other than those required to maintain a stable thermal environment.

Dimensions	Stored:	12 x 15 x 14 inches
	Operational:	30 x 36 x 14 inches

Time Requirements: 1 experiment/man/week, 120 minutes each

NASA
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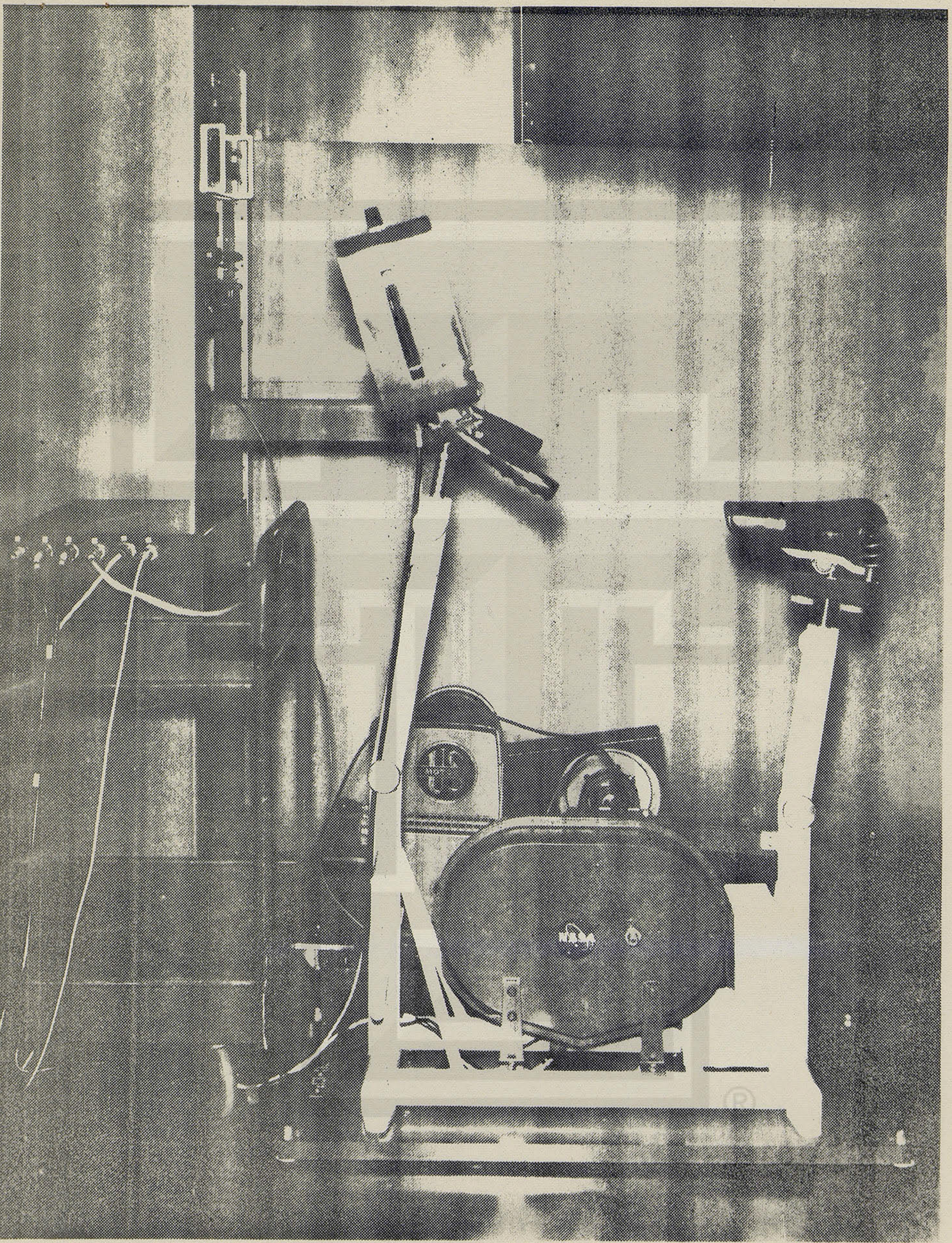

Bicycle Ergometer

SPECIMEN MASS MEASUREMENT DEVICE (SMMD)

Characteristics:

Weight - 14 lbs. Launch (3# Stowage Box + 11# SMMD)
0 lbs. Return

Size - 0.3 $ft.^3$ Launch
0 $ft.^3$ Return

Power - 2 watts, 28 VDC (supplied through IMBLMS)

Spacecraft Interface

Undetermined at present. May interface with Space Station for storage. May interface with IMBLMS during operation.

Dimensions
Stored: 6 x 10 x 8 inches
Operational: 6 x 10 x 14 inches

Time Requirements: 90 minutes/day, operator only

(See Photo: Body Mass Measurement Device (BMMD))

ROTATING LITTER CHAIR (RLC)

Characteristics:

Weight - 265 # Launch (container plus equipment)
10 # Return (otolith test goggles - OTG)

Size - 11.2 ft.^{3} Launch 38 ft.^{3} operational
84 in.^{3} Return (goggles)

Power - 180 watts average, 400 watts peak (supplied through IMBLMS)

Spacecraft Interface

Provision must be made for structurally mounting the rotating litter chair base to the Space Station. Adequate support in the form of cross members is essential to provide a stable platform for the RLC. A minimal lighting intensity of 20 ft. candles is required.

Subsystem Support

None from the Space Station.

Environmental Constraints - None other.

Dimensions: Stored: 22 x 26 x 10 inches
Operational: (a) As chair, about those of a Barany chair
(b) As litter, about those of an operating room table (exact dimensions unavailable)

Time Requirements: Each astronaut one test every second day
Each test: 60 minutes

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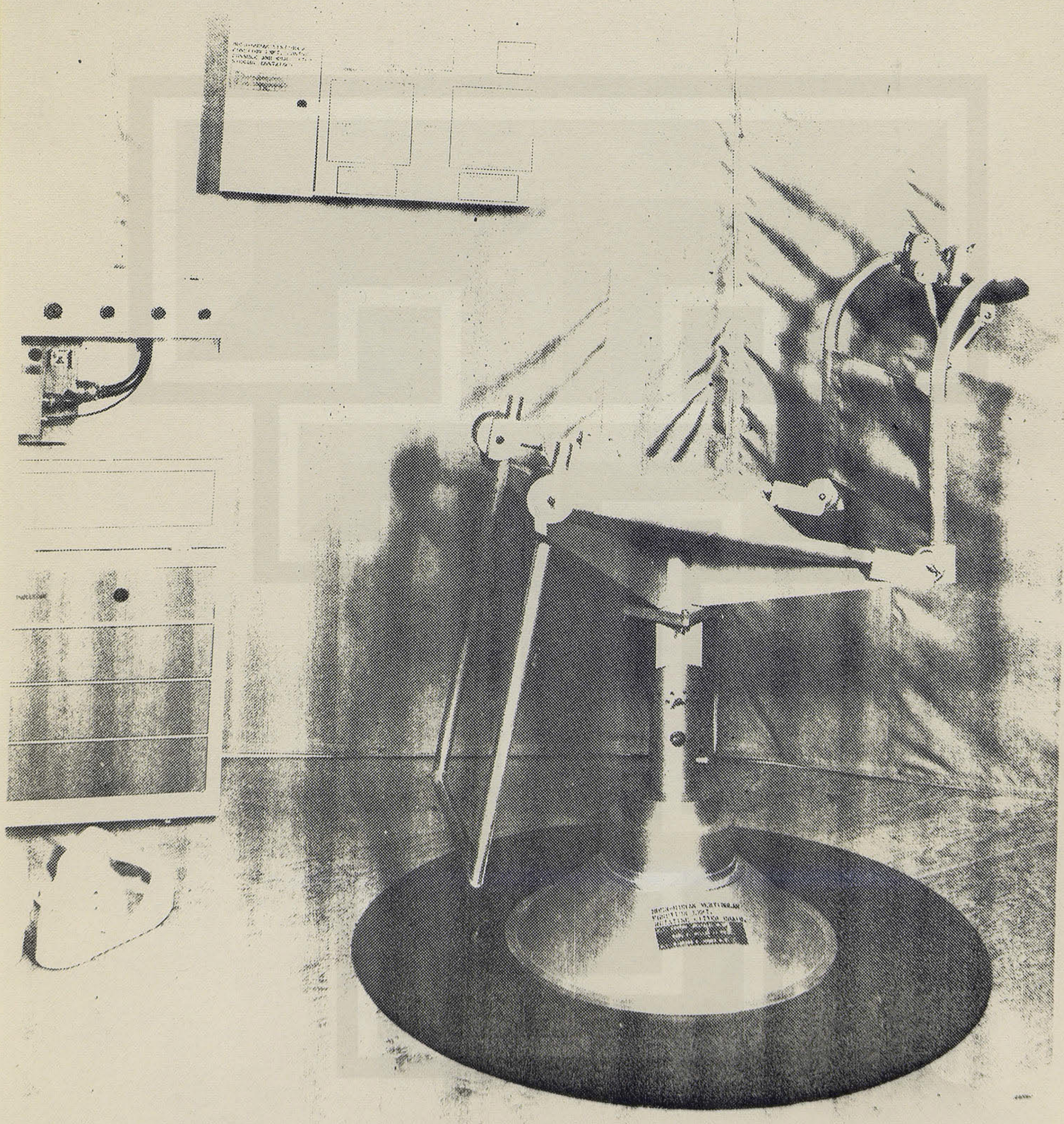
S-67-47301



Rotating Litter Chair

LOWER BODY NEGATIVE PRESSURE DEVICE (LBNP)

Characteristics:

Weight	-	33# Launch 0 Return
Size	-	5 $ft.^3$ Launch 10.6 $ft.^3$ operational Return
Power	-	28 VDC

Spacecraft Interface

Operational mounting location and provisions must be provided which allow subject free access to open end of the LBNP and enough clearance for comfortable space operation. Location of the LBNP device should be in the area of the supporting console and in the viewing cone of the experimenter.

Environmental Constraints - None

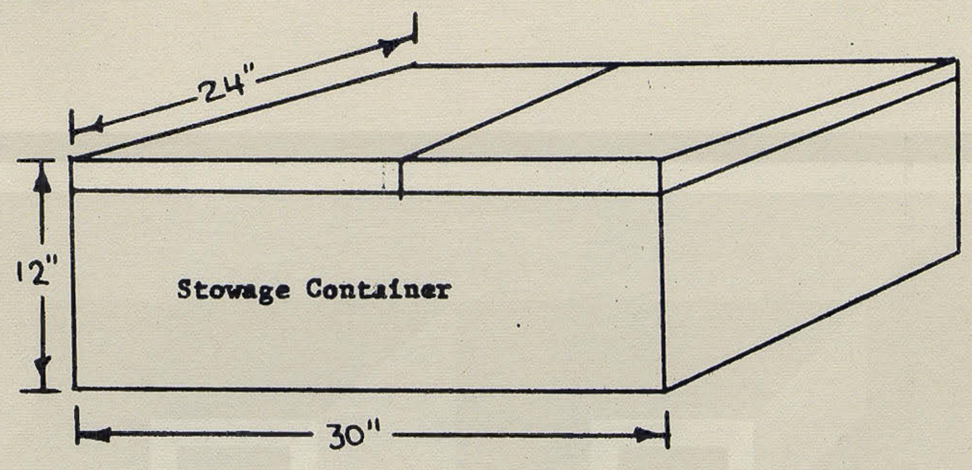
General Operational Requirements

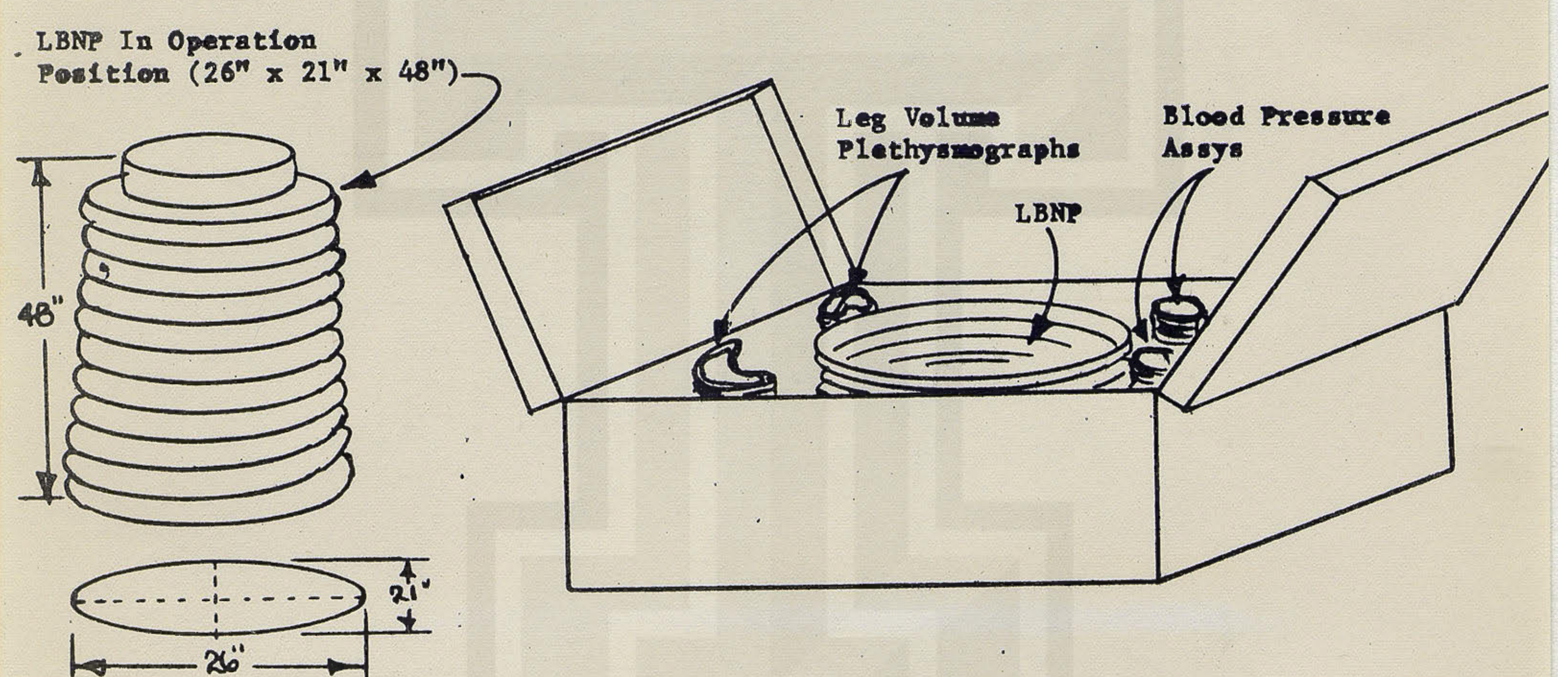
Flight Operational Requirements - None

Dimensions: Stored: 24 x 30 x 12 inches

Time Requirements: One test for every subject every fourth day, 75 min/test.

2. **ENVELOPE**


24"
12"
Stowage Container
30"


LBNP In Operation
Position (26" x 21" x 48")
48"
21"
26"
Leg Volume
Plethysmographs
LBNP
Blood Pressure
Assys

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II. C. SCHEDULE/AVAILABILITY

II. C. SCHEDULE/AVAILABILITY

Phase B3 of the IMBLMS effort was completed in February 1970. Two contractors worked competitively during this 14-month phase which consisted of the construction, test, delivery, and installation at MSC of IMBLMS functional breadboards. The competition will continue to the end of Phase B4, the preliminary design of a flight IMBLMS. This phase, begun in April 1970, will also result in the delivery of full planning documentation and competitive technical and cost proposals for Phases C and D. The full flight IMBLMS will be flown aboard the Space Station. An earlier, less complete IMBLMS will be readied for flight aboard Skylab II. However, schedules will be altered in accordance with manned space flight requirements. All of the Skylab experiments, candidate Skylab experiments, and medical/behavioral experiments currently in definition will be served by the IMBLMS aboard Skylab II and Space Station, according to present planning. During the time period between now and the flight of IMBLMS new medical/behavioral experiment proposals will be received, some of which will be approved for support and ultimate flight. It is believed that the planning of the IMBLMS has provided for most of these, but if additional equipment should be necessary, Skylab and Space Station planning should remain flexible enough to accommodate it.

APPENDIX A

SKYLAB MEDICAL/BEHAVIORAL EXPERIMENTS APPROVED AS OF July 1969

M070 - NUTRITION AND MUSCULOSKELETAL FUNCTION (Governing Protocol)

Principal Coordinating Scientist: Paul C. Rambaut, Ph.D., MSC

Assistant Coordinating Scientists: Richard Boster, D.V.M., MSC
Miss Rita Rapp, MSC
Malcolm Smith, D.V.M., MSC

Individual Experiments or Measurements:

M071 - Mineral Balance

Principal Investigator: G. Donald Whedon, M.D., NIH

Co-Investigator: Leo Lutwak, M.D., Ph.D.
Cornell University

M072 - Bone Densitometry

Principal Investigator: Pauline B. Mack, Ph.D.
Texas Women's University

M073 - Bioassay of Body Fluids

Principal Investigator: Craig L. Fischer, M.D., MSC

Co-Investigator: Carolyn Leach, Ph.D., MSC

M074 - Specimen Mass Measurement

Principal Investigator: John Ord, Colonel, USAF, MC
Brooks AFB, Texas

Co-Investigator: William Thornton, M. D., MSC

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M090 - CARDIOVASCULAR FUNCTION (Governing Protocol)

Principal Coordinating Scientist: G. W. Hoffler, M.D. (Acting)

Individual Experiments or Measurements:

M091 - LBNP (Pre- and post-flight)

Principal Investigator:	John Ord, Colonel, USAF, MC Brooks AFB, Texas
Co-Investigator:	Robert L. Johnson, M.D., MSC

M092 - Inflight LBNP

Principal Investigator:	R. L. Johnson, M.D., MSC
Co-Investigator:	John Ord, Colonel, USAF, MC Brooks AFB, Texas

M093 - Vectorcardiogram

Principal Investigator:	Capt. N.W. Allebach, Bureau of Medicine & Surgery, Washington, D.C.
Co-Investigator:	R. F. Smith, M.D., Naval Aerospace Medical Institute, Pensacola, Fla.

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M110 - HEMATOLOGY AND IMMUNOLOGY (Governing Protocol)

Principal Coordinating Scientist: Craig Fischer, M.D., MSC

Individual Experiments or Measurements:

M111 - Cytogenetic Studies of Blood (Pre- and post-flight)

Principal Investigator:	Michael Bender, Ph.D., ORNL, Tenn.
Co-Investigator:	Miss P. Carolyn Gooch, ORNL, Tenn.

M112 - Immunology Study (Pre- and post-flight)

Principal Investigator:	S.E. Ritzman, M.D., University of Texas, Galveston
Co-Investigator:	W.C. Levine, M.D., University of Texas, Galveston

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M110 - HEMATOLOGY AND IMMUNOLOGY (cont'd)

M113 - Blood Volume and Red Cell Life Span

Principal Investigator: Phillip C. Johnson, M.D.
Baylor University, Texas

M114 - Red Blood Cell Metabolism

Principal Investigator: C. Mengel, M.D.
University of Missouri

Consultants: Wallace N. Jensen, M.D., George Washington University
David Turner, Ph.D., Hospital for Sick Children
Scott N. Swisher, M.D., Michigan State University
Vernon Knight, M.D., Baylor University
Wolf Vishniac, Ph.D., University of Rochester

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M130 - NEUROPHYSIOLOGY (Governing Protocol)

Principal Coordinating Scientist: Milton R. DeLucchi, Ph.D., MSC

Individual Experiments or Measurements:

M131 - Human Vestibular Function

Principal Investigator: Ashton Graybiel, M.D., Naval Aerospace Medical Institute, Pensacola, Florida

Co-Investigator: Earl F. Miller, Ph.D., Naval Aerospace Medical Institute, Pensacola, Florida

M132 - Neurological Experiment - EEG

Principal Investigator: Dr. W. Ross Adey
University of California, Los Angeles

Peter Kellaway, Ph.D.
Baylor University, Texas

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M150 - BEHAVIORAL EFFECTS (Governing Protocol)

Principal Coordinating Scientist: Edward C. Moseley, Ph.D., MSC

Individual Experiments or Measurements:

M151 - Time and Motion Study

Principal Investigator: Joseph F. Kubis, Ph.D., Fordham University, New York

Co-Investigator: Edward J. McLaughlin, Ph.D. NASA Headquarters

Consultants: John T. Elrod, Ph.D.
Jesse Orlansky, Ph.D.

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M170 - PULMONARY FUNCTION AND ENERGY METABOLISM (Governing Protocol)

Principal Coordinating Scientist: John A. Rummel, Ph.D., MSC (Acting)

Individual Experiments or Measurements:

M171 - Metabolic Activity

Principal Investigator: Mr. Edward Michel, MSC

Co-Investigator: J. A. Rummel, Ph.D., MSC

M172 - Body Mass Measurement

Principal Investigator: John Ord, Colonel, USAF, MC Brooks AFB, Texas

Co-Investigator: William Thornton, M.D., MSC

Consultants: Ulrich C. Luft, M.D., Lovelace Foundation
Wayland Hull, Ph.D., MSC
George C. Armstrong, Jr., M.D., MSC

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ADDITIONAL AREA OF INVESTIGATION:

M190 - MICROBIOLOGY (Governing Protocol)

Principal Coordination Scientist: James McQueen, D.V.M.

Assistant Coordinating Scientist: James K. Ferguson, Ph.D.

APPENDIX B

MEDICAL/BEHAVIORAL MEASUREMENT CAPABILITY of INTEGRATED MEDICAL AND BEHAVIORAL LABORATORY MEASUREMENT SYSTEM (IMBLMS)

I. Clinical

History

Physical Examination

II. Cardiovascular

ECG

VCG

PCG

VbCG

ZCG

Cardiac Output

Heart Rate

Blood Pressure (arterial)

Blood Pressure (venous)

Plethysmography (limb)

Pulse Wave Velocity

Pulse Wave Contour

Ballistocardiogram

III. Respiratory

Respiratory Rate (RR)

Vital Capacity (VC)

Timed Vital Capacity (VC_1, VC_3)

Inspiratory Capacity (IC)

Expiratory Reserve Volume (ERV)

Tidal Volume (TV)

Minute Tidal Volume (MTV)

Maximum Inspiratory Flow (MIF)

Maximum Expiratory Flow (MEF)

Maximum Breathing Capacity (MBC)

Alveolar pO_2

Alveolar pCO_2

Respiratory Dead Space (V_D)

Alveolar Ventilation (V_A)

Residual Volume (V_R)

Airway Resistance (R_A)

Lung Compliance

Cardiac Output

O_2 Consumption

CO_2 Production

Diffusing Capacity

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IV. Metabolism

Ear Canal Temperature

O_2 Consumption, CO_2 Production

Average Skin Temperature

Muscle Size and Strength

Body Mass and Specimen Mass

Balance Studies

V. Endocrinology

(See Section X, Laboratory Analysis)

VI. Hematology

(See Section X, Laboratory Analysis)

VII. Neurological

EEG

EMG

EOG

Agravic Perception

Ocular Counterrolling

Oculogyral Illusion

Angular Accel Threshold

Visual Task w/Head Rotation

Coriolis (Motion) Sickness Susceptibility

VIII. Behavioral

Sensory

Vision

Depth Perception

Brightness Threshold

Visual Field

Critical Flicker Fusion

Phorias

Acuity

Dark Adaptation

Photo Stress

Color Perception

Auditory

Pitch Discrimination

Auditory Absolute Threshold

Auditory Temporal Acuity

Speech Intelligibility

Cutaneous

Pressure Thresholds

Psychomotor

Fine Motor Abilities - Steadiness

Complex Motor Abilities

Gross Body Coordination

Continuous Control - Tracking

Reaction Time (Simple & Complex)

VIII. <u>Behavioral</u> (Cont'd)

<u>Complex</u>

- Time and Motion
- Concentration (Problem Solving)

IX. <u>Microbiology</u>

<u>Bacteria/Fungi</u>

- Culture/Sensitivity
- Stain
- Observe
- Identify
- Transmit
- Photograph

X. <u>Laboratory Analysis</u>

<u>Blood</u>

- Hemoglobin
- Hematocrit
- pH
- pCO_2
- RBC Count
- WBC Count
- WBC Differential
- Platelet Estimation
- Reticulocytes

X. <u>Laboratory Analysis</u> (Cont'd)

<u>Blood</u> (cont'd)

- RBC Fragility
- RBC Mass
- Bleeding Time
- Clotting Time
- RBC Survival
- RBC Morphology
- Clot Retraction
- pO_2

<u>Plasma</u>

- Sodium
- Potassium
- Chloride
- Calcium
- Proteins
- Glucose
- Phosphate
- Plasma Volume
- SGOT
- SGPT
- Alkaline Phosphatase
- Bilirubin

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X. <u>Laboratory Analysis (Cont'd)</u>

Urine

Color

Volume

Specific Gravity

Glucose

Protein

Bile

pH

Blood

Microscopic

Calcium

Phosphate

Sodium

Potassium

Chloride

Acetone Bodies

Miscellaneous

Total Body Water

XI. Environment

Pressure

Atmospheric Composition

Temperature, Humidity

Spacecraft Motion

Noise

Radiation

3-4

APPENDIX C

MEDICAL/BEHAVIORAL EXPERIMENTS

Experiments in Definition

M075	Gastric Motility	W. Ballinger L. Wise Washington University
M076	Chemical Analytic Techniques	V. R. Huebner and R. Nakamura Beckman Instruments
M115	Endogenous CO Production	J. Laurence and H. Winchell University of California (Berkeley)
M211	Urinary Endocrine Assay	D. Nelson University of Utah J. E. Bethune University of Southern California

MEDICAL EXPERIMENT PROGRAM

SUPPORTIVE REQUIREMENTS

NON-INVASIVE CARDIAC OUTPUT DETERMINATION TECHNIQUE
NON-INVASIVE VENOUS PRESSURE TECHNIQUES (PERIPHERAL AND CENTRAL)
NON-INVASIVE REGIONAL BLOOD VOLUME MEASUREMENT TECHNIQUES

    * MICROWAVE PROPOSAL

IMPROVED LIMB PLETHYSMOGRAPHY
IMPROVED ARTERIAL PRESSURE MONITORING METHODS
IMPROVED DYNAMIC TESTS OF CIRCULATORY RESPONSE
IMPROVED TECHNIQUE FOR INFLIGHT MEASUREMENT OF PULMONARY DIFFUSION CAPACITY
VIGILANCE INDICATOR TECHNIQUES
TECHNIQUES TO IDENTIFY CEREBRAL DEFICIT
GROUP SELECTION CRITERIA
METABOLIC ANALYZER, RAPID RESPONSE, ADAPTABLE TO SUITED ACTIVITY
SWEAT MEASUREMENT AND SAMPLING TECHNIQUES
INFLIGHT BODY VOLUME MEASUREMENT TECHNIQUE (LEAN BODY MASS)

    * TIRR PROPOSAL FOR PHOTOMETRIC MEASUREMENT

IMPROVED TECHNIQUES FOR INFLIGHT BIOCHEMISTRY

    * ORION PROPOSAL FOR EXPANSION OF SPECIFIC ION ELECTRODE TECHNIQUE

AUTOMATED BLOOD CELL COUNTING TECHNIQUES FOR INFLIGHT USE
IMPROVED URINE VOLUME MEASUREMENT METHODS
INFLIGHT SAMPLE HANDLING TECHNIQUES
SAMPLE PRESERVATION TECHNIQUES FOR INFLIGHT USE
TECHNIQUES FOR INFLIGHT ISOTOPE HANDLING
MICROBIAL CULTURE AND IDENTIFICATION TECHNIQUES FOR INFLIGHT USE

(NOTE: * - PROMISING PROPOSALS)