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April 1, 1968

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SATURN I WORKSHOP EXPERIMENTS

The Saturn I Workshop, the first of the Apollo Applications missions, will offer the space agency the largest volume ever placed into earth orbit in which to carry out experiments.

These experiments will be in five major groups: scientific, technological, Department of Defense, engineering and medical.

Candidate experiments are being considered for the workshop mission as well as other flights in the Apollo Applications cluster. Five principal investigators have been selected to provide the solar measuring instruments for the Apollo Telescope Mount. Principal investigators representing government and industry are developing the workshop experiments.

Three NASA Headquarters program offices, Space Sciences and Applications, Advanced Research and Technology and Manned Space Flight plus the Department of Defense, are contributing to the experiment pool. OMSF has the overall experiment management chore. The NASA-Marshall Space Flight Center is the integrating center for Saturn I workshop experiments.

While all of the following described experiments will not fly on the Saturn I workshop, this list contains the principal candidates and some alternate choices.

Scientific Experiments

S027 - Galactic X-ray Mapping

This experiment is designed to survey a large portion of the sky for X-ray sources of very low flux and gather spectral data of limited resolution. A collimated detection system will be used to detect X-rays in the spectral range from 0.5 to 8 Angstroms.

S061 - Potato Respiration

The objective of this experiment is to determine whether removal from the earth's rythmic geophysical environment will effect a well known biorhythm, the daily uptake of oxygen. A potato, a simple organism with a well established biologic rhythm, will be placed into earth orbit while maintaining the same organism on earth under identical experimental conditions. The potato's oxygen consumption rate both in orbit and on earth will be measured and compared.

S065 - Multi-band Terrain Photography

The objective of this experiment is to photograph the earth's surface using four boresighted cameras. Simultaneous exposures will be made in four different spectral regions to determine the extent to which multi-band photography from space may be effectively applied to earth sciences.

S069 - X-ray Astronomy

The objective of this experiment is to continue the study of X-ray astronomy by locating and measuring the size of galactic X-ray sources.

It is important to measure locations accurately for comparisons with predictions from various production mechanisms; and to measure spectra to shed light on source distances.

S073 - Gegenschein/Zodiacal Light

The objective of this experiment is to measure the surface brightness and polarization of the night sky light over as large a portion of the celestial sphere as possible. The same measurements will be made on the sunshine reflected from the spacecraft to determine the extent and nature of spacecraft corona.

The nighttime portion of the experiment will delineate the astronomical sources of light without confusion from the airglow layer. The spacecraft corona measurements will define the optical environment for daytime astronomy and navigation in spacecraft missions remote from the earth.

Technological Experiments

Technological experiments are designed to improve and apply scientific knowledge, methods or research to the industrial arts.

T003 - In-flight Nephelometer

The objective of this experiment is to determine the aerosol particle concentration and size distribution in the spacecraft atmosphere as a function of time. Air samples of the spacecraft atmosphere will be analyzed twice daily and collection of measured aerosol particles will be returned for post-flight analysis.

T013 - Crew-Vehicle Disturbance

The objective of this experiment is to measure the effects of various crew motions on the dynamics of manned spacecraft to determine how these motions may effect high accuracy pointing experiments such as Lunar Module/ Apollo Telescope Mount experiments. Crew tasks ranging from simple arm motions to whole body motions will be measured and the results compared to analytical studies of the same activity.

T017 - Meteoroid Impact and Erosion

The objective of this experiment is to obtain data on the frequency and density of micrometeoroids striking special experiment samples of Vycor glass surfaces. This is one of the experiments that will be conducted over several Apollo Applications Program missions with experiment samples being exposed between missions and recovered on subsequent missions.

T018 - Precision Optical Tracking

The objective of this experiment is to track the Saturn launch vehicle with a laser radar system during the early launch phase to determine lift-off motion. An accurate measurement of vehicle dynamics can be obtained to aid evaluation of guidance and propulsion system performance.

T020 - Jet Shoes

The objective of this experiment is to determine the feasibility of the jet shoe concept for astronaut locomotion in space. The astronauts will perform a series of tasks within the Saturn I Workshop involving translation and rotational maneuvers typical of extra vehicular activity.

T021 - Meteoroid Velocity

The objective of this experiment is to measure the impact velocity and penetration depth into soft aluminum of meteoroids having a minimum mass of 0.1 billionth of a gram. Soft aluminum impact plates and a velocity measuring device will be exposed during orbital flight and returned for evaluation.

T023 - Surface Adsorbed Materials

The objective of this experiment is to investigate the deposition of contaminants on spacecraft surfaces during the launch phase to allow a determination of potential detrimental effects on spacecraft windows and vehicle thermal control surfaces.

T025 - Coronagraph and Contamination Measurements

The objective of this experiment is to determine whether or not an induced atmosphere is present about the Apollo spacecraft in flight. Such an atmosphere can cause light scattering and such scattering may have an influence on certain Lunar Module/Apollo Telescope Mount solar and other scientific instruments.

T027 - Contamination Measurement

The objective of this experiment is to measure the sky brightness background caused by solar illumination of contamination particles about a spacecraft. A second objective is to measure the change in optical properties of lenses, mirrors and gratings as a result of surface contamination. Ths contamination could affect the Lunar Module/Apollo Telescope Mount solar telescopes.

Department of Defense Experiments

Department of Defense experiments are designed and performed on Apollo Applications Program missions to obtain flight experience and data applicable to the Manned Orbiting Laboratory program.

D008 - Radiation in Spacecraft

The objective of this experiment is to measure and record the absorbed radiation dose rate and total radiation dose inside the spacecraft to assure astronaut protection against excessive ambient space radiation.

D017 - Carbon Dioxide Reduction

The objective of this experiment is to determine the operational capabilities of a solid electrolyte CO_2 reduction system in a zero-G environment.

D019 - Suit Donning and Sleep Station Evaluation

The objective of this experiment is to evaluate the time required and techniques of pressure suit donning in a zero-G environment. Conduct of this experiment will permit subjective and objective evaluation of the sleep restraint itself and the effectiveness of the workshop rails as a body restraint in the donning of a space suit.

D020 - Alternate Restraints Evaluation

The objective of this experiment is to evaluate various Manned Orbiting Laboratory crew restraint devices under zero gravity conditions by having the astronauts perform operational or maintenance tasks on selected equipments.

D021 - Expandable Airlock Technology

The objecitve of this experiment is to demonstrate the feasibility of employing expandable structures in an earth orbital environment and to evaluate the functional characteristics of a particular airlock design based upon this technology. Test samples of the material will be retrieved during an extravehicular activity and returned for analysis to determine the effect of exposure to the space environment.

D022 - Expandable Structures

The objective of this experiment is to provide and evaluate the expansion and rigidization of a chemically rigidized expandable structure which has experienced packaging, the launch environment and orbital storage. For this experiment it is necessary only to deploy and rigidize small flat test panels since this is primarily a materials development program. Test panels will be retrieved during Extravehicular Activity after some 10 days exposure to the space environment. Other panels will be left and retrieved during a revisit mission in order to obtain data on long term exposure to space.

Engineering Experiments

Engineering experiments are designed to evaluate and demonstrate engineering principles or techniques and to apply this information to improved methods of accomplishing engineering tasks.

M402 - Orbital Workshop

This experiment is a primary objective of the AAP-2 mission. The objective is to demonstrate the feasibility of utilizing the S-IVB spent stage

hydrogen tank which has a large volume of some 10,000 cubic feet to provide a habitable, shirt sleeve environment for use by the astronauts as a living and working space for periods initially up to 28 days duration and extending the periods of continuous use up to one year or more on subsequent revisit missions.

M415 - Thermal Control Coatings

The objective of this experiment is to evaluate and compare the stability of the properties of thermal control coatings throughout exposure to manufacturing, storage, transport, prelaunch, cleaning, launch and space environment. Several thermally insulated panels will be placed on the outside of the launch vehicle instrument unit in unprotected positions. Data collection will begin during vehicle assembly at the factory.

M423 - Hydrostatic Gas Bearing

The objective of this experiment is to evaluate a hydrostatic gas bearing while it is subjected to extended periods of reduced gravity at various gas pressures. Measurements will be made of the transient and steady state displacements of the gyro wheel while it is supported by the gas bearing.

M439 - Star-Horizon Automatic Tracking

The objective of this experiment is to (1) validate, while in earth orbit, the definition of the horizon based on scattered visual light, (2) to validate the measurement techniques for on-board autonomous navigation sightings during missions, and (3) to provide a worldwide check of the earth horizon model.

M479 - Zero Gravity Flammability

The objective of this experiment is to determine the effects of zero gravity on the flammability of non-metallic materials in a spacecraft environment. Information is required on the ignition of various non-metallic materials, flame propagation and extinguishment characteristics so that design of future space equipment will provide for maximum crew safety and equipment reliability.

M487 - Habitability/Crew Quarters

The objective of this experiment is to evaluate the capability of astronauts to live and perform experiments in an orbital workshop for extended periods of time. This evaluation includes size and arrangement of crew quarters; advanced crew systems, including food and waste management, sleep station design and orientation and personal hygiene equipment. The crew will be required to assemble and construct the crew quarters in the Saturn I workshop subsequent to the passivation of the S-IVB stage hydrogen tank.

M489 - Heat Exchanger Service

The objective of this experiment is to evaluate various concepts of heat exchanger water servicing, to observe the mechanism of heat exchanger water wicking and boiling and to compare zero gravity performance with one-G performance of these systems. The results will be utilized in the design of lighter weight, higher performance heat exchangers for future spacecraft.

M492 - Tube Joining Assemblies

The objective of this experiment is to develop and demonstrate a capability for repairing tubing assemblies in a space environment and obtain experience in orbital assembly, disassembly, maintenance and repair techniques. The specimen will be returned to earth for evaluation of joint strength, metallurgical properties, leakage, vacuum storage and physical flow of brazing alloy.

M493 -Electron Beam Welding

The objective of this experiment is to develop and demonstrate a capability for welding in a space environment. This experiment will determine the effects of zero gravity space environment on the complex electron beam metal reactions and on the electron beam welding equipment.

M508 - Extravehicular Activity Hardware Evaluation

The purpose of this experiment is to evaluate extravehicular activities, hardware and crew equipment in a zero gravity environment. This evaluation will be conducted within the Saturn I workshop over long periods of time under controlled laboratory-like conditions with relative safety to the astronaut. Major equipment to be evaluated include crew/equipment transfer devices, tools, restraints and tethers, and suits.

M509 - Astronaut Maneuvering Equipment

The objective of this experiment is to conduct an evaluation of various astronaut maneuvering techniques to assist the astronaut to perform tasks which are representative of future extra vehicular activity requirements.

The experiment will be performed inside the Saturn I workshop and the evaluation will be conducted using a hand held maneuvering unit and/or a combined rate gyro and control moment gyro maneuvering unit.

Medical Experiments

Medical experiments are being conducted to determine and enhance man's ability to function in space without impairment on very long space flights of the future, and to advance man's scientific knowledge of human functions.

NASA has changed the numbering and designation of medical experiments from what was shown in the past in order to more properly represent the components of the overall investigative effort and to establish governing protocols which represent the body function areas. The following are the medical experiments to be performed on Apollo Applications missions.

M070 - Nutrition and Musculoskeletal Function

The purpose of this experiment is to determine the extend of skeletal and muscular alternations which occur during space flight and to evaluate nutritive requirements as they may differ from those in the earth environment.

M071 - Mineral Balance (M007)

Astronauts will be maintained on a programmed mineral diet for a specified period prior to flight and during the flight. Mineral balance will be determined from carefully controlled mineral intake and output measurements, and the rate and amount of material lost by the body under space flight conditions will be determined.

M072 - Bone Densitometry (M006)

Densitometric comparison of pre and post flight X-rays of the os calcis (heel bone) and terminal phalanx (end bone) of the fifth digit of right hand will be the approach to establish the occurrence and degree of bone demineralization in prolonged weightlessness.

M073 - Bioassay of Body Fluids (M005)

Plasma and urine samples will be obtained, before and after flight and analyzed with urine samples taken inflight, to evaluate changes in blood and urine of astronauts for objective data regarding physiological effects of space flight.

M074 - Small Mass Measurement (M056)

Using a mass pendulum and standard calibrated masses and known masses, as food packages, the feasibility of making a series of small mass determinations during orbital flight will be determined. The technique will be utilized in conjunction with the mineral balance investigation.

M090 - Cardiovascular Function

The purpose of this experiment is to reevaluate changes in cardiovascular physiology and responsiveness as a function of duration of flight and as modified by corrective procedures.

M091 - LBNP (Pre-and Post-flight) (M023)

Negative pressure will be applied to lower half of astronaut's body for a predetermined time pre- and post-flight. Simultaneous blood pressure and electrocardiogram monitoring will provide data to ascertain changes in cardiovascular function as a result of this provocative test situation.

M092 - LBNP (In-flight)

Heart rate, blood pressure, and electrocardiogram data in conjunction with negative pressure on the lower half of the body, will be recorded on astronauts during flight and will be compared and evaluated with control data. The objective is to evaluate space flight cardiovascular deconditioning and to establish the time course of any changes.

M093 - Vectorcardiogram (M018)

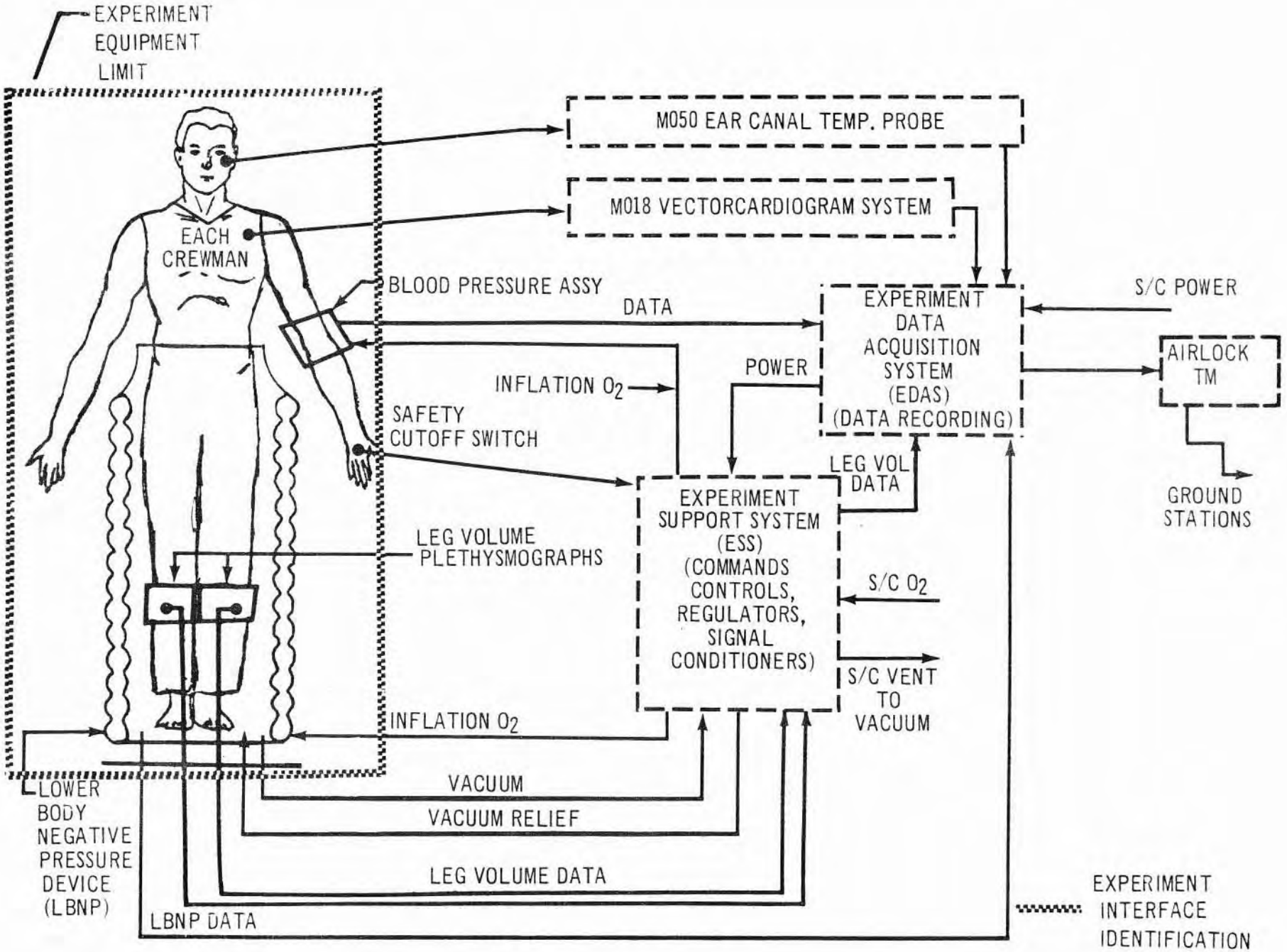
Using sensors and signal conditioners during earth orbit, electrical actions of the heart will be monitored. The Frank Lead System which consists of six electrodes as sensors attached to the astronauts will be used to obtain inflight spatial vectorcardiograms on astronauts.

M094 - Antideconditioning Garment (M048)

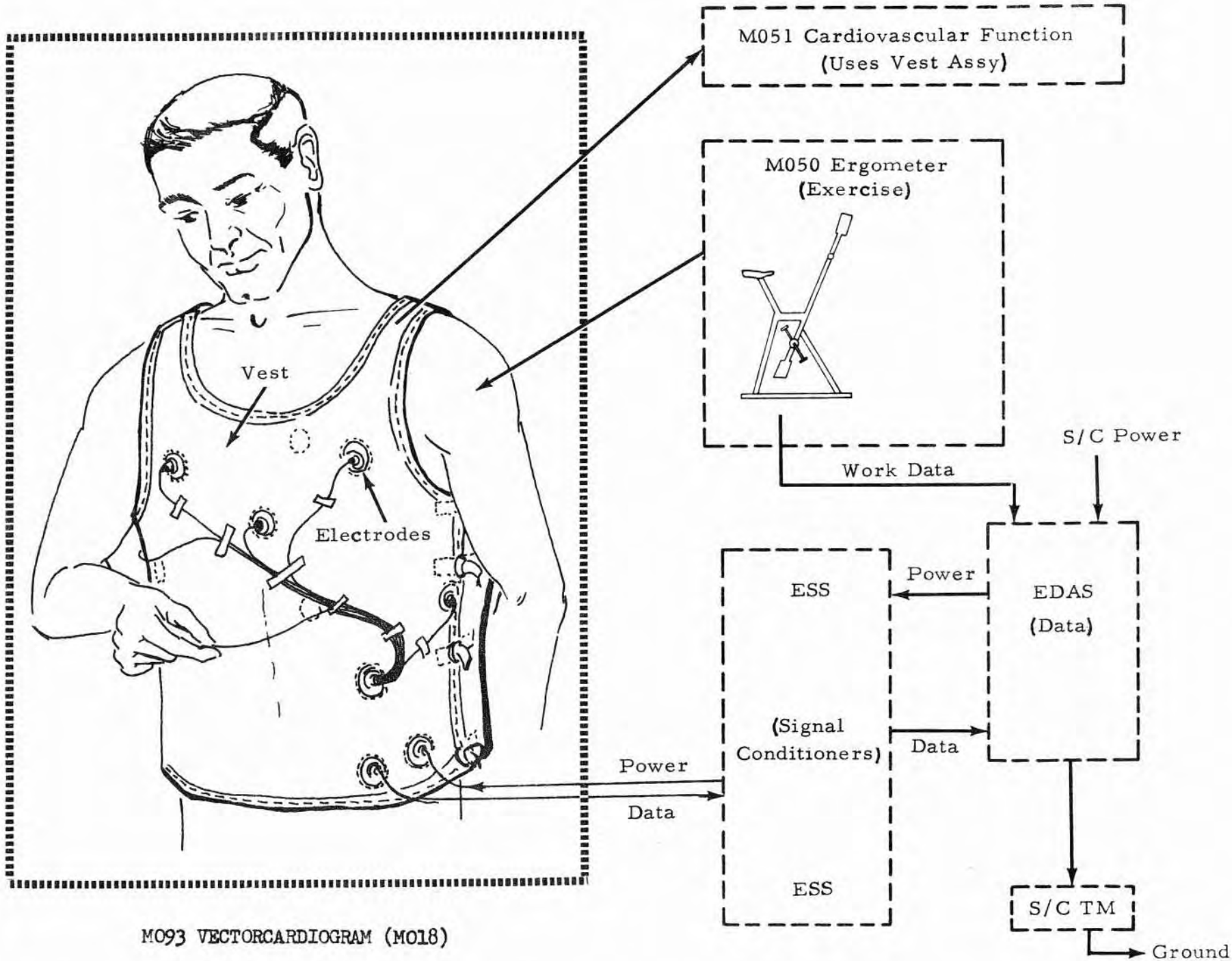
The objective of this experiment is to determine the effectiveness of an elestic lower vascular support garment which the astronaut will don prior to retrofire. The garment will be evaluated for its effectiveness in preventing or reducing circulatory changes due to prolonged space flight.

M130 - Neurophysiology

The purpose of this experiment is to determine neurological changes which might take place as a function of space flight. It is expected that the evaluation of human vestibular function will be supplemented by at lease an electroencephalogram study in the near future.



M092 LOWER BODY NEGATIVE PRESSURE



M093 VECTORCARDIOGRAM (M018)

M131 - Human Vestibular Function (M053)

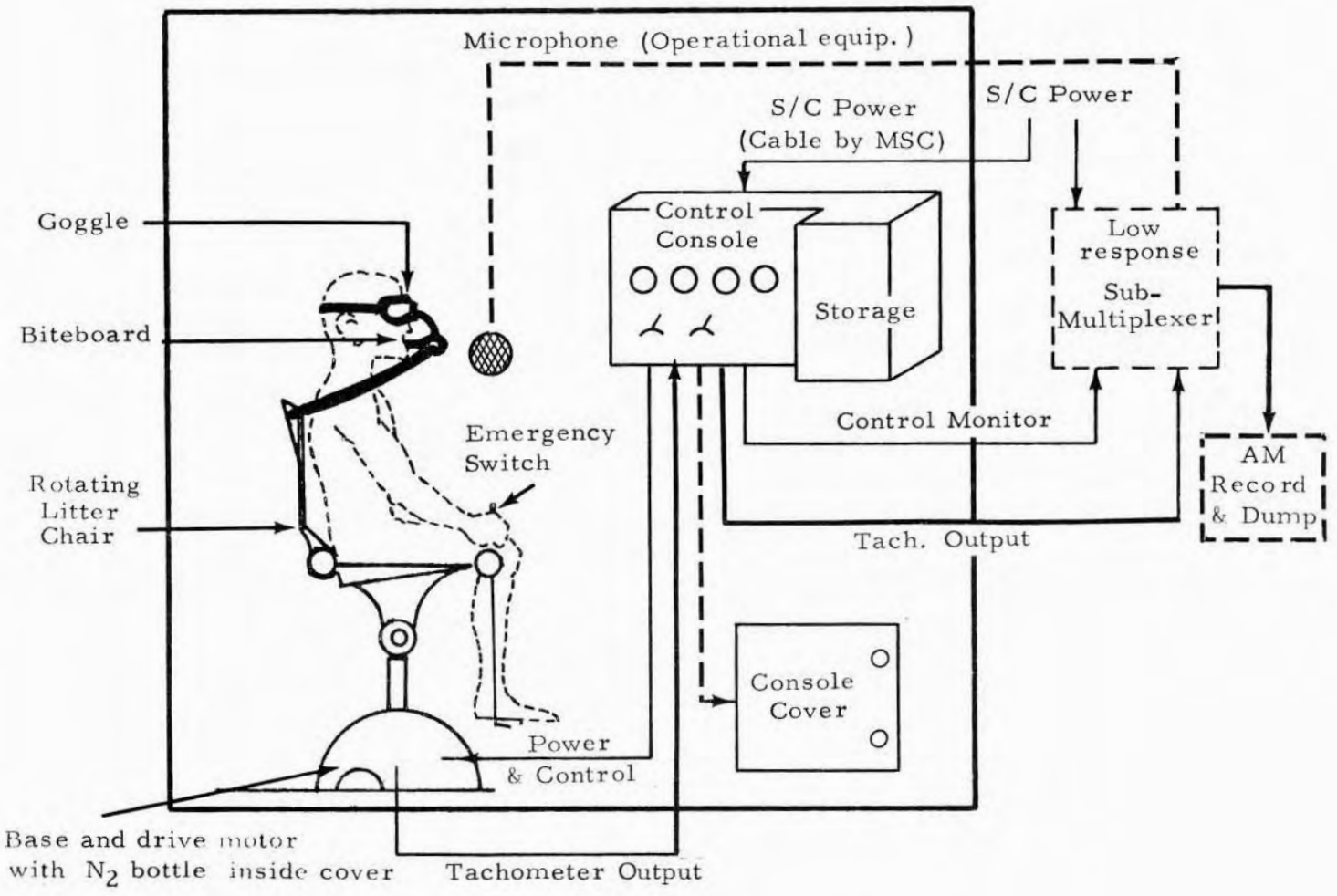
Using a litter-chair, otolith goggle, and semi-circular canal test equipment, evaluations will be performed on the crew during flight to determine the angular acceleration comfort zone and to identify vestibular changes which may occur during space flight. The objective is to investigate the effects of weightlessness and subgravity states on the perception and the organization of personal and extrapersonal space; and to establish the integrity of the vestibular apparatus during the prolonged weightlessness. This includes the determination of susceptibility to canal sickness and various known vestibular illusions as may be affected by space. Data will be used to determine the requirement for an artificial gravitational force for space flight and to compare vestibular response in space with preflight baseline data.

M150 - Behavioral Effects

The purpose of this experiment is to evaluate changes in the behavioral area which might be induced by space flight conditions as a function of time. This area at present includes only the "time and motion" study shown but will be supplemented in the future by further studies of habitability as well as determination of sensory, perceptual, memory, vigilance, and other behavioral functions.

M151 - Time and Motion Study (M055)

Using a Maurer camera and film magazines, the astronauts will be filmed periodically during the mission as they perform selected tasks; the flight activity will be compared with preflight data. The objective is to evaluate the relative consistency between ground-based and inflight task performance as



M131 HUMAN VESTIBULAR FUNCTION (M053)

conducted by astronauts and as measured by time and motion determinations.

M170 - Pulmonary Function and Energy Metabolism

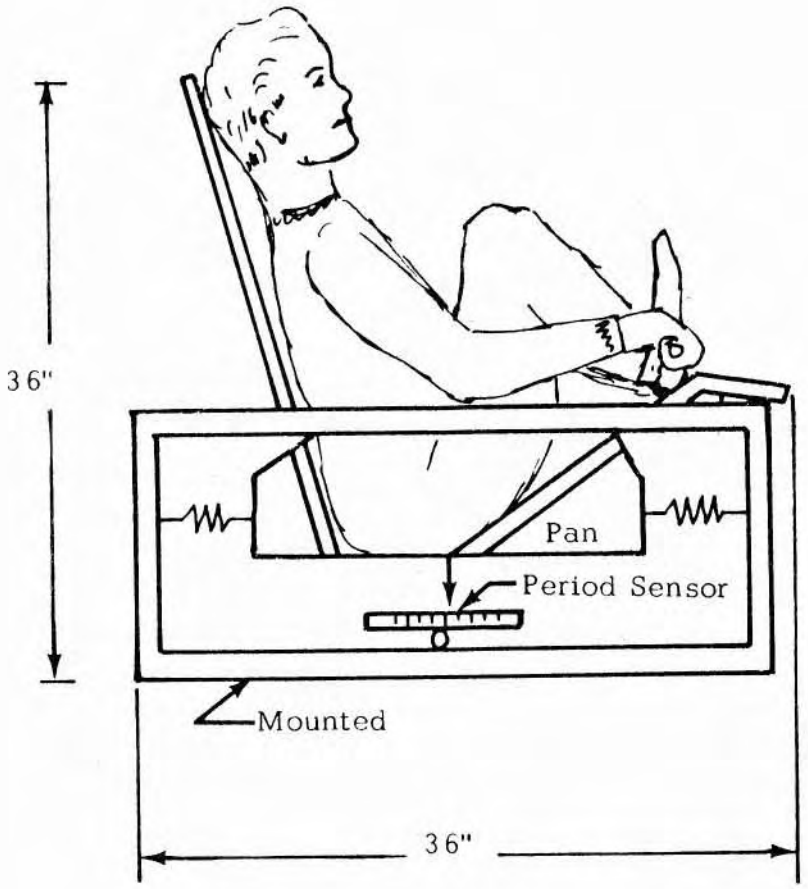
The purpose of this experiment is to determine possible changes on pulmonary function and the metabolic cost of various activities in varying degrees during space flight.

M171 - Metabolic Activity (M050)

The metabolic cost to the astronauts of completing a set of tasks under weightless conditions will be observed. The objective is to determine if man's metabolic effectiveness in doing mechanical work is progressively altered by exposure to the space environment.

M172 - Body Mass Measurement (M058)

Using a mechanical spring mass oscillator method, the body mass measurement system and its applicability to determining body weight during weightless flight will be evaluated.



M172 BODY MASS MEASUREMENT (M058)