SKYLAB MEDICAL ALTITUDE TEST

DETAILED TEST OBJECTIVE

I. Experiment
   a. Title
      1. M093 Vectorcardiogram
   b. Principal Coordinator
      1. Dr. Robert L. Johnson
   c. Principal Investigator
      1. Dr. Newton W. Allebach and Dr. Raphael F. Smith

II. Purpose and Background
   a. Purpose of Experiment
      1. To detect changes in the electrical activity of the heart that may be associated with exposure to a simulated space environment and other specific stressors.
      2. To provide baseline data and analysis information applicable to the corresponding Skylab experiment.
   b. Justification for Experiment
      1. Changes in cardiac function which are reflected in electrical potential variations at the body's surface have been observed postflight. By utilizing the vectorcardiogram in the chamber study, it will be possible and to a degree quantitate these possible changes and correlate them with related physiological functions. Thereby, additional fundamental knowledge of the cardiovascular response will be obtained.

III. Participants
   a. Number of Crewmen Required
      1. Three crewmembers, designated #1, #2, and #3.
   b. Function of Each Crewman
      1. Two crewmen are required for each experiment; one as the subject, the other as test conductor.
      (Para. IX, a, 2)

1. ~~Table 5-I.~~ Experiment Preparation Requirements

CREW TASK	APPROXIMATE TIME (MINUTES)	CREW MEMBERS ~~A~~ ~~B~~ ~~C~~ #1 #2 #3		
Unstow equipment ~~on OWS~~	4 min.(est.)	X		
Hookup and calibration of Electrodes	15 min.(est.)	X	X	
Controls: ON-OFF Switch Cal.Control				
Display: Electrodes Contact Checkout				

2. ~~Table 6-II.~~ Experiment Operation Requirements

CREW TASK	APPROXIMATE TIME (MINUTES)	CREW MEMBERS ~~A~~ ~~B~~ ~~C~~ #1 #2 #3		
Vectorcardiograms (VCG) will be taken as ~~during the following:~~				
Calibration	1 min			X
Rest: Baseline data	5 min. ~~(Mandatory)~~	X		
Exercise on Ergometer (150 watts)	2 min. ~~(Mandatory)~~	X		
Rest: Post Exercise Control Data	10 min. ~~(Mandatory)~~	X		
Calibration	1 min.			X

Note: During the ~~mission~~ chamber test, the experiment shall be repeated ~~every third day for each astronaut.~~ as shown on schedule (par IX a, 1)

3. ~~Table 6-III.~~ Post Operation Tasks

CREW TASK	APPROXIMATE TIME (MINUTES)	CREW MEMBERS ~~A~~ ~~B~~ ~~C~~ #1 #2 #3		
Remove, clean and stow equipment	7 min. est.	X	**	
** The subject may require a second astronaut to assist in removing electrodes and, if necessary, cleansing the subject.				

IV. Functional Objectives

Vectorcardiograms (VCG) utilizing the Frank lead system will be taken at regular intervals during the chamber test in order to determine serially the possible changes in cardiac electrical activity. Pre, post and ~~during the~~ chamber test recordings will be made before, during and after a three minute period of exercise. Computer techniques will be used for data reduction and analysis, and correlation with possible anatomical and functional changes of the heart. As this chamber study is designed to simulate a Skylab flight, except for weightlessness, the data will provide information, heretofore unknown, for comparison with baseline laboratory and that which will be obtained during future Skylab flights.

V. Test Conditions

a. Environmental Requirements

1. Thermal Requirements - The thermal environment ~~shall comply with the requirements of LRQ-DB-57-67 Revision B, and~~ shall be equivalent to an environment in which gas temperature and mean radiant temperature are equal and within the range of 67-78°F, at 5.0 psi and 70-80°F at 14.7 psi with air motion control from 15 ft./min to 100 ft./min.

b.

1. The experiment shall not be performed less than 3 hours after eating or less than one half hour after vigorous exercise or performance of experiments M092 (Inflight LBNP) and M131 (Human Vestibular Function). The cumulative time that the electrodes are in place shall be held to a minimum.

2. Each test will require approximately 45 minutes.

3. Two crewmen are required for each experiment.

4. Test Schedule (Para. IX, a, 1)

Experiment Equipment	Function
Vectorcardiogram (VCG) Harness Assembly	The VCG Harness Assembly worn by each astronaut will provide an electrical and mechanical interface point between the harness leading from the electrode positions on the subject and the umbilical to the ESS.
Electrodes	The electrodes are sensors which detect the electrical potential at the body's surface. There are eight electrodes including the reference electrode.
VCG Harness	The VCG Harness is the wiring carrying signals from the electrode positions to the umbilical interface.
Input Amplifiers	The input preamplifiers serve as impedance matching devices between the electrodes and the VCG Electronics Module.
Electro-Shock Protection System	The Electro-Shock Protection System is provided to protect the subject against electrical shock. Both of these systems may be located either at the harness-umbilical interface or at the electrode position.
VCG Umbilical Cable	From the preamplifiers the signals are carried to the VCG Electronics Module by the umbilical.
VCG Electronics Module	The VCG Electronics is the set of electronic equipment defined as follows:
Frank VCG Resistor Network	The Frank VCG Resistor Network serves to normalize electrocardiogram signals, taken on the body, into the three orthogonal electrocardiogram signals required for vectorcardiogram analysis.
ECG Signal Conditioner	The ECG Signal Conditioner filters and amplifies the three channels from the Frank VCG Resistor Network for recording and telemetry.
Electrode Checkout Device	The Electrode Checkout Device permits the measurements of the contact resistance between each electrode and the skin.
Calibration and Timing Circuitry	The Calibration and Timing Circuitry applied calibration signals to the inputs of the three ECG Signal Conditioner channels.
Electrode Kit	The Electrode Kit is a preparation kit which contains the electrodes, cleaner, and the attachment and conduction materials.
Heart Rate System	The Heart Rate System derives heart rate information and displays it on a 3-digit readout, with updating on the basis of five consecutive periods between pulses. It also supplies analog data to TM and digital data to the M171 ergometer and the M092 BPMS.

Equipment Item	Function	Storage List Item Number	Source
Ergometer with cables	The Bicycle Ergometer shall be used by the astronaut to provide the exercise required for a vectorcardiogram. The Ergometer is part of Experiment M171 (Metabolic Activity).	211.2.0	MSC/MR&O (Part of M171)
Timer, 2-Speed	The timer shall be used to time exercise and rest periods.	169.0.0	FCSD
OWS Data File	The OWS Data File shall be used for subject or observer comments regarding performance of equipment.	183.0.0	FCSD
ESS	The ESS provides mounting, electrical power, and data processing for VCG electronics.	610.15.0	MSC
Tape Recorder	To record and dump VCG data.	610.9.0	

a) Number and Time of Performances

1. Schedule

Time M093 — PRECHAMBER *

	T- MONTHS					T DAYS										0
	6	5	4	3	2	30	25	21	20	14	10	7	5	3	1	0
	X	X	X	X	X	X										

Day M093 — CHAMBER MISSION DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		1,2	3	1	2	3	1	2,3		1	2	3	1	2	1,3		2	3	1	2

Day M093 — CHAMBER MISSION DAY

22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
3	1,2		3						1,2	3	1	2	3	1	2,3		1	2	3	1	2

Day M093 — CHAMBER MISSION DAY

44	45	46	47	48	49	50	51	52	53	54	55	56	0
1,3		2	3	1	2	3	1,2		3				X

Day M093 — POST CHAMBER

T+ DAYS							
1	2	3	5	7	14	18	21
X — — Each day until normal — —							

* Training of crew member will be performed during the Prechamber test.

X. Data Requirements
   a. Unique Measurements from this Experiment

VII. Chamber Interfaces
a. Stowage Requirements

Weight and Volume

Equipment Item	Weight (lbs)	Volume (ft^3) Stowed	Operation
~~VCG Vest (3)~~	~~2.0~~	~~0.6~~	
VCG Electronics Module	10.0	0.35	0.35
Electrode Kit	3.0	0.17	0.6
VCG Umbilical Cable	6.0	0.12	-

b. Refernce ICD
? ——— 1. ?

c. Special or Unique Interfaces
1. The vectorcardiogram (M093 Experiment) must be located in a position such that it can be operated as required with the M092 and M171 medical experiments.
2. The bicycle ergometer must be located to permit its use in both the M093 and M171 Experiments. The ergometer is part of Experiment M171 (Metabolic Activity)

VIII. Crew Training
a. Briefings Required
1. Six training periods (Para. IX, a, 1)

b. Number of Hours
1. Approximately one hour per training period for a total of approximately 6 hours. *for crewman.*

c. Schedule
1. See paragraph IX a, 1 *Prechamber*

(months) T-6, T-5, T-4, T-3, T-2
(Days) T-30

Table 3-I. Experiment Measurement List

Name of Measurement	Meas. No.	1 Meas. Type	2 Meas. Format	3 Meas. Purp.	4 Meas. Range	5 % + Max. Error	6 Redline Values	7 Sampling Rate ST	RT	8 Mis. Disp. Meas.	9 Remarks
1 VCG (Right-Left)	P7300-M093	S	A	P/SD	2.5±2.5V	5		320	320	PP/RT	
2 VCG (Front-Back)	P7301-M093	S	A	P/SD	2.5±2.5V	5		320	320	PP/RT	
3 VCG (Up-Down)	P7302-M093	S	A	P/SD	2.5±2.5V	5		320	320	PP/RT	

Explanation of Columns:

1. Scientific (S), or Housekeeping (H)

2. Analog (A), Digital (D), or Event (E)

3. Performance Evaluation (P), Malfunction Diagnosis (M), Environmental (E), Safety (S), Ground Checkout (CC), Flight Checkout (FC), or Scientific Data (SD)

4. Line 1 - Amplitude in Standard International Units
   Line 2 - Amplitude in Volts
   Line 3 - Frequency, if applicable

5. Allowable error, end to end based on 3 sigma values

6. Values which, when exceeded, result in termination of test, launch countdown, or flight operation

7. Programmed sampling rate, in terms of samples per second, stored data (ST), and real time data (RT).

8. Real Time (RT), Post Pass (PP), or Post Mission (PM)

9. Applicable characteristics, properties, or requirements peculiar to a given measurement

Table 3-II. Spacecraft Systems Measurement List

Name of Measurement	Measurement Number	1 Meas. Format	2 Meas. Purp.	3 Meas. Range	4 ± % Max. Error	5 Sampling Rate ST	5 Sampling Rate RT	6 Mis. Disp. Meas.	7 Remarks
Voice		A	All			X	X	PP/RT	
Calibration and Timing Mode-Interval, Mission	IA021-47	D	P			X	X	PP/RT	
Ambient Temperature	C7301	A	P	40°-100°F 0-5V	2%FS	1.25	1.25	PP/RT	
Ambient Pressure	C7301	A	P	0-6PSIA 0-5V	2%FS	1.25	1.25	PP/RT	
Experiment/Subject Identification	C7301	Bi-Level	P		N/A	0.42	0.42	PP/RT	
Ergometer Work Output	T7301-M171	A	SD	25-300 watts 0-5V	+9 watt	1.25		PP	
RPM	Same as M171 Data	A	SD	40-90RPM 0-5V	+3 RPM	1.25		PP	

Explanation of Columns:
1. Analog (A), Digital (D), or Event (E).
2. Performance Evaluation (P), Malfunction Diagnosis (M), Environmental (E), Safety (S), Ground Checkout (GC), or Flight Checkout (FC).
3. Line 1 - Amplitude in Standard International Units.
   Line 2 - Amplitude in Volts.
   Line 3 - Frequency, if applicable.

4. Allowable error, end to end based on 3 sigma values.
5. Programmed sampling rate, in terms of samples per second, stored data (ST) and real time (RT).
6. Real Time (RT), Post Pass (PP), or Post Mission (PM).
7. Applicable characteristics, properties, or requirements peculiar to a given measurement.

b. Data from other Experiments
   1. Data from M093 will be correlated with data from M091, M092, and M171.

   2. Portions of M093 will be photographed as required for the objectives of M151, Time and Motion Study. Photographic equipment will be provided by M151. A copy of this film will be provided to the Principal Coordinator of M093.

c) Data Requirements - The requirements are for data generation, acquisition and processing. Requirements identified with an "E" are for experimental use and those identified with an "O" are ~~required~~ for operational use. The following data are required for Pre and Post and Inchamber tests:

(1) Test Conductor's Log Book (E) - The Test Conductor shall record the following information in a permanent log book for each preflight test:

   Test Identification
   Subject Identification
   Subject Weight or Body Mass
   Date and Time of Day
   Time since Subject's Last Meal
   Amount of, and Time since, Subject's Last Sleep
   Time since Venipuncture
   Left and Right Calf Circumferences before Test
   Comments as to any Exposure to Unusual Environmental Stresses, e. g., Severe Physical Effort in Preceding Hours
   Signs and Symptoms Before and During Test, e. g., Syncope, Pallor, Nausea
   Recent Minor Illness

(2) VCG Strip Charts (E) - Strip chart recordings
     shall be made during each baseline test. The
     recording shall be made on an eight-channel re-
     corder at a nominal paper speed of 10 mm/sec.
     and shall contain the following parameters:

          VCG, X-Axis
          VCG, Y-Axis
          VCG, Z-Axis
          Ergometer Work Load
          Ergometer RPM
          Ambient Temperature (if available)
          Ambient Pressure (if available)
          Time

(3) Digital Data Tape (E) - A computer compatible digital
     tape shall be generated from each analog tape recorded
     on line during the preflight baseline tests. The tape will be
     used as an input for further processing (VCG Analysis
     and Statistical Analysis programs) and a copy will be
     provided for archival purposes. The analog data will
     be sampled at their full inflight sampling rate. The
     three VCG components shall be time-correlated to each
     other to within an end-to-end accuracy of 100 micro-
     seconds. The format used shall be the same as that
     used for the M093 inflight data except those measure-
     ments that are not available will utilize fill data.
     The tape may be merged into as few tapes as possible
     and shall contain the following parameters:

          VCG, X-Axis
          VCG, Y-Axis
          VCG, Z-Axis
          Ergometer Work Load
          Ergometer RPM
          Ambient Temperature
          Ambient Pressure
          Heart Rate
          Time

     The tape shall contain a standard header with
     the test date, subject I.D., and other pertinent
     information. The heart rate shall be calculated
     from the VCG X,Y or Z axis (selectable) and inserted
     in the digital data.

(4) Hard Copy Plots (E & O) - To be determined

(5) Voice Tape (E) - A magnetic tape copy of the voice
     track on the analog test tape taken during the base-
     line tests is required. _shall be made on line_ The tape shall be recorded
     on a 1/4-inch, 4-track recorder, with voice on
     track #1 and IRIG-B time on track #3 at a speed of

(6)(8) Vector Loop Displays (E) - The MR&OD Cardiovascular Laboratory at MSC and the Medical Test Facility at KSC shall have the capability of displaying a planar vector loop on a vectorscope by selecting any two of the VCG axes.

This capability shall exist in real time and during analog tape playback.

(7)(9) Polaroid Pictures (E&O) - Polaroid pictures shall be made of significant vector loops, as displayed on the vectorscope, for use in documenting each crew member's baseline condition. The capability shall exist for taking one picture of each of the three major heart planes for each of the following test conditions:

(a) Rest period prior to application of work load

(b) During work load application

(c) Rest period following termination of work load

(8) X-Y Plots - Paper (E&O) - To be determined.

(9) (12) Analytical and Statistical Processing (E) - Special processing of the digital data tape will be required to compute analytical and statistical data from baseline data for experiment evaluation purposes. Requirements are TBD. The outputs will include:

(a) Comparisons of VCG parameters from one test to another by analysis of variance; divided by subject, test and phase

(b) Microfilm plots of characteristic loops

(c) Tabular printouts

10) Console Display - (E) - Real time analog display of heart rate.

11) Television (E&O) - Real time monitoring will be provided by television.