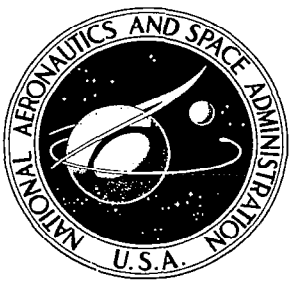
NASA CONTRACTOR REPORT



NASA CR

NASA CR-692

A STUDY OF THE POSSIBLE PREVENTIVE EFFECTS OF MUSCULAR EXERCISES AND INTERMITTENT VENOUS OCCLUSION ON THE CARDIOVASCULAR DECONDITIONING OBSERVED AFTER 10 DAYS BED RECUMBENCY

EXPERIMENTAL DESIGN

by D. Cardus, W. C. Beasley, and F. B. Vogt

Prepared by
THE TEXAS INSTITUTE FOR REHABILITATION AND RESEARCH
TEXAS MEDICAL CENTER
Houston, Texas
for Manned Spacecraft Center

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • FEBRUARY 1967

A STUDY OF THE POSSIBLE PREVENTIVE EFFECTS OF MUSCULAR EXERCISES AND INTERMITTENT VENOUS OCCLUSION ON THE CARDIOVASCULAR DECONDITIONING OBSERVED AFTER 10 DAYS BED RECUMBENCY

EXPERIMENTAL DESIGN

By D. Cardus, W. C. Beasley, and F. B. Vogt

Prepared under Contract No. NAS 9-1461 by
THE TEXAS INSTITUTE FOR REHABILITATION AND RESEARCH
TEXAS MEDICAL CENTER
Houston, Texas

for Manned Spacecraft Center

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

For sale by the Clearinghouse for Federal Scientific and Technical Information
Springfield, Virginia 22151 – Price $3.25

A STUDY OF THE POSSIBLE PREVENTIVE EFFECTS OF MUSCULAR EXERCISES AND INTERMITTENT VENOUS OCCLUSION ON THE CARDIOVASCULAR DECONDITIONING OBSERVED AFTER 10 DAYS BED RECUMBENCY

EXPERIMENTAL DESIGN

ABSTRACT

Studies conducted under contract with the Manned Spacecraft Center of NASA at the Immobilization Study Unit of the Texas Institute for Rehabilitation and Research in 1963 confirmed a syndrome called cardiovascular deconditioning arising from prolonged bed recumbency, muscular inactivity or immobilization. At the request of the Space Medicine Branch of NASA Manned Spacecraft Center another study was carried out in the summer of 1964 to evaluate intermittent venous occlusion and muscular exercises as possible means of preventing the cardiovascular deconditioning observed after bed recumbency. This report describes the subjects, the planning and conditions of the experiment and the methods and techniques that were used.

FOREWORD

The present study was sponsored by the NASA Manned Spacecraft Center under extension of Contract NAS 9-1461. Dr. Lawrence F. Dietlein, Chief, Space Medicine Branch, served as monitor.

The study was conducted at the Immobilization Study Unit of the Texas Institute for Rehabilitation and Research during the summer of 1964. A previous study was conducted in the summer of 1963 to document the physiological effects of prolonged bed recumbency. To the extent that this is possible, the bed recumbency experiments were conducted to simulate the condition of weightlessness.

The purpose of the study was to investigate two possible means of preventing post recumbency cardiovascular deconditioning: intermittent venous occlusion of the lower extremities and muscular exercises with limited movement. This first report deals with the experimental design. Others describing the results will follow. This is the experimental protocol as it was planned at the beginning of the study. Some variations that were introduced as the investigation progressed will be emphasized in the reports summarizing the results.

The authors of this report have the following affiliations with Baylor University College of Medicine: Dr. David Cardus, Departments of Physiology and Rehabilitation; Dr. Willis C. Beasley, Departments of Rehabilitation and Physical Medicine, and Dr. Fred B. Vogt, Department of Rehabilitation.

The authors wish to acknowledge the help and advice of Dr. William A. Spencer in the organization of the study, the collaboration of Dr. Marcus Fuhrer in the planning and execution of the psychological studies, the cooperation of the Crew Systems Division, Space Medicine Branch, Bioinstrumentation Section, and Data Systems Development Branch of the NASA Manned Spacecraft Center, and the secretarial assistance of Mrs. Jacqueline Clark and Mrs. Mary Garber in preparing this report.

TABLE OF CONTENTS

A STUDY OF THE POSSIBLE PREVENTIVE EFFECTS OF MUSCULAR EXERCISES AND INTERMITTENT VENOUS OCCLUSION ON THE CARDIOVASCULAR DECONDITIONING OBSERVED AFTER 10 DAYS BED RECUMBENCY

EXPERIMENTAL DESIGN

SUMMARY

A study was conducted under contract with the Manned Spacecraft Center at the Immobilization Study Unit of the Texas Institute for Rehabilitation and Research, to evaluate intermittent venous occlusion and muscular exercise as possible preventive measures of the cardiovascular deconditioning observed after prolonged bed recumbency. This report describes the experimental subjects participating in the study, the planning and conditions of the experiments, the methods and techniques of physiological and psychological testing, and the general procedure of data handling.

INTRODUCTION

The results obtained during the summer of 1963 under Contract NAS-9-1461 confirmed that after three and fourteen days recumbency in bed the human body undergoes cardiovascular deconditioning. This cardiovascular deconditioning is manifested by increased intolerance to the tilt test and by an increase in the heart rate at rest and during exercise. Since manifestations of orthostatic cardiovascular instability were observed in astronauts Schirra and Cooper and in Russian cosmonauts after orbital space flights, studies on preventive measures of orthostatic cardiovascular deconditioning were considered of interest because of their possible effectiveness in counteracting cardiovascular deconditioning. At the request of NASA officials, a new series of bed-rest experiments was planned by Texas Institute for Rehabilitation and Research investigators. The study was carried out in support of a Gemini inflight experiment (proposed by NASA officials) aimed at preventing cardiovascular deconditioning during or consecutive to space flights.

PURPOSE

The purpose of the investigation carried out at the Texas Institute for Rehabilitation and Research in the summer of 1964 was to study the efficacity of exercise and/or intermittent leg cuff inflation in preventing cardiovascular deconditioning. The leg cuff inflation was provided in an attempt to stimulate and maintain the vasomotor tone as well as to prevent abnormal transfer of fluids in the tissue spaces of the lower extremities. The exercises were designed to maintain muscular activity during the time that the recumbent position was maintained.

GENERAL CONSIDERATIONS ON THE EXPERIMENTAL DESIGN

The principal investigators at the Texas Institute for Rehabilitation and Research gave careful consideration to the NASA contract extension, Amendment No. 2, and defined the formal statistical and analytical requirements that would yield a definitive evaluation of the various treatments proposed. Briefly, the following statements summarize these requirements:

The treatments would be limited to the following:

a. Bed recumbency without exercise or intermittent inflation of cuffs placed on the extremities.

b. Bed recumbency with concomitant exercise.

c. Bed recumbency with intermittent inflation of extremity cuffs.

The time sequence for the test periods would be two weeks for each treatment (b) and (c); there would be a following treatment (a), which would occur twice in the sequence. This would give effectively four treatment periods of two weeks each, with interposed stabilization periods of equal duration.

Taking these four treatment periods as the basis for the experimental design, the neutralization of the effects from time order would require 24 permutations of the sequence. The time interval between treatments would still be another factor, which in a totally effective design should be varied to gain knowledge as to the minimum value required for recovery to the initial conditions. For the present design, this period was assigned a fixed value of two weeks.

Each permuted group should contain a sufficient number of individuals to permit a reliable estimate, which is generally recognized as 30 subjects, to achieve a valid estimate relative to biological variation among individuals. For 24 permutations, a minimum of 720 subjects would be required. This complete permutation

of four treatment periods would involve one complete replication of the total experiment, since the treatment (a) bed recumbency alone, although duplicated in each period of four treatments, would present a replication when permuted. This meant that there would be exactly twelve different sequences presented in the complete permutation, and each of these would be repeated once in the set of twenty-four. The power of the statistical analysis would be doubled by this replication, which would permit an estimate of reliability for the total experiment. This might seem to be excessive, but years of experimental science in studies involving biological variability stands as a witness to the correctness of this approach. Such sampling would permit a reliable estimation of interaction effects between variables in a multiple frame that could not be achieved otherwise. This design was not impossible, but was expensive. It would, however, produce definitive answers to the problems posed.

As a compromise dictated by the proposed budget and the specified time for execution of the actual experimentation, one sequence was chosen of the possible 12 different permutations. We did not know whether the stabilization period of two weeks was adequate for each individual to return to his initial condition (prior to the beginning of the preceding treatment period). In the sequence chosen, there was also a lack of a full two weeks pre-sequence observation period because of the unavailability of subjects who were to be medical and dental students undergoing end-of-year examinations.

We chose as a criterion of recovery to the initial condition uniformity of response to the following tests: (a) lack of orthostatism on passive tilt (b) bicycle ergometry, and (c) response to isometric exercise. These criterion tests were scheduled at the beginning and end of each treatment period. The permutation chosen might provide

indicative trends on the effects these treatments depending on the uniformity of response among the subjects in the small sample of six. Such a minimal experiment would not yield statistically valid conclusions on the multiple interaction effects.

PLAN

The calendar of experimentation for the studies conducted in the summer of 1964 is shown in Figure 1. Three 10-day bed recumbency periods are indicated. During recumbency period number 1, half of the subjects had cuffs applied to their lower extremities, and the other half of the subjects performed a routine of periodic "isotonic" exercises. During recumbency period number 2, the subjects who previously had cuffs performed exercises, and the group who had performed exercises had cuffs applied to their lower extremities. During recumbency period number 3, all of the 10 subjects were exposed only to the 10-day period of Bedrest.

The cuffs were applied to the proximal part of lower extremities and were inflated to a pressure of 75 mm Hg with a cycle of 5 minutes on, 10 minutes off, for the entire duration of the 10-day period preceding the first period of recumbency. A 3-week interval was allowed between bedrest periods to assure that the subjects had recovered from the deconditioning that occurred with each period of recumbency. The subjects were submitted to bedrest in 2 groups separated by one day to allow for performance of a complete tilt-table test on the day immediately preceding bed recumbency, as well as on the final day of bed recumbency. Numerous other testing procedures were carried out on the subjects periodically and are indicated in the Appendix.

SELECTION AND DESCRIPTION OF SUBJECTS

The subjects were selected from the local college population on the basis of age, current health, and past medical history. Their ages ranged from 21 to 25 years.

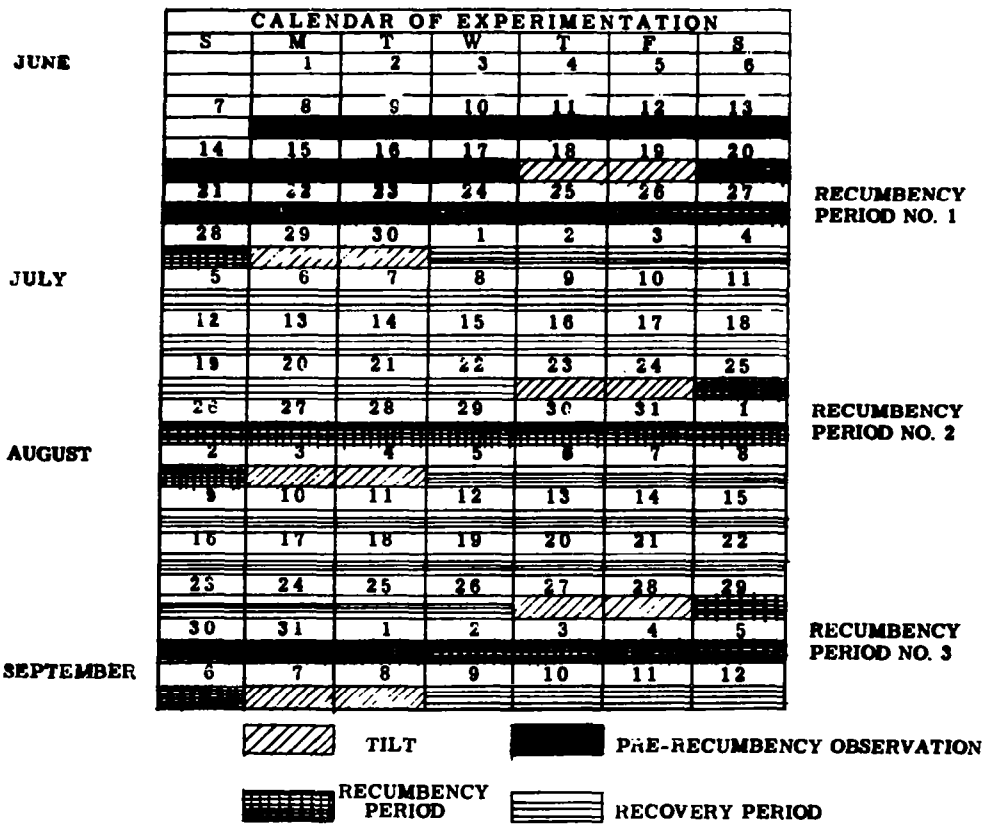

CALENDAR OF EXPERIMENTATION
S M T W T F S
JUNE
JULY
AUGUST
SEPTEMBER
RECUMBENCY PERIOD NO. 1
RECUMBENCY PERIOD NO. 2
RECUMBENCY PERIOD NO. 3
TILT
PRE-RECUMBENCY OBSERVATION
RECUMBENCY PERIOD
RECOVERY PERIOD

Figure 1

Fees of 10 dollars per day during routine testing and recovery periods, and 30 dollars per day during the bed recumbency period were paid to the subjects. Each potential subject was given a complete medical history (see Appendix 1), and physical examination (see Appendix 2) by a physician. The physical exam included a routine chest x-ray, serology, CBC, urinalysis, and electrocardiogram. The response to a simple tilt-table test (20 minutes duration) determined the selection of a prospective subject. The subjects were admitted to the Texas Institute for Rehabilitation and Research as hospital patients for experimental studies. They signed the proper forms and authorizations relinquishing responsibility prior to active participation in the study. The purpose of the experiment and the risk involved were explained to them in detail prior to the start of the study. In addition, each individual selected for the study was submitted to a psychological interview which included Cattell's 16 PF, Guilford's Activity Dimension, and the Focused Thematic Apperception test (see Appendices 11.1.1, 11.3 and 11.4).

Psychometric assessment revealed no notable psychopathology within the subject-group. As indicated by the Cattell personality inventory, the subject's profiles did not deviate substantially from average profiles obtained in a normative population of college males. It is perhaps noteworthy that the mean score for the group on the anxiety factor was shifted in the direction of high anxiety. This may have reflected the subjects' uncertainty and concern about the impending events in the study.

It was particularly interesting to examine the scores of the one subject who had to be replaced after the first ten days of bedrest. At least two of this subject's scores might have justified the prediction that he would have difficulty in adjusting to the stresses inherent in the experimental situation. First, he received the highest anxiety score of any subject. Second, this subject's score for mental adjustment,

though not extremely deviant from the scores of the normative population, was the lowest within the subject-group.

Eleven healthy adult males were utilized as experimental subjects. They were coded for identification for scheduling (see Appendix 3). Nine of the subjects participated in all 3 periods of recumbency; Subject A.P.K. participated only in the first period of recumbency and was replaced by Subject L.F.E. who participated in the last 2 periods.

The subjects' physical characteristics are shown in Table 1. The detailed somatic descriptions of the subjects are recorded in the Texas Institute for Rehabilitation and Research clinical histories, the identification number of which is indicated in the second column of Table 1. These histories are kept in the Medical Record Room of the Texas Institute for Rehabilitation and Research. Photographs showing the body build of these subjects are presented in Figure 2.

DESCRIPTION OF TESTING AREA

For the entire duration of the experimental study the subjects were housed in an experimental ward located in the basement of the Texas Institute for Rehabilitation and Research. Figure 3 shows a view taken from one end of the ward. Privacy for individuals beds was provided by means of a curtain which circled each bed. Environmental conditions were controlled by the usual hospital environmental control mechanisms. The temperature and humidity were maintained fairly constant at 74°F. and 58%, respectively, throughout the studies. Barometric pressure was not controlled. There were no measurements made of these conditions on a routine basis. The area was fully air-conditioned. The lights were turned off every night at 10:00 p.m. and turned on at 7:00 a.m. There was a television set in the room which was turned off every night at 11:00 p.m.

TABLE # 1

Name	Age	Subject No.	Group	Classification	Hospital No.	Height (cm.)	Weight (cm.)	Weight (kg.) (Theoretical)	BSA (Theoretical)
M.A.C.	22	2	1	NA	70020	177.8	65.2	71.2	1.88
L.F.E.	24	11	2	A	70028	190.5	75.9	81.6	2.10
R.S.H.	23	3	1	A	70021	173.4	65.6	67.1	1.80
J.A.H.	24	5	1	NA	70022	179.1	83.1	72.1	1.90
B.E.H.	21	1	1	NA	70019	177.8	70.2	71.2	1.88
A.C.I.	23	6	2	A	70018	163.2	51.7	56.2	1.60
A.P.K.	24	8	2	NA	70023	174.0	60.4	68.0	1.82
W.F.M.	23	7	2	NA	70024	170.8	67.2	65.3	1.76
C.E.R.	25	10	2	A	70025	195.6	81.1	85.3	2.18
G.S.R.	25	4	1	A	70026	177.8	67.2	71.2	1.88
R.R.T.	22	9	2	NA	70027	172.7	78	67.1	1.80

Age is determined from the last birthday unless a birthday occurred during the study.

Theoretical weight is determined by height plus 1 inch (for shoes) minus 7 pounds (for men's clothes). The chart is a Metropolitan Life Ins. Co. height-weight chart.

Theoretical Body Surface Area (BSA) is determined by the Dubois Body Surface Chart (as prepared by Boothby and Sandiford of the Mayo clinic).

Classification: A=athlete; NA=non-athlete.

The height given was determined at the beginning of the study.

The weight given was determined at the beginning of the study.

CONTROL OF SUBJECTS

A. During Bed Recumbency

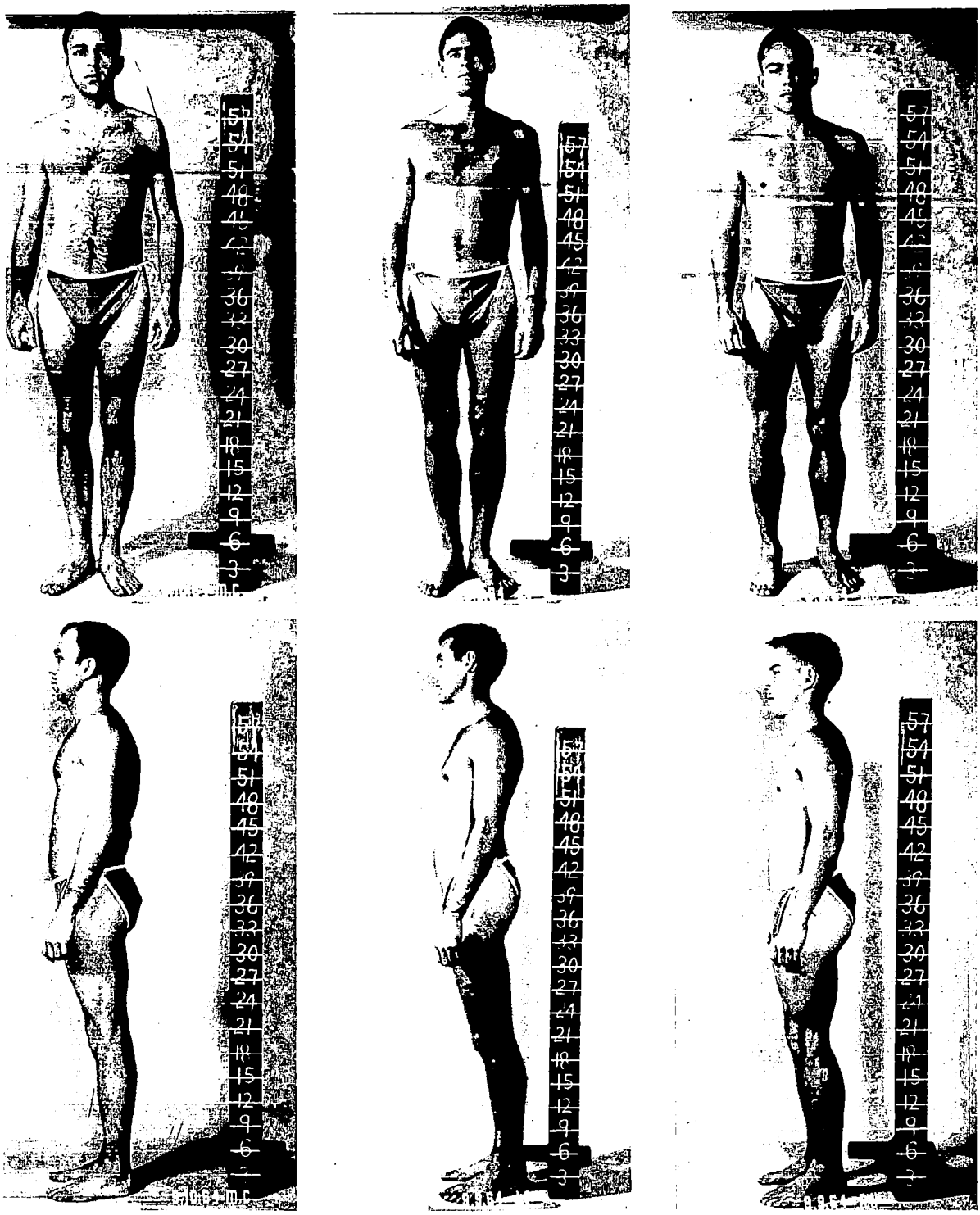
The subjects were required to remain in bed during the recumbency periods. They were given one pillow for use under their head, were allowed to turn in bed and roll from side to side, and to feed themselves by turning on their side in bed. They were not allowed to sit in bed or to get up for bathroom privileges. Subjects were supervised by a physician during the bed recumbency periods, and a physician was on call during all other times of the study. Two orderlies assisted in subject care—one during the day, and the other during the night.

B. Before and After Bed Recumbency

During the pre-bed recumbency and recovery periods, the subjects were encouraged to follow a routine approximating that prior to becoming an experimental subject. The subjects spent every night in the ward, including the nights of the recovery periods. Athletes were allowed to participate in an active training schedule if they had followed one previously. Except for the times of testing, eating and urine collection periods, the subjects were free to come and go from the hospital. The record of activities performed was kept on an hourly basis according to a daily activity record (see Appendix 4).

C. Meals

The subjects were given a standard hospital kitchen diet and were required to eat all food that was served to them. The food trays were prepared and weighed to provide each subject with an identical diet. The dietary content of sodium chloride approximated 10 grams daily. An additional food tray was prepared and sent to the laboratory for analysis of sodium and potassium content. No food or beverages were allowed during the times the subjects were away from the hospital. The subjects

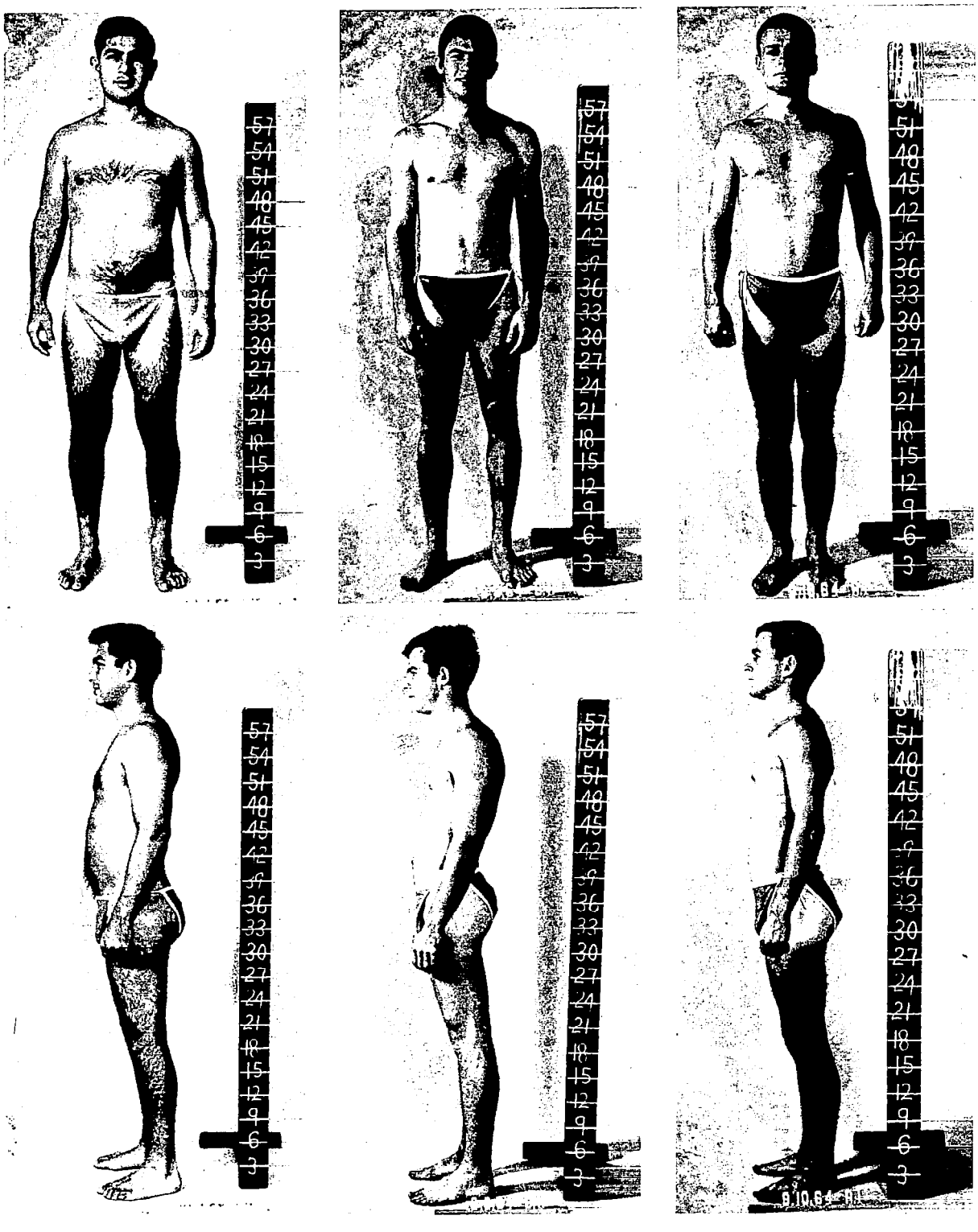


TIRR # 70020 M.A.C.

TIRR # 70028 L.F.E.

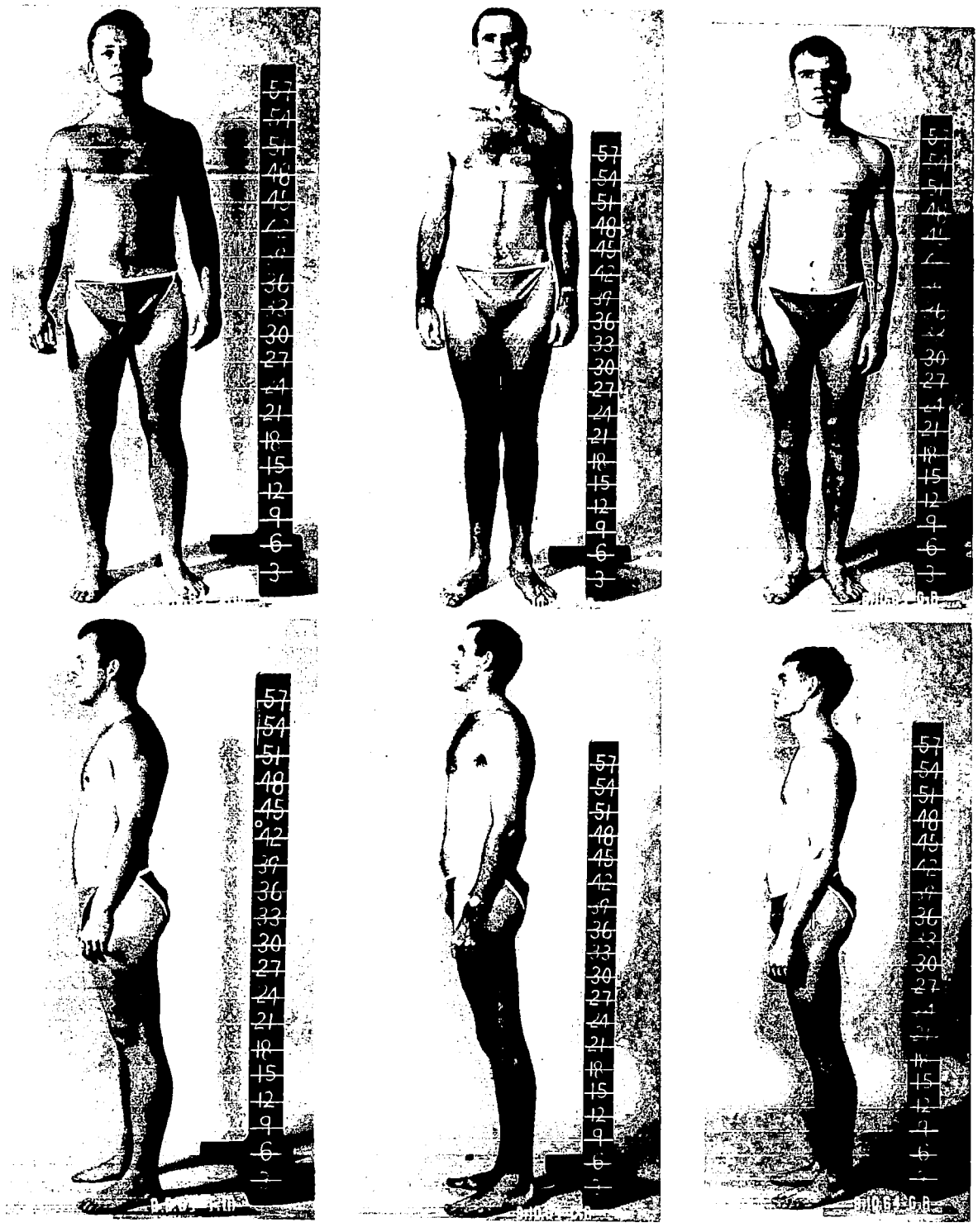
TIRR # 70021 R.S.H.

Figure 2. Photographs of Subjects



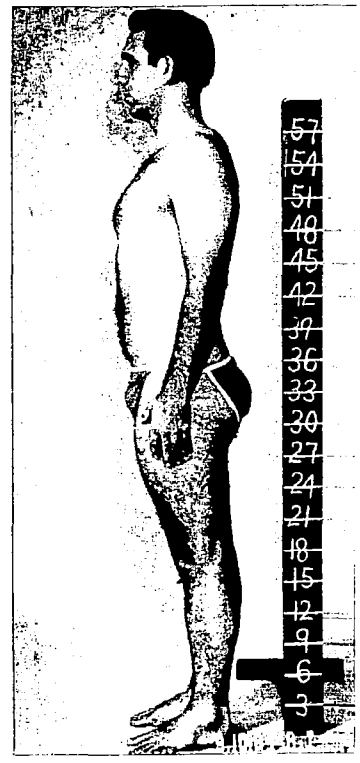
TIRR # 70022 J.A.H. TIRR # 70019 B.E.H. TIRR # 70018 A.C.I.

Figure 2. (continued)



TIRR # 70024 W.F.M. TIRR # 70025 C.E.R. TIRR # 70026 G.S.R.

Figure 2. (continued)



TIRR # 70027 R.R.T.

Figure 2. (Concluded)

Figure 3. View of Experimental Ward

were allowed to drink distilled water ad libitum, but a strict record for intake was maintained (see Appendix 5).

PHYSIOLOGICAL AND PSYCHOLOGICAL OBSERVATIONS

A. During Bed Recumbency

1. Periodic serum sodium and potassium determinations were made using the flame photometry technique.
2. Urine was collected in 6-hour collection periods which began at 1 a.m. over the entire duration of the study. Sodium, potassium and osmolarity determinations were made on each 6-hour sample for each subject, using the flame photometry technique. A total 24-hour aliquot was also obtained and analyzed for sodium and potassium. Urine was collected and preserved for the determination of 17-hydroxycorticoids and catecholamines on the same 6-hour samples (see Appendix 6.1 and 6.2).
3. Food was pooled for a 24-hour period and analyzed for sodium and potassium content using the flame photometry technique.
4. Feces was pooled for a 4 to 6 day collection period depending on the phase of the study and was analyzed for sodium and potassium content using the flame photometry technique (see Appendix 7).
5. Radioisotope measurements to determine plasma volume, extracellular fluid space, total body water, and red cell mass were determined on days 1, 4, and 10 of each bedrest period (see Appendix 8).
6. Body Weight: Each subject was weighed daily in the early morning after emptying his bladder. During the periods of bedrest, weights were obtained by means of a platform scale rolled to each bedside so that the subjects could maintain a horizontal position (see Appendix 9).

7. Leg Circumference: Measurements of leg circumference at three sites on each leg were made twice daily, in the morning and the afternoon. These measurements were performed using a flexible measuring tape which was wrapped around previously determined marks on the legs to assure that the same sites were measured at all times (see Appendix 10).

8. Psychological Testing: A test battery consisting of: (a) simple reaction time, (b) aiming, (c) visualization, (d) number facility, and (e) speed of closure was administered immediately preceding and following each passive tilt procedure and on the fourth day of bed recumbency. The Holtzman Inkblot Test and an alternating perspective measure were administered on days 2, 6, and 10 of bed recumbency. Tests of time perception, word fluency, perceptual speed, and responses to the Clyde Mood Scale were obtained twice daily. At the conclusion of each period, responses to a questionnaire were obtained from the subjects. In addition, ranking of the subjects was obtained from independent observers along four dimensions: (a) sociability, (b) arousal, (c) attitude toward the experiment, and (d) affective expression. Additional variables were administered during the second and third bed recumbency periods. These included reaction time, number facility, speed of closure, visualization and aiming (see Appendices 11.1.3, 11.3, and 11.4). The details of the psychological studies will be given in a separate report.

B. <u>During Provocative Testing</u>

After each bed recumbency period the subjects were tested with passive tilt, the bicycle ergometer, and Erkin exercise. A brief description of these provocative tests follows:

1. Passive Tilt Test

Comprehensive head-up passive tilt procedures were conducted on the subjects immediately before and after the 3 periods of recumbency. In addition, simple tilt procedures were determined weekly during the pre-bed recumbency period and during the recovery periods to determine the individual's day-to-day pattern of response to the tilt-table test (see Appendix 12.1).

The procedure used in performance of comprehensive head-up tilts was as follows:

a. The subjects were given nothing by mouth for several hours prior to the tilt-table test to protect against regurgitation and aspiration of foods should fainting and an association vagal response occur. It was found desirable to allow the subjects to drink a glass of milk several hours before the tilt procedure so that they would not be hungry at the time the tilt-table test was performed.

b. The subject was fitted with appropriate sensors prior to being placed on the tilt-table.

c. An emergency cardiac drug tray, defibrillators, cardiac pacemaker, artificial respiration equipment, and atropine drawn into a syringe was kept available for any cardiac emergency.

d. A motorized tilt-table with an English saddle type of support was used to tilt the subjects from 0 to 70° in 30 seconds. Provision was made to release the gear mechanism for instaneous tilt-down with occurrence of syncopal or vagal type of reactions.

e. Measurements during the tilt-table test included the following:

1) Frank Lead system vectorcardiogram.

2) Impedance pneumogram.

3) Intra-arterial blood pressure from the right brachial artery.

4) Forearm circumference changes by means of a Whitney mercury-in-rubber strain gauge connected to a Sanborn amplifier.

5) Right and left leg calf circumference by a Whitney mercury-in-rubber strain gauge placed around the calfs of both legs at the same site for each tilt procedure.

6) Precordial vibration by means of Ling-Temco-Vought capacitance type of microphone.

7) Venous pressure from the left forearm by means of venous intracatheter connected to a Statham pressure tranducer.

8) Measurements of forearm blood flow, venomotor tone, and peripheral vascular resistance were determined (see Appendix 12.2).

f. Pulmonary ventilation measurements made by means of arterial blood samples and expired air samples simultaneously obtained during a two-minute period from each subject prior to tilting.

g. A Flack procedure performed 5 minutes prior to and 5 minutes after tilting the subject to the 70° upright position. A code sheet was used for tilt-table studies to record observations made during the study, and to document the time of occurrence of the various tests performed. Each sheet allows for identification of the magnetic tape, test date, subject number, time of day, experimental circumstance, and the EECO code corresponding to the magnetic tape (see Appendices 12.3 and 15.1).

The simple tilt differed from the comprehensive tilt study in that only one lead of ECG was obtained and blood pressure was obtained by a cuff-microphone technique rather than by direct arterial puncture.

The details of the tilt studies will begiven in a separate paper.

2. Bicycle Ergometer Test

Bicycle ergometer tests were conducted on the subjects of this study before and after the recumbency periods (see Appendix 13.1). The Lanooy Bicycle Ergometer was used for these studies.

The information recorded before, during and after bicycle testing consisted of:

1) Frequency of the heart
2) Frequency of breathing
3) Pulmonary ventilation
4) Oxygen consumption
5) CO_2 elimination
6) Heart rate recovery time

Pulmonary ventilation, oxygen consumption, and CO_2 elimination were obtrained from samples of expired air obtained at 40, 80, 120 watts, and at the final work load. The concentration of oxygen and CO_2 in the samples of expired air were carried out with the Scholander apparatus. Volumes of expired air were measured with a wet gas meter. This information was recorded in source documents (see Appendix 15.2.1 through 15.2.5) for automatic data processing.

The electrocardiogram and the impedance pneumogram were continuously recorded on magnetic tape. This information was coded in source documents (see Appendix 15.2.6 through 15.2.8). The information stored on magnetic tape was played back with a strip chart recorder for pre-automatic processing inspection. It was further digitized by means of automatic analog to digital conversion.

Figure 11 is a photograph of the exercise laboratory with the instrumentation layout. The details of the results of the bicycle ergometer test including

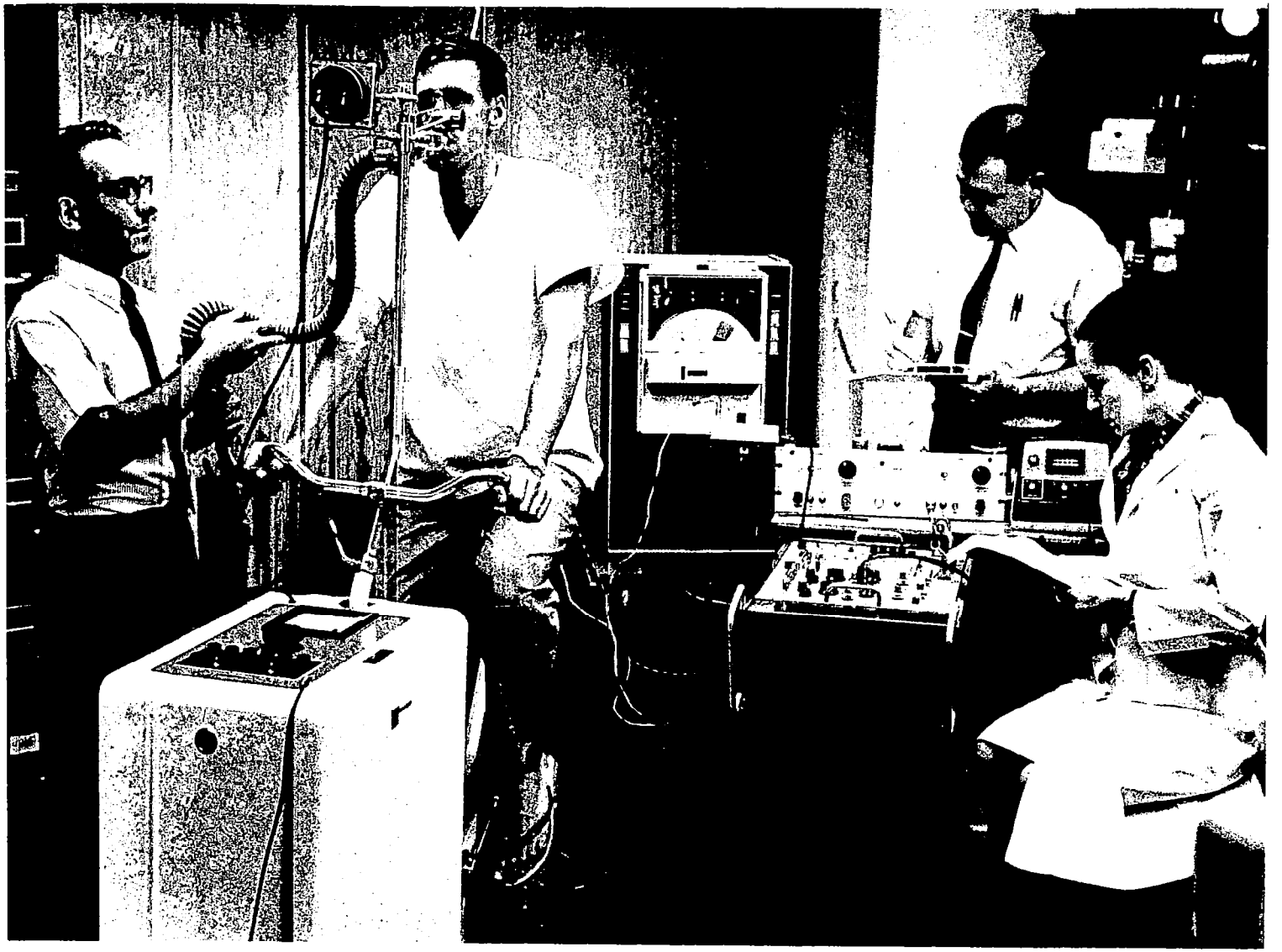


Figure 11. View of the Exercise Laboratory and Instrument Layout

gas exchange analysis and heart rate response will be given in separate reports.

3. Erkin Tests and Exercises

The Erkin* program is divided into two aspects: (1) criterion test (Erkin I, II, III, IV, and VI) designed to evaluate strength level, endurance, and cardiovascular response to this form of stress tests; and (2) conditioning exercises (Erkin V) intended to aid in the prevention of physiological deconditioning observed after bed recumbency. The schedule of the various Erkin tests and exercises is given in Appendix 14.1.

The objectives of the bedrest studies were reviewed in detail prior to devising these Erkin tests and exercises. Restrictions upon the form of the proposed exercise resulted from the limitation in the range of motion of the arms (elbow flexion) and the short range of extension allowable at the knee joint. The exercise procedure was designed so that it could be used by astronauts in the Gemini space capsule. The conditioning exercises were developed, therefore, around a pattern of isotonic motion of limited range.

The device employed for conditioning exercises is called a Bungie since the load is produced by the stretch imposed upon two strands of bungie rubber, such as that used in underwater spear guns. An initial model of this exerciser was provided by NASA. Subsequently, several modifications were made to adapt the primary model more effectively to this study program.

In order to have predictable and measured loads or exercise doses for each individual subject, the bungie strands were carefully calibrated by applying known weight loads and measuring the stretch produced. Calibration curves

* The term "Erkin" was improvised from the words ergonomics and Kinesiology as a brief designation for this program. It is used also as a coding category for computer processing of data (see Appendix 15.3).

were derived from these data for all bungie strands employed in the exercisers. Also, several strands were hazed up to 5000 times to determine durability and retention of elasticity. The exercise units were then assembled in a manner to permit adjustments in load and range for individual subjects.

Erkin III was designed as a functional test and is described below, along with Erkin V which was designed as a conditioning exercise.

The Erkin III test was designed to reveal the subject's condition and changes from time to time in respect to strength level, endurance (or fatiguability), and response of heart rate to 50 per cent of maximum exercise series. The sequence was standardized for each subject. This test was given before and after each bedrest period and several times between. It was used throughout the whole study as a criterion of changes in the mentioned particular functions. This test was also given to each subject on the last day of each bedrest period (the day preceding tilts) with the standing phase omitted. The following is the standard sequence employed in Erkin III while tensive force of each pull, the electrocardiogram, respiration and blood pressure were monitored:

a. Subject stands one minute.

b. Subject lies supine, and gives two maximum pulls on the tensiometer cable, arms at full extension.

c. Subject rests quietly four minutes.

d. Subjects pulls fifteen times, five seconds on, five seconds rest on cable tensionmeter at maximum effort.

e. Subject rests quietly five minutes.

f. Subject pulls fifteen times, five seconds on, five seconds rest, on cable tensiometer at maximum effort.

g. Subject rests quietly five minutes.

h. Subject stands one minute.

The Erkin V conditioning exercise was the standard in-bed exercise routine used throughout the study for individuals (or groups) for whom exercise was prescribed. The dose used for each individual was that standarized in the Erkin II series, and remained the same throughout. Each subject had his own Bungie exerciser.

These exercises were performed simultaneously by all subjects for whom exercise was prescribed in the master protocol. The routine was repeated ten times daily, at hourly intervals throughout the ten-day bedrest period, beginning at approximately 8:00 a.m.

The exercise routine was as follows: 120 pulls on the prescribed Bungie at the rate of one pull per second, i.e., an exercise period of two minutes.

This routine was interrupted slightly once per day during the bedrest period for ECG monitoring. The routine was also monitored with ECG twice before and twice after each bedrest period. For this set, each individual was tested sequentially, and the ECG was monitored two minutes before the exercise. This monitoring once daily was done also to subjects not on the exercise schedule. During the control bedrest period when no subjects were on exercise, Erkin V was given once every two days to all subjects as a criterion test.

A brief summary follows of the purpose and the procedure for each of the other Erkin tests as used throughout this study (see Appendix 14.2).

The details of the Erkin exercise and testing program and the analysis of Erkin III Criterion Tests will be discussed in a separate report.

INSTRUMENTATION

The general instrumentation developed for this study will be described in a separate report. Specific instrumentation for Erkin exercises and testing, tilt testing, and bicycle ergometer testing will be described in the reports giving the results obtained with each of these testing procedures.

DATA PROCESSING

Laboratory data and analog recordings of the functional tests were prepared for automatic data processing. A considerable amount of data was manually digitized for preliminary reports and presentations of the data. In some instances, semi-automatic devices for analog-to-digital conversion were used for the same purpose.

A technique was studied for the automatic analog-to-digital conversion of the electrocardiogram and blood pressure recordings obtained during the bicycle ergometer test, the tilting procedure and the Erkin tests.

All the discrete data was punched into cards for electronic data processing (see Appendix 15). The data were conveniently prepared for statistical analysis. The general statistical methods and automatic data processing techniques utilized will be described in a separate report.

REVIEW OF PROGRESS

In accordance with Amendment 3 of the contract, brief monthly progress reports were made to Dr. Lawrence F. Dietlein, Technical Monitor of the project, and to Mr. A.C. Wilder, Contracting Officer.

CONTRIBUTORS

The authors wish to express their appreciation to the subjects who participated in this study and the following persons for their help and cooperation.

Consultation and Assistance from: Moise Axelrad, M.D., Rudolph Freund, Ph.D., Mark Fuhrer, Ph. D., Philip C. Johnson, M.D., Harry Lipscomb, M.D., Ferrin B. Moreland, Ph.D., William A. Spencer, M.D., Carlos Vallbona, M.D., Thomas Watts, M.D., Mr. William F. Blose, Mrs. Bette Costis, and Mr. James McConnell.

Secretary: Mrs. Carolyn A. Caldwell.

Research Assistants: Mr. Jesse Baldwin, Mr. Michael Craig, Mr. Jack Fleetwood, Mr. Alfred Johnston, Mr. James Kennedy, Mr. Robert Naylor, and Mr. Thomas Smith.

Laboratory Technicians: Mrs. Judy Brock, Mr. Albert Canida, Mr. Robert Connor, Mr. T.C. Erwin, Mrs. Marion Ford, Mrs. Angela Fraga, Mrs. Kathleen Hohl, Mr. Lawrence Jones, Miss Ann Landry, Mrs. Carmen Langford, Miss Cheryl Mitchell, Mrs. Lois Shawver, and Miss Peggy Watters.

Senior Systems Analyst: Mr. James C. Goodlett.

Junior Systems Analyst: Mr. C.L. Chang, Mr. John Saxon, and Mr. Larry Smith.

Data Preprocessing Clerks: Mrs. M.N. Boysen, Mr. John A. Kraft, and Mr. Joseph A. Sunbarger.

REFERENCES

Previous Reports on Bed Recumbency Studies Conducted at the Texas Institute for Rehabilitation and Research

1. Vallbona, C., Vogt, F.B., Cardus, D., Spencer, W.A., and Walters, M.: The Effect of Bedrest on Various Parameters of Physiological Function: Part 1. Review of the Literature on the Physiological Effects of Immobilization. NASA Contractor Report CR-171, March 1965.

2. Vallbona, C., Vogt, F.B., Cardus, D., and Spencer, W.A.: The Effect of Bedrest on Various Parameters of Physiological Function: Part II. Experimental Design. NASA Contractor Report CR-172, March 1965.

3. Vogt, F.B., Lamonte, R.J., McConnell, J.R., Hallen, T.O., Vallbona, C., Cardus, D., Spencer, W.A., and Holt, T.W.: The Effect of Bedrest on Various Parameters of Physiological Function: Part III. Bioinstrumentation. NASA Contractor Report CR-173, April 1965.

4. Vallbona, C., Spencer, W.A., Blose, W., Cardus, D., Vogt, F.B., and Leonard, J.: The Effect of Bedrest on Various Parameters of Physiological Function: Part IV. A System for Processing Data Collected in the Immobilization Study Unit. NASA Contractor Report CR-174, March 1965.

5. Walters, M.E., Vallbona, C., Cardus, D., Vogt, F.B., and Spencer, W.A.: The Effect of Bedrest on Various Parameters of Physiological Function: Part V. Dietary Requirements. NASA Contractor Report CR-175, September 1965.

6. Vogt, F.B., Cardus, D., Vallbona, C., and Spencer, W.A.: The Effect of Bedrest Immobilization on Various Parameters of Physiological Function: Part VI. The Effect of the Performance of Periodic Flack Maneuvers on Preventing Cardiovascular Deconditioning of Bedrest. NASA Contractor Report CR-176, July 1965.

7. Cardus, D., Spencer, W.A., Vallbona, C., and Vogt, F.B.: The Effect of Bedrest on Various Parameters of Physiological Function: Part VII. Cardiac and Ventilatory Response to the Bicycle Ergometer Test. NASA Contractor Report CR-177, April 1965.

8. Vallbona, C., Cardus, D., Vogt, F.B., and Spencer, W.A.: The Effect of Bedrest on Various Parameters of Physiological Function: Part VIII. The Effect on the Cardiovascular Tolerance to Passive Tilt. NASA Contractor Report CR-178, April 1965.

9. Vallbona, C., Spencer, W.A., Vogt, F.B., and Cardus, D.: The Effect of Bedrest on Various Parameters of Physiological Function: Part IX. The Effect on the Vital Signs and Circulatory Dynamics. NASA Contractor Report CR-179, March 1965.

10. Vogt, F.B., Spencer, W.A., Cardus, D., and Vallbona, C.: The Effect of Bedrest on Various Parameters of Physiological Function: Part XI. The Effect of Bedrest on Blood Volume, Urinary Volume, and Urinary Electrolyte Excretion. NASA Contractor Report CR-181, April 1965.

11. Vogt, F.B., Mack, P.B., Beasley, W.G., Spencer, W.A., Cardus, D., and Vallbona, C.: The Effect of Bedrest on Various Parameters of Physiological Function: Part XII. The Effect of Bedrest on Bone Mass and Calcium Balance. NASA Contractor Report CR-182, April 1965.

12. Cardus, D., Vallbona, C., Vogt, F.B., Spencer, W.A., Lipscomb, H.S., and Eik-Nes, K.B.: The Effect of Bedrest Immobilization on Various Parameters of Physiological Function: Part XIV. Effect of Bedrest on Plasma Levels and Urinary Excretion of 17-Hydroxycorticosteroids. NASA Contractor Report CR-184, April 1965.

13. Cardus, D., Vallbona, C., Vogt, F.B., Spencer, W.A., Lipscomb, H.S., and Eik-Nes, K.B.: Influence of Bedrest on Plasma Levels of 17-Hydroxycorticosteroids. Aerospace Medicine 36: 524, 1965.

14. Beasley, Willis C.: The Erkin Tests and Exercises. Proceedings of a Research Contractors Conference. NASA Manned Spacecraft Center. December 3 and 4, 1964, pp. 105-113.

APPENDIX

(Schedules, Methods and Techniques)

SUBJECT CANDIDATE QUESTIONNAIRE*

TEXAS INSTITUTE FOR REHABILITATION AND RESEARCH

in the
Texas Medical Center

IDENTIFICATION DATA

Subject Number: (not to be filled out by applicant) _____ | | | | | |

Name: _____
(Last name first)

Date of Birth: _____ | | | | | | Mo. Day Yr.

Religion: _____

Place of Birth: _____
(City and State)

(Please use proper code numbers in answering questions)

Sex: ___ (1. Male, 2. Female) _____ |

Race: ___ (1. White, 2. Negro, 3. Latin American, 4. Yellow, 5. Other) _____ |

Current Height: _____ (in inches) _____ | | |

Usual Weight _____ (in pounds) _____ | | |

Marital Status: _____ (1. Single, 2. Married, 3. Divorced, 4. Widower) _____ |

Current Occupation: ___ (1. Student, 2. Employed, 3. Unemployed, 4. Other) |

If employed:
1. Current Occupation: _____
2. Employer: _____

If student:
1. What is major course? _____
2. Where attending? _____
3. Working toward what degree? _____
4. Have you ever been on scholastic probation? _____
5. Have you ever been expelled from school? _____
   If yes, give cause: _____

* This questionnaire was adapted from the 1963 Study.

EDUCATION AND WORK EXPERIENCE

List below names of schools (begin with High School) you have attended.

Dates						
From		To		Name	Location	Degree Obtained
Mo.	Year	Mo.	Year			

List below in chronological order any jobs you have held in the past and the length of your employment.

Dates					
From		To			
Mo.	Year	Mo.	Year	Place of Employment	Job Description

PAST MEDICAL HISTORY

DEVELOPMENTAL HISTORY

(Please use proper code in answering questions)

To the following questions answer: 1. Don't know, 2. No. 3. Yes

Were you a full term baby?	
Were you a premature baby	
Did you have any abnormalities at birth?	
Were you breast fed	
Were you bottle fed?	

As a child did you have any problem with the following:

Feeding or nursing	
Bed Wetting	
Thumb sucking	
Stammer or Stuttering	
Temper Tantrums	
Sleepwalking	
Nightmares	
Eating	
Nervousness	
Convulsions	
Asthma	
Allergies	
Hay Fever	
Chocolate	
Penicillin	
Sulfa	
Other Drugs	
Plants	
Dust	
Insects	

Indicate APPROXIMATE age in months of the following: (if known).

Sitting up		
Walking		
First Distintive Words		

ILLNESSES

The following is a list of frequent illnesses in childhood or adulthood. Please indicate whether or not you have had any of them. If you do not know, please indicate.

Disease	Don't know	No	Yes	Age	Where hospitalized if known	Complications if any
Measles						
German measles						
Chicken Pox						
Whooping Cough						
Mumps						
Diptheria						
Frequent Colds						
Scarlet Fever						
Typhoid Fever						
Asthma						
Rheumatic Fever						
Pneumonia						
Bronchopneumonia						
Abscessed Ears						

List all other illnesses that you have had.

Year	Age	Disease or Complaint	Were you hospitalized? If so, where?	Recovery complete? If not, complications.

Venereal Diseases: Syphilis, Gonorrhea or other (please specify).

Year	Age	Disease	Were you treated?	Were you given full clearance?

Allergies: Are you at the present time allergic to any one of the following? If you have allergies to agents not indicated below, please list them in the blank spaces provided. Indicate:1.Don't know, 2. No, 3. Yes

Hay Fever	
Chocolate	
Penicillin	
Sulfa	
Other Drugs	
Plants	
Dust	
Insects	
Other:	

OPERATIONS

List all known operations since birth, even minor ones such as circumcision. Be as precise as possible in giving dates.

Date						
Mo.	Day	Year	Type of Operation	Name of Physician	Where Hospitalized	Remarks

INJURIES OR ACCIDENTS

List all injuries or accidents requiring the services of a physician. Be as precise as possible in giving dates.

Date						
Mo.	Day	Year	Type	Name of Physician	Hospital	Remarks

IMMUNIZATION RECORD

Use Code: 1. Don't know, 2. No, 3. Yes

Small Pox	
Last vaccination against Small Pox was in year:	
Diphtheria	
Last vaccination against Diphtheria was in year:	
Whooping Cough	
Last vaccination against Whooping Cough was in year:	
Tetanus	
Last vaccination against Tetanus was in year:	
Typhoid Fever	
Last vaccination against Typhoid Fever was in year:	
Yellow Fever	
Last vaccination against Yellow Fever was in year:	
Armed Forces Routing Vaccinations	
Last time I received Armed Forces Routine Vaccinations was in year:	
Poliomyelitis Salk Vaccine	
Number of injections to date	
Last injection was received in year:	
Poliomyelitis Sabin Type I	
Last time I received this vaccine was in year:	
Poliomyelitis Sabin Type II	
Last time I received this vaccine was in year:	
Poliomyelitis Sabin Type III	
Last time I received this vaccine was in year:	
Any other vaccines you have received: Give name and year.	
Have you received the following immunizing agents? Use Code: 1. Don't know, 2. No, 3. Yes. Indicate when you last received the serum by year.	
Serum against Tetanus	
What year	
Serum against Diphtheria	
What year	
Gamma Globulin	
What year	
Any other: Give type and year.	

FAMILY HISTORY

LIVING RELATIVES

Check if you are adopted son		
Relation	Age at present	
Paternal Grandfather		
Paternal Grandmother		
Maternal Grandfather		
Maternal Grandmother		
Father		
Mother		
Brother		
Brother		
Brother		
Brother		
Brother		
Brother		
Brother		
Brother		
Sister		
Sister		
Sister		
Sister		
Sister		
Sister		
Sister		
Spouse:		
List your living children: (indicate if any of the children are adopted)		
Son		
Son		
Son		
Son		
Daughter		
Daughter		
Daughter		
Daughter		

FAMILY HISTORY

DECEASED RELATIVES

Relation	Cause of Death	Age at Death	
Paternal Grandfather			
Paternal Grandmother			
Maternal Grandfathe r			
Maternal Grandmother			
Father			
Mother			
Brother			
Brother			
Brother			
Brother			
Brother			
Brother			
Brother			
Sister			
Sister			
Sister			
Sister			
Sister			
Sister			
Sist er			
Spouse:			
Children:			
Son			
Son			
Son			
Son			
Daughter			
Daughter			
Daughter			
Daughter			

DISEASES IN FAMILY

Disease	Don't know	No	Yes	Relatives affected
Diabetes				
Cancer				
Tuberculosis				
Asthma				
Epilepsy				
Stroke				
Mental Disorder				
Nervous System disease				
High Blood Pressure				
Heart Disease				
Migraine				
Leukemia				
Arthritis				
Hay Fever				
Paralysis (any form)				
Other:				

MILITARY SERVICE

If you have served in any branch of the Armed Forces, Please answer the following questions.

Branch of service _____

Total number of months in service _____ Classification _____

If you received dishonorable discharge, give cause: _____

If you have retained reserve status, give last date of duty tour and location: _____

List any honors or decorations you received while in service: _____

SOCIAL HISTORY

SMOKING

Use code: 1. Don't know, 2. No, 3. Yes, in answering the following questions.

Have you ever smoked? _____
Do you now smoke? _____
If yes to above question:
How many cigarettes per day do you smoke? _____
How many cigars per day do you smoke? _____
How many pipes per day do you smoke? _____
Do you use tobacco in any other form? _____
If yes, explain: _____

DRINKING

Have you ever drunk alcoholic beverages? _____
Do you now drink alcoholic beverages? _____
If you drink socially put a check mark in the box _____
If you drink regularly, indicate the average number of drinks per day you take. _____
If you drink beer regularly, indicate the average number of beers you drink per day. _____
Please indicate your average daily consumption of the following:
Coffee (indicate the number of cups) _____
Hot tea (indicate the number of cups) _____
Cold tea (indicate the number of glasses) _____
Milk (indicate the number of glasses) _____
Coke (indicate the number of bottles) _____

DIET

Describe your average breakfast: _____

Describe your average lunch: _____

Describe your average dinner: _____

SOCIAL HISTORY

DIET (continued) Use code: 1. Don't know, 2. No, 3. Yes

Have you ever dieted to lose weight? ____
Have you ever taken medication to help you lose weight? ____
If yes, give name of medication and dosage: ____
Are you at the present time taking medication for weight loss? ____

EXERCISE

Give an estimate of the amount of exercise that you do in one week. Please use this rating. 1. Minimal amount, 2. Moderate amount, 3. A lot. ____

SPORTS

Use code: 1. Don't know, 2. No, 3. Yes

Have you ever been engaged in active sports? ____
Are you now engaged in active sports? ____
Please indicate the sports in which you have participated in the past and those in which you now participate. ____

DRIVING

Use code: 1. Don't know, 2. No, 3. Yes

Have you been or are you now a regular operator of any of the following vehicles:
Car ____
Plane ____
Motorcycle ____
Bus or Public vehicle ____
Power boat ____
Sail boat ____
Other: ____

RESIDENCES

Please list below the names of the places where you have resided.
Give name of town only:

Dates		
From	To	Name of town

Have you ever lived or visited in another country?
Use code: 1. Don't know, 2. No, 3. Yes:
If yes, give the name of the country and the length of your stay.

CONTAGIOUS CONTACTS

Please indicate with check in box if you have had any recent contagious contact with any of the following illnesses.

measles	
chicken pox	
mumps	
meningitis	
tuberculosis	
typhoid fever	
poliomyelitis	
flu	
venereal disease	
hepatitis	
other:	

CURRENT MEDICATIONS

If you are currently taking any medications (including aspirin) please indicate the following:

Name of medicine	Amount	Frequency	Only occasionally

SYSTEMS REVIEW

Please put a check mark (√) in box if you have or have had any of the following.

HEAD

Frequent headaches	
Frequent pain in face	
Pounding headaches or flushing of the face	
Migraine	
Intermittent swelling of the face not related to injury or infection	

EYES

Need to use glasses	
Contact lenses	
Farsightedness	
Nearsightedness	
Astigmatism	
Crossing of the eyes	
Blind spots	
Partial blindness of your visual field	
Difficulty in seeing at night	
Color Blindness	
Yellowish discoloration of the eyes	
Swelling of the eyelids in the mornings	
Pain in the eye	
Burning or itching of the eyes	
Pressure feeling in the eyes	
Double Vision	
Lump in the eyelid	
Injury to the eye ball	
Operation in the eye	
Intolerance to bright light	

EARS

Severe earache	
Draining in ears	
Ruptured ear drum	
Temporary or permanent hearing loss	
Ringing or buzzing in the ears	
Dizziness	
Air sickness	
Motion sickness	
Mastoiditis	
Otitis media	

SYSTEMS REVIEW

EARS (continued)

Trouble with your ears after swimming	
Fungus infection of the ears	
Extreme sensitivity to noise	
Injury to the ear	
Surgery to the ears	

NOSE

Frequent head colds	
Frequent sneezing	
Excessive nasal discharge	
Frequent nose bleeding	
Post Nasal drip	
Trouble breathing through the nose	
Deviation of the septum	
Fracture of the nose	
Surgery of the nose	
Acute sinus infection	
Chronic sinus infection	
Difficulty in smelling various odors	
Stuffy nose	
Allergic reaction to:	
Plants	
Dust	
Insects	
Other	
If yes to above, specify:	

MOUTH

Frequent sores inside of the mouth	
Fever blisters around the mouth or throat	
Frequent bleeding or tender gums	
Complete or partial dental plates	
Pyorrhea or infection of the gums	
Large number of cavities in your teeth	
Excessive bleeding following extraction of tooth	
Frequent toothache	
Intolerance to cold in contact with the teeth	
Intolerance to heat in contact with the teeth	
Dental work in the last six months	
Foul breath or halitosis	
Excessive dryness of the mouth	
Abnormality in sense of taste	

SYSTEMS REVIEW

THROAT

Difficulty in pronouncing words	
Frequent soreness in throat	
Hoarseness	
Recent and permanent change in your voice	
Stuttering	
Difficulty in swallowing	

SKIN

Frequent pimples or boils	
Acne or pimples on face	
Easy bruising	
Excessive sweating	
Ulcers on any part of your skin	
Discoloration of the skin	
Any moles	
Skin rashes	
Dryness of the skin	
Greasy coating of the skin	
Giant hives (urticaria)	
Excessive loss of hair	
Changing in the texture of the hair	
Excessive softness of the hair (seborrhea)	

NECK

Deformities of the neck	
Enlargement of the glands of the neck	
Tumors or masses in the neck	
Pain or stiffness in the neck	
Whiplash accident	
Wryneck	
Visible pulsating veins	

SPINE

Slipped disc	
Low back pain	
Back injury	
Deformity of the spine	
Fracture of the spine	

SYSTEMS REVIEW

RESPIRATORY

Chronic or recurrent cough	
Coughing up of blood or pus	
Pain in chest	
Shortness of breath while lying down	
Shortness of breath while sitting up	
Asthmatic attacks	
Chest wheezes	
Collapsed lung	
Shingles of the chest wall (small vesicles or herpes zoster)	
Pain in the chest on deep breathing	
Pleural inflammation	

CARDIOVASCULAR

Disturbances in the blood supply to the heart (coronaries)	
Bluish discoloration of the lips, skin, fingers or toes (cyanosis)	
Congenital defect in the heart	
Heart murmur	
Enlargement of the heart	
Rheumatic fever affecting the heart	
Anemia	
High blood pressure	
Low blood pressure	
Dizzy spells related to change in posture	
Feeling of light headedness upon arising in the morning	
Hardening of the arteries	
Loss of consciousness from head injury	
Loss of consciousness while receiving an injection	
Have you ever fainted	
Heat prostration	
Sudden changes in the speed of the heart beat (too fast or too slow)	
Sensation of skipping a beat (extrasystoles)	
Chest pain during exercise	
Occasional dizzy spells	
Easy tiring with slight effort	

DIGESTIVE

Stomach distention	
Discomfort in stomach during night	
Burning sensation in stomach that is relieved by milk, alkalines or food	
Frequent indigestion	
Tendency to vomit	

SYSTEMS REVIEW

DIGESTIVE (continued)

Tendency to belch	
Severe pains in the stomach	
Intermittent pain in the abdomen	
Need to get up in the morning hours to eat or drink to relieve pain in the stomach	
Peptic ulcer	
Gallbladder disease	
Gallstones	
Liver disease	
Jaundice	
Cirrhosis	
Hepatitis	
Diseases of the pancreas	
Swelling in the abdomen	
Bowel distention	
Irregularity of the bowels	
Frequent constipation	
Frequent diarrhea	
Thin stools	
Clay stools	
Staining of the stools	
Black or tarry bowel movements	
Hemorrhoids	
Itching around rectum	
Rectal polyps	
Rectal fistula or abscess	
Unusual amount of hiccoughs	
Pain in rectum	
Pain during bowel movements	
Lack of control of the bowels	
Large, bulky, foamy or foul smelling stools	

ENDOCRINE

Fluctuations in body weight independent of dieting	
Excessive amount of fat in the body (obesity)	
Excessive weight loss	
Craving for food	
Excessive thirst or craving for water	
Excessive amount of urinary output	
Diabetes	
Need to take insulin	
Fullness of the neck (goiter)	
Need to take thyroid medication	
Dry and scaly skin	

SYSTEMS REVIEW

ENDOCRINE (continued)

Coarse hair	
Protusion of the eyeballs and marked jitters	
Retention of water in the skin and swelling of some parts of body	
Excessive sweating	
Unusual amount of hair (hirsutism)	
Precocious appearance of hair on the body or around the genitalia	
Loss of calcium from the bones	
Tendency to have spontaneous fractures of the bones	

URINARY

Difficulty in passing urine	
Need to have a catheter in bladder for any reason	
Infection of the kidneys	
Infection of the bladder	
Pus in the urine	
Blood in the urine	
Sugar in the urine	
Albumin or protein in the urine	
Dark brown urine	
Kidney stones	
Shooting pains in the back radiating down to the testicles	
Need to get up at night to pass urine	
Frequency in urination	
Burning sensation during urination	
Trouble starting or stopping the stream during urination	
Inability to control your bladder	

GENITALIA (to be filled out by men only)

Circumcision	
Swelling or enlargement of either testicle	
Injury to the testicles	
Itching around the genitalia	
Urethral discharge	
Hernia	
Swelling of the scrotum	
Sexual difficulties	
Sterility	
Infection of the prostate gland	
Enlargement of the prostate gland	
Pain in your penis	
Injury to your penis	

EXTREMITIES

Numbness or tingling of the feet	
Numbness or tingling of the hands	
Pain in the calves of the legs while walking	
Shooting pains down the leg	
Swelling or enlargement of the veins in the legs (varicose veins)	
Swelling of the feet or ankles	
Swelling of the hands	
Blood clots in the legs	
Stiffness of the joints	
Dislocation of any joint	
Pain in any joint	
Swelling of any joint	
Injury or fractures of any joint or bones	

MUSCLES

A feeling of weakness in some of your muscles	
Twitching of the muscles	
Loss of muscle mass (atrophy)	
Increase in the size of the muscles (hypertrophy)	
Weakness after exercise	
Low grip strength	
Difficulty in loosing your grip after grasping an object with the hands	
Muscle tenderness	
Inflammation of muscles	

CENTRAL NERVOUS SYSTEM

Coma or unconsciousness	
Convulsions	
Difficulty in falling asleep (insomnia)	
Tendency to fall asleep	
Tendency to be excited	
Weakness or paralysis in any muscle group	
Brisk or jerky reflexes	
Decreased reflexes	
Sustained tremors	
Decreased sensation to touch in any part of the body	
Decreased sensation to heat or cold	
Need to have a spinal tap	
Injury that has rendered you unconscious	
Encephalitis	
Meningitis	
Electroshock treatments	

SYSTEMS REVIEW

CENTRAL NERVOUS SYSTEM (continued)

Surgery to the brain or spinal cord	
Injury to surgery to nerve	
Transient or permanent loss of memory	
Difficulty in identifying objects	
Staggering gait	

GENERAL

Have you ever had any blood transfusions reactions	
Have you ever been exposed to any of the following:	
Toxic substances (be specific)	
X-ray radiation	
Poisons (be specific)	
Chemicals (be specific)	
Other toxics:	

REMARKS: (not to be filled in by subject candidate)

PHYSICAL EXAMINATION SHEET

HISTORY AND PHYSICAL

NAME: _____ NUMBER: _____

DATE OF ADMISSION: _____

REASON FOR ADMISSION:

PAST HISTORY: (This included past medical, past traumatic, past surgical, etc.)

FAMILY HISTORY:

SOCIAL HISTORY:

REVIEW OF SYSTEMS: (This included skin, head, neck, cardiovascular, respiratory, EENT, locomotor, neuropsychiatric, genito-urinary, gastro-intestinal)

PHYSICAL EXAMINATION: (This included age, sex, height, weight, temperature, EENT, pulse, respiration, blood pressure, general appearance, skin, head, neck, chest, heart, lungs, abdomen, genitalia, lymphatics, blood vessels, locomotor, extremities, neurological, musculature, rectal)

IMPRESSION:

Appendix 3

SUBJECT IDENTIFICATION FOR SCHEDULING

SUBJECT NUMBER	SUBJECT NAME	HOSPITAL NUMBER
1	B.E.H.	70-0-19
2	M.A.C.	70-0-20
3	R.S.H.	70-0-21
4	G.S.R.	70-0-26
5	J.A.H.	70-0-22
6	A.C.I.	70-0-18
7	W.F.M.	70-0-24
8	A.P.K.	70-0-23
9	R.R.T.	70-0-27
10	C.E.R.	70-0-25
11	L.F.E.	70-0-28

DAILY ACTIVITY RECORD

SUBJECT ACTIVITIES AND BEDSIDE OBSERVATIONS

DATE TIME

NAME _____ START _____ _____

SUBJECT NO. _____ END _____ _____

TIME	OBSERVATION	INITIAL
0700 - 0800		
0800 - 0900		
0900 - 1000		
1000 - 1100		
1100 - 1200		
1200 - 1300		
1300 - 1400		
1400 - 1500		
1500 - 1600		
1600 - 1700		
1700 - 1800		
1800 - 1900		
1900 - 2000		
2000 - 2100		
2100 - 2200		
2200 - 2300		
2300 - 2400		
2400 - 0100		
0100 - 0200		
0200 - 0300		
0300 - 0400		
0400 - 0500		
0500 - 0600		
0600 - 0700		

Appendix 5

FLUID INTAKE
Record

DATE TIME

SUBJECT _____ START _____ _____
SUBJECT NO. _____ END _____ _____

TIME	ORDERLY INITIAL	VOLUME (ml.)
Twelve hour total----------		

Twelve hour total----------		

Twenty-four hour total

URINE STUDIES

URINE OUTPUT
Record

DATE TIME

NAME _____ START _____ _____

SUBJECT NO. _____ END _____ _____

TIME	VOLUME (ml.)	SUGAR 0 - ++++	SPECIFIC GRAVITY	ORDERLY INITIAL

Six hour total _____

Six hour total _____

Six hour total _____

Six hour total _____

TWENTY-FOUR HOUR TOTAL ---------- _____

17-HYDROXYCORTICOSTEROID TECHNIQUE

A complete 24-hour specimen of urine is collected and the volume determined. Instructions for this collection are as follows:

1st day - (a) Upon arising, empty bladder (discard urine) record time.
(b) All subsequent urine goes into collection bottle.
(c) Keep bottle on ice or in refrigerator.
2nd day - (d) Set alarm for same time as (a), add this voiding to collection bottle.
(In other words, discard first morning's sample, save second morning's sample.)

Following the measurement of total volume, a 75-cc aliquot of urine is frozen until the determination, and the remainder is discarded.

PROCEDURE: Hydrolysis

1. Set up 250-ml Erlenmeyer flasks for the following:
Two H_2O blanks, marked 1 & 2; the number of flasks required to run each sample (the first sample is marked 7). Flasks 3 - 6 will be picked up on the second day of the determination.
2. Weigh into each of the above flasks the following:
25 mg of Ethylediamine Tetraacetic Acid (Versene)
40 mg of L-Cysteine HCL (Cysteine)
3. With a 10 ml vol. ppt. add to the H_2O blanks 10 ml of demineralized H_2O.
4. Using a 10 ml vol. ppt. add 10 ml of urine to all samples. Use a new ppt. for each.
5. With a 10 ml serological ppt. add to each flask 1 ml of 1 M phosphate buffer of pH 6.65.
6. Swirl each flask by hand to mix solutions.
7. With a 10 ml serological ppt. add 1 ml of B-gluceronidase solution to each of the flasks. Swirl by hand.
8. With a 10 ml sero. ppt. or a burette add 1.5 ml or redistilled $CHCL_3$ to each flask and swirl. (This $CHCL_3$ must be distilled freshly each day.)
9. Cover each flask with a tissue held securely with a rubber band.
10. Place all flask in incubater for either 4 hours or overnight at 37°c.

Extraction

11. Remove flasks from incubator.
12. Set up flasks numbered 3 - 6.
    #3 is the third H_2O blank, which does not go through hydrolysis.
    #4 - 6 are standards which begin from extraction.
13. Set up 6 conical-tip glass-stoppered centrifuge tubes (50 ml) for standard recovery. Mark 3 of the tubes with an S, and the other three with ØS.
14. With a 1 ml vol. ppt. add 1 ml of standard (20 ug/ml in ethanol) to flasks 4,5, & 6 and tubes S and ØS (all six tubes).
15. Evaporate to dryness in a water bath at 37° C with air.
16. Once dried, stopper the six tubes and place in refrigerator.
17. Using a 10 ml Vol. ppt., add 10 ml of demineralized H_2O to flasks 3 - 6.
18. Add 90 ml of redistilled CH_2CL_2 to each flask, #1 - #X. Cover immediately with foil to avoid evaporation.
19. Carefully place all flasks on rotating table and extract for 20 min. at 48 rpm. Freeze overnight or for several hours until water and urine are solid.

Transfer of Volumes and Color Development

20. Set up 125 ml separatory funnels equipped with teflon stopcocks, one for each flask in extraction. Beneath each funnel set up a 125 ml erlen. flask with a funnel (plain-stem) which has been loosely packed with pyrex wool. (Do not pack walls) Put one teaspoon sodium sulfate in each funnel.
21. Set up two rows of 50 ml conical tip tubes, one set for each sample. Mark the first row Ø1 - ØX and the second row 1 - X.*
22. Into each tube in the front row (Ø) put 3.0 ml HØE reagent; into each tube in the back row put 3.0 ml HE reagent. Set aside.
23. Remove extraction flasks, not more than 6 at a time, from the freezer.
24. Carefully transfer the CH_2CL_2 from each flask into its respective sep. funnel by pouring it over the ice, making certain that none of the liquid is left behind.
25. Add to each sep. funnel 5.0 ml of 0.1N NaOH for washing. Stopper the sep. funnels and invert for 20 seconds, releasing pressure frequently. Remove the stoppers and allow the two phases to separate.
26. Now filter the CH_2CL_2 through the sodium sulphate into its receiving flask, leaving the NaOH behind. Cover receiving flasks with foil.
27. From each receiving flask, measure out 40 mls into each of the

* Standard tubes: Into each ØS tube, 3.0 ml of HØE; into each S tube, 3.0 ml HE. Also set up two tubes to hold the reagents alone, as a purity check; 3.0 ml into each.

respective 50 ml tubes, Ø and non-Ø. Stopper tubes immediately.

28. With all stoppers tightly fitted, shake tubes 3 times for 20 seconds. Rotate Standard tubes three times.
29. Centrifuge tubes, with stoppers removed, for 10 minutes at 2000 rpm.
30. Aspirate the top layer, CH_2CL_2. Cover the open tubes with a towel or foil and place in a dark place overnight to develop color.
31. Read on Beckman DU at 410.

FECES COLLECTION SHEET

DATE TIME

NAME _____ START _____ _____

SUBJECT NO. _____ END _____ _____

DATE	CHARACTER	BOTTLE NO.

8. FLUID AND ELECTROLYTE STUDIES

PLASMA VOLUME TECHNIQUE

TECHNIQUE OF I-131 OR I-125 HSA BLOOD VOLUME

A. Dilution of Stock Solution

1. Determine volume of stock solution that will contain 100 uc of I-131 or 300 uc of I-125.

$$\text{Volume} = \frac{100 \text{ uc}}{\text{uc/ml as on shipping notices assay x decay factor}}$$

DECAY FACTOR TABLE

Days	I-131 Factor	I-125 Factor
1	0.918	0.988
2	0.843	0.977
3	0.774	0.964
4	0.711	0.952
5	0.653	0.942
6	0.600	0.930
7	0.551	0.919
8	0.506	0.907
9	0.465	0.897
10	0.427	0.886

2. Dilute this volume to about 50 ml using stock solution of sterile normal saline to which 1 ml of HSA (250 mg) has been added. A sterile multiple injection bottle should be used. We find it convenient to use a 30 ml bottle of sterile saline, e.g. Cutter's Ambot 30 cc normal saline USP for injection.

B. Preparation of Standard:

1. Draw off 1 ml of this diluted stock solution using a sterile disposable plastic syringe and a #21-1 inch needle. Remove the needle. Glass syringes require the use of larger volumes, e.g. 5 ml.

2. Wash this 1 ml of stock solution into tap water contained in a 1000 ml volumetric flask. The syringe should be washed twice with the water contained in the flask.

3. Mix by gently agitating the flask.

4. Dilute with water to the 1000 ml mark and mix again.

5. Using a 1 ml volumetric pipette, measure out 1 ml into two tubes used for counting in a scintillation well-counter.

6. Determine the radioactivity in each tube using a scintillation well-counter. Count for at least 10,000 counts.

7. If the counts per minute obtained vary by less than 1 percent between any of the two tubes, stopper the tubes with corks and use for standards whenever a plasma volume is to be determined using this stock solution.

8. If the counts obtained vary by more than 1 percent between the two tubes, repeat steps B (5) through (7).

C. Procedure on Patient (Note alternate procedure)

1. A sterile 1 ml syringe is filled through a #21-1" needle to the 1 ml mark with the stock solution in the exact same way used for the standard. Do not remove the needle which is used for the patient.

2. If the patient has received a previous tracer dose of radioactive isotope or if there is any doubt about it, a 10 ml blood specimen is drawn into an oxalated or heparin tube and shaken. This will be used for determining background activity.

3. Inject the 1 ml of stock IHSA into an arm vein, then aspirate a syringe full of blood and reinject this to flush the syringe of all radioactivity two times. NOTE: It is crucial that all the radioactivity be injected into the blood stream since any albumin injected into the subcutaneous tissues will not reach the plasma for several hours.

4. Ten minutes later, draw a 10 ml blood specimen and place in a heparin or oxalate tube.

D. Laboratory Procedure (Before working with the blood, mix it thoroughly)

1. Determine the hematocrit of each blood specimen.

2. Centrifuge and remove the plasma from each blood specimen.

3. Pipette 1 ml of blood from each blood specimen into each of two well-counter tubes, using a volumetric pipette.

4. If a background specimen of blood is necessary, perform steps 1 through 4 on it.

5. Count these specimens and the standards in a scintillation well-counter. Routinely, a count of 10,000 is satisfactory.

6. During pipetting, the detector background should be obtained.

E. Calculations

1. The counts per minute of background for room or plasma are determined.

2. The counts per minute of each blood sample and each standard are determined. The corrected counts per minute = crude counts per minute minus background.

3. The corrected counts/minute are averaged for the 2 blood specimens, and also for the 2 standards.

4. The plasma volume is ml is expressed as follows:

$$B.V. = \frac{\text{ml IHSA Solution Injected} \times \text{Average of Corrected Std.} \times \text{Dil. of Std.}}{\text{Average of Corrected Counts of Blood}}$$

5. Plasma volume is obtained by multiplying the blood volume by one minus hematocrit expressed as a decimal or it can be obtained directly by using plasma instead of blood in Step D-#3.

Some of the errors inherent in this method have been discussed by Hlad, et. al. He notes as have others, that the biggest source of error is in the syringe. We have found that plastic syringes and making up the standard dilution with a syringe using the exact same technic used for injecting the patient corrects most of the problem.

CALCULATION OF A TYPICAL BLOOD VOLUME

10 uc of I-125 iodinated human serum albumin.

Standard diluted - 1:1000
Counting time - 3 minutes per sample
Mean air background - 2481/3 minutes
Standard Count - #1 - 13418/minute
#2 - 13495/minute
Mean 13135 - 2481 = 10,654/3 minutes

$$\text{Plasma Volume} = \frac{13629 \times 10^3}{3551} = 3838 \text{ ml.}$$

TECHNIQUE OF RED CELL MASS

A. Bottles, made specially for sodium chromate red cell survival tests, are now available containing acid citrate dextrose solution. These bottles may be used or if this is not possible you may use any sterile stoppered container with a multiple injection top. It has been found that acid citrate dextrose produces a higher percentage of tagging than do other anticoagulants, e.g. heparin or oxalate. Even so, heparin and oxalate are perfectly adequate for the use in this test.

B. Approximately 50 ml of blood are withdrawn from the patient and injected into the bottle containing the ACD solution.

C. 100-150 mc of sodium chromate are injected into the bottle. (Sodium chromate gradually deteriates if it is placed in the bottle prior to the addition of the blood).

D. The bottle is agitated gently and maintained at 37° for 15 to 30 minutes.

E. At the end of that time 0.5 gm of Vitamin C is added to the bottle. and the bottle is gently stirred.

F. Exactly 20 ml of this blood is removed with a sterile syringe and reinjected into the patient. Enough blood is kept within the tagging bottle to determine a hematocrit and the counts per minute in the cells and plasma.

G. Approximately 6 ml of this blood is removed and centrifuged. Two ml of plasma is pipetted into a 1,000 ml volumetric flask already containing water and a few ml of 0.1N HCL. Two ml of blood are pipetted into a second volumetric flask also containing HCL.

H. Two, 1 ml samples are obtained from each volumetric flask and placed in counting bottles and the radioactivity in each counting bottle is determined.

1. Ten minutes after the chromate has been injected into the patient a 6 or 8 ml venous blood specimen is obtained. One ml aliquots of the plasma and blood are counted and a hematocrit determined. The red cell mass is determined by the following formula:

$$\text{Red Cell Mass} = \frac{\text{Red Cell Radioactivity of Std. x ml injected x Dilution}}{\text{Red Cell Radioactivity at 6 minutes}}$$

$$\text{Red Cell Mass} = \frac{(\text{Cts/min Bl} - \text{Cts/ min Plasma Std.}) \times 1\text{-Hematocrit} \times}{(\text{Cts/min Bl at 10 min}) - (\text{Cts/min Plasma}) \times}$$

$$\frac{20 \times \text{Hematocrit at 10 min}}{(1 - \text{Hematocrit at 10 min} \times \text{Hematocrit}}$$

EXTRACELLULAR FLUID SPACE TECHNIQUE

EXTRACELLULAR SPACE DETERMINATION USING S-35 O_4

Extracellular is defined as all tissue fluid lying outside of cell walls. This includes plasma, interstitial, cerebrospinal, peritoneal, pleural, pericardial and synovial fluids, ocular humor, urine and all glandular secretions. Diffusion of ions and water into some of these fluids occur at rates considerably slower than the diffusion between plasma and interstitial fluid. In most calculations of extracellular fluids, areas with slow diffusion rates are excluded by obtaining samples before these more slowly diffusing compartments have reached equilibrium with the remaining interstitial fluid. Different tissues vary in their relative proportions of extracellular water. As an example, skin contains more extracellular water than does muscle. However, the proportions of extracellular water and intracellular fluid are similar enough to consider all fluids of the body as a single system.

The earliest recorded method for measuring extracellular fluid was the estimation of the spaces between cells in frozen cross-sections of muscle. Since that time, the early distribution spaces of sodium, chloride, bromide, thiocynanate, thiosulfate, insulin, sucrose mannitol and sulfate have been used for this determination. An ideal tracer for measuring extracellular fluid should reach equilibrium rapidly and should not enter cells or bind to proteins. Of the available methods, the sulfate ion appears to be the most ideal ion for measuring extracellular fluid. Its chief advantages are that it has a short biological half life, is excreted almost entirely by the kidneys, is only slightly metabolized and reaches equilibrium within 18 minutes. Radiosulfate is known to equilibrate with peritoneal, pleural, and pericardial fluids. A small amount is found in gastric juice, sweat, cerebrospinal fluid, bile and other gastro-intestinal fluids. It is not known whether it enters lymph, synovial fluid or occular humor. After its initial equilibrium in the extracellular fluid, limited amounts of sulfate enter erythrocytes and other body cells. Some of it is bound by serum proteins. Kidney excretion of sulfate is rapid with about 50% of a tracer dose excreted in the first 6 hours. The renal clearance of sulfate is nearly constant allowing an estimate of renal excretion to be substituted for actual collection of urine. Most authors consider urinary excretion to be 4-8% of the administered dose. Less than one percent appears in the stool. There is a diurnal variation in the sulfate space. Daytime ECF is about 7.5% smaller than a night time value for ECF.

The sulfate space may be determined by plotting the values of hourly blood samples on semilogarithmic paper and extrapolating this line back to zero time. An alernate method is to collect two hourly urines. The sulfate excreted in these urines is subtracted from the total injected radioactivity. The disadvantage of the method where the values are plotted is that the determination requires four hours to be completed. The disadvantage of the urinary collection method is the difficulty of obtaining accurate urine samples. If one's time is available, plotting the blood samples would seem to be the better of the two methods. In the methods to be described, a probable error of $\pm$ 5% is possible.

THE SIMULTANEOUS TOTAL BODY WATER, EXTRACELLULAR FLUID, INTRACELLULAR FLUID, AND PLASMA VOLUME TECHNIQUE

It is convenient to make up solutions to be injected in a 30 ml volume of sodium chloride injections, USP, with a multiple dose stopper (e.g. Ambot, Cutter Laboratories, California).

FORM	RADIOISOTOPE	CONVENIENT CONCENTRATION
Water	H-3	300 uc/ml
Sodium Sulfate	S-35	50 uc/ml
Albumin	I-131 or I-125	25 uc/ml

PATIENT:

1. A 5 ml heparinized blood sample is obtained from a non-fasting well hydrated patient. This is labeled BACK-GROUND SULFATE. The patient is told to empty his bladder and discard the urine.

2. Fifty uc of sodium sulfate containing S-35 is injected intravenously.

3. Ten ml heparinized blood samples are drawn at 20, 40, 60, 120, 180, and 240 minutes. The patient is asked to empty his bladder to collect the urine excreted during the first and second hours. The urine volumes are recorded. The urine samples are labeled one and two hour sulfate urine.

4. Ten uc of radioiodinated serum albumin and 300 uc of tritrated water are injected intravenously.

5. Ten minutes later 10 ml of heparinized blood is obtained for plasma volume. This is labeled ten minute plasma.

6. The urine excreted during the third hour is collected. This sample's volume is measured and it is labeled TBW background urine.

7. Three separate urine specimens are obtained over the next four hours to use for body water. Timing of these urines is not critical. If urine is inconvenient to obtain, 2 1/2-4 hour blood samples can be used. The urines are labeled TBW urines #1, #2, #3.

PREPARATION OF BLOOD SAMPLES: All blood samples are centrifuged and the plasma removed.

1. Duplicate 1 ml plasma aliquots from the background plasma and 10 minute plasma samples are pipetted into counting tubes and the radioactivity measured with the plasma standard in a well-counter.

2. A. Duplicate 1 ml aliquots background sulfate and the 20, 40, 60, 120, 180, and 240 minute sulfate bloods are pipetted into clear test tubes. One ml of 40% trichloroacetic acid is added to each tube.

   B. The solutions are stirred, care being taken to keep the precipitate from adhering and drying to the side of the test tube.

   C. The tubes are centrifuged for about 20 minutes.

   D. The supernatent is removed making sure that flakes of the precipitate are not included since these contain the radioiodinated serum albumin.

   E. Duplicate one-tenth ml samples of each are pipetted into counting bottles and 15 ml of diatol scintillation solution is added to each bottle. The solutions are mixed and the radioactivity measured.

3. Body water is determined free of other activity by distilling the samples.

   A. About 3 ml of each urine sample is added to 25 ml Erlenmeyer flasks containing boiling chips.

   B. Single hole is made in multiple injection type stopper so a glass tube with a 20° angle can be inserted into the stopper. The cooling arm of the glass tube should be long enough to allow collection of the distillate in a test tube.

   C. The flasks are heated at low heat on a hotplate. The

samples are boiled slowly until one-half ml of distilled water has been collected from each.

D. One tenth ml aliquots of the distillate are placed in counting bottles.

E. 15 ml of diatol scintillation solution is added to each counting bottle and the solutions are mixed. The radioactivity is determined.

4. If plasma is used rather than urine for the body water, the following procedure is followed:

A. The plasma sample is placed in a large test tube with a multiple injection stopper in which an angled glass tube is inserted.

B. The test tube is placed in an Erlenmeyer flask and placed on a hot plate.

C. The flask is heated to coagulate the protein. Any distillate produced is collected.

D. The test tube is removed, centrifuged and the water removed.

E. The protein free water is placed in a small test tube and treated in the same way as a urine specimen.

NOTE: Blood, because of its high protein content is more difficult to distill than urine. A 10 ml blood sample produces only about 0.1 ml of distillate.

DIATOL COUNTING SOLUTION:

Toluene	500 ml
Dioxane	500 ml
Methanol	300 ml
2,5-Diphenyloxazole (PPO)	6 gm
1,4-bis-2-(5 Phenyloxazolyl) Benzene	150 mg
Napthalene	100 gm

The solutions are mixed and placed in an automatic filling and leveling buret.

STANDARDS: Plasma

1. Ten uc of radioiodinated serum albumin solution are pipetted into a one liter volumetric flask half filled with water. The flask is filled to the one liter mark with water and the flask is shaken.

2. Two, one ml aliquots are removed and placed in counting tubes. These aliquots must be removed immediately because albumin absorbs into the glass. If the samples cannot be removed immediately, stable albumin should be added to the volumetric flask, prior to adding the radioactive albumin.

STANDARDS: Sulfate

1. One ml of the injectable radioactive sulfate solution is placed in a half full 100 ml volumetric flask which is then brought to volume. The flask is shaken.

2. Triplicate one tenth ml samples are placed in counting bottles.

3. Fifteen ml of diatol scintillation solution are added, the samples are shaken.

STANDARDS: Radioactive Water

1. One ml of the injectable water solution is placed in a half-full 100 ml volumetric flask which is then brought to volume. The flask is shaken.

2. Triplicate one tenth ml aliquots are added to counting bottles.

3. Fifteen ml of diatol solution is added and the solutions mixed.

CALCULATIONS: Plasma Volume

$$\frac{\text{ncpm Std} \times 1000 \times \text{ml injected}}{\text{ncpm 10 min. plasma} - \text{ncpm bkgd plasma}} = \text{10 min. plasma space}$$

CALCULATIONS: Extracellular Fluid Space

$$\frac{\text{ncpm Std} \times 100 \times \text{inj.} - \text{ncpm ml sulfate 1 hr urine} \times \text{vol.}}{\text{ncpm 60 min. sulfate plasma} - \text{ncpm bkgd sulfate}} = \text{60 min. sulfate space}$$

$$\frac{(\text{ncpm Std} \times 100 \times \text{ml inj.}) - (\text{cpm/ml 1 hr urine x vol.} + \text{cpm/mj 2 hr urine x vol.})}{\text{ncpm/ml plasma} - \text{ncpm bkgd plasma}} =$$

$$= 120 \text{ sulfate space}$$

The best results are obtained if you mean these two values.

CALCULATIONS: Alternate Sulfate Space

1. Plot the ncpm/ml sulfate on semilogarithmic paper with cpm

on the log scale and time on the linear scale. Extrapolate the line to zero time.

$$\frac{(\text{ncpm Std} \times 100 \times \text{ml injected})}{\text{ncpm zero time}} = \text{sulfate space}$$

CALCULATIONS: Body Water

The mean value of the three urine determination are used.

$$\frac{\text{ncpm Std} \times 100 \times \text{ml/inj.}}{\text{ncpm urine sample} - \text{ncpm background urine}} = \text{3 hour water space}$$

ncpm = net counts per minute

Bkgd = background

CALCULATIONS: Intracellular Fluid

Total Body Water = Extracellular Fluid + Intracellular Fluid

CALCULATIONS: Lean Body Mass

$$\frac{\text{TBW}}{0.718} = \text{Lean Body Mass}$$

Total Weight = Lean Body Mass + Total Body Fat

NORMAL VALUES:

	% of Body Weight	
	Male	Female
Plasma Volume	See Nomogram	
Extracellular Space	23	23
Total Body Water	54	49
Intracellular Fluid	31	26

Appendix 8.5

RADIOISOTOPE SCHEDULE

DATE	SUBJECT NUMBER	TESTS
6-9-64	1,2,3,4,5,6,7,8,9,10	P.V., RBCM, Hgb, Hct, ECF, TBW
6-15-64	1,2,3,4,5,6,7,8,9,10	P.V., RBCM, Hgb, Hct, ECF, TBW
6-19-64	1,2,3,4,5	P.V., RBCM, Hgb, Hct, ECF, TBW
6-20-64	6,7,8,9,10	P.V., RBCM, Hgb, Hct, ECF, TBW
6-22-64	1,2,3,4,5	P.V., RBCM, Hgb, Hct, ECF, TBW
6-23-64	6,7,8,9,10	P.V., RBCM, Hgb, Hct, ECF, TBW
6-28-64	1,2,3,4,5	P.V., RBCM, Hgb, Hct, ECF, TBW
6-29-64	6,7,8,9,10	P.V., RBCM, Hgb, Hct, ECF, TBW
6-29-64	1,2,3,4,5	P.V., Hgb, Hct (Pre & Post Tilt)
6-30-64	6,7,8,9,10	P.V., Hgb, Hct (Pre & Post Tilt)
7-8-64	1,2,3,4,5,6,7,8,9,10	P.V., ECF, Hgb, Hct
7-21-64	1,2,3,4,5,6,7,8,9,10	P.V., ECF, Hgb, Hct
7-23-64	1,2,3,4,5	P.V., Hgb, Hct (Pre & Post Tilt)
7-24-64	1,2,3,4,5	P.V., Hgb, Hct
7-24-64	6,7,8,9,10	P.V., Hgb, Hct (Pre & Post Tilt)
7-25-64	1,2,3,4,5,6,7,8,9,10	P.V., Hgb, Hct
7-26-64	1,2,3,4,5,6,7,8,9,10	P.V., Hgb, Hct
7-27-64	1,2,3,4,5,6,7,8,9,10	P.V., ECF, Hgb, Hct
7-28-64	6,7,8,9,10	P.V., ECF, Hgb, Hct
8-2-64	1,2,3,4,5	P.V., ECF, Hgb, Hct
8-3-64	6,7,8,9,10	P.V., ECF, Hgb, Hct
8-3-64	1,2,3,4,5	P.V., Hgb, Hct (Pre & Post Tilt)
8-4-64	6,7,8,9,10	P.V., Hgb, Hct (Pre & Post Tilt)

DATE	SUBJECT NUMBER	TESTS
8-19-64	1,2,3,4,5,6,7,8,9,10	P.V., RBCM, Hgb, Hct, ECF, TBW
8-27-64	1,2,3,4,5	P.V., Hgb, Hct (Pre & Post Tilt)
8-28-64	6,7,8,9,10	P.V., Hgb, Hct (Pre & Post Tilt)
8-28-64	1,2,3,4,5	P.V., Hgb, Hct, RBCM, ECF, TBW
8-29-64	6,7,8,9,10	P.V., Hgb, Hct, RBCM, ECF, TBW
8-31-64	1,2,3,4,5	P.V., Hgb, Hct, RBCM, ECF, TBW
9-1-64	6,7,8,9,10	P.V., Hgb, Hct, RBCM, ECF, TBW
9-6-64	1,2,3,4,5	P.V., Hgb, Hct, RBCM, ECF, TBW
9-7-64	6,7,8,9,10	P.V., Hgb, Hct, RBCM, ECF, TBW
9-7-64	1,2,3,4,5	P.V., Hgb, Hct (Pre & Post Tilt)
9-8-64	6,7,8,9,10	P.V., Hgb, Hct (Pre & Post Tilt)

*P.V.: I^{125} - RISA Plasma Volume
RBCM: Cr^{51} - Red Blood Cell Mass
ECF: S^{35} - Sodium Sulfate - Extracellular Fluid
TBW: H^3 - Tritium - Total Body Water

Appendix 8.6

RADIOISOTOPE STUDIES

RESULTS SUMMARY SHEET

SUBJECT _____ SUBJECT NO. _____

	A	B	C	D	E	F	G	H	I	J
Date	Weight	Plasma Volume	R.B.C. Mass	B.V. Pv&Pcm	Hct.	Hgb.	T.B.W.	E.C.F.	I.C.F.	L.B.M.

BODY WEIGHT RECORD

NAME _____ SUBJECT NO. _____

DATE	WEIGHT		ORDERLY
	Kilograms	Pounds	

LEG CIRCUMFERENCE MEASUREMENT RECORD

SUBJECT ____________________ SUBJECT NO. __________

DATE		LEG CIRCUMFERENCE *					
		RIGHT LEG			LEFT LEG		
		1	2	3	1	2	3
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						
	AM						
	PM						

* See attached diagram

PSYCHOPHYSIOLOGICAL STUDIES

The Effects of Experimentally Induced Bed Recumbency on Psychophysiological Functioning

Within the framework of the total investigation, it was possible to study a broad range of psychophysiological and behavioral changes as a function of restricted activity and its associated physiological effects. The choice of variables was directed by theoretical considerations involving the effect of restricted activity upon the pattern and level of proprioceptive input with associated changes in muscle tonus, general arousal level, and vascular control mechanisms. One battery of tests involved psychologic and behavioral variables presumed to reflect an altered arousal level induced during bedrest. A second battery concerned variables reflecting sensorimotor performance which were investigated with respect to cardiovascular changes induced by passive body tilt both before and after the bedrest periods.

11.1 EXPLANATIONS OF TESTS

PREDICTOR VARIABLES

The following variables were examined for relationships to both psychological and physiological changes which occurred as a function of prolonged bed recumbency. All tests in this group were administered before the subjects began their first period of bedrest.

11.1.1.1 Personality Factors. Personality traits were assessed using Cattell's Sixteen Personality Factor Inventory, a 374-item questionnaire. The test is scored on the following sixteen bi-polar factors which have been derived through factor analytic techniques:

a. schizothymia - cyclothymia
b. low "g" - high "g" (general intelligence)
c. low ego strength - high ego strength
d. submissiveness - dominance
e. desurgency - surgency
f. low superego - high superego
g. threctia - parmia
h. harria - premsia
i. alaxia - protension
j. praxernia - autia
k. artlessness - shrewdness
l. assurance - guilt proneness
m. conservatism - radicalism
n. group adherence - self sufficiency
o. low integration - high self-concept
p. low ergic tension - ergic tension

(See test 11.2.1)

11.1.1.2 Modes of Aggressivity. A thematic projective test was used to assess individual differences in characteristic manner of dealing with aggression. The test consisted of seven pictures, depicting people in various situations, that were presented sequentially on slides. The subject was given five minutes to compose a story concerning each picture.

These pictures were designed especially to elicit themes having to do with hostile aggression and aggressive activity in the sense of assertiveness. Stories were analyzed by three psychologists who provided independent ratings of story-content on a number of conceptually related dimensions, including degree of hostile aggression, direction of aggressive action (against hero or against others), level of activity expressed, passivity vs. assertiveness, and presence of anxiety or guilt.

Previous investigators have reported a relationship between scores on a similar instrument and tolerance for g-stress in a human centrifuge. They have suggested that the subject's characteristic affective reaction under stress ("anger in" vs. "anger out"), which is presumable reflected in his thematic test responses, may be associated with a relative epinephrine / noreponephrine preponderance that could be the biochemical mechanism accounting for differences in cardiovascular response to g-stress. (See test 11.2.2)

11.1.1.3 Activity Level. A pool of questionnaire items which define a general activity and energy factor was taken from the Guilford-Zimmerman Temperament Survey. The test was used to distinguish between persons having a disposition to engage in vigorous overt action and those with a tendency toward inertness and disinclination for motor activity. It was hypothesized that differences in reaction to an extended period of inactivity should be related to the subjects' need for activity. (See test 11.2.3)

11.1.1.4 Kinesthetic After - Effect. Repeated estimations of size on the basis of kinesthetic cues were obtained prior to and following intervals of kinesthetic satiation. Individual differences in kinesthetic after-effects have been shown to be predictive of the ability to tolerate sensory deprivation involving multiple modalities. Extent and persistence of satiation effects have also been found to correlate with extroversion and intolerance for sensory deprivation. (See test 11.2.4)

BED RECUMBENCY BATTERY

These variables were selected to assess changes in behavior which might occur as a function of physical inactivity and confinement during extended bedrest. The wealth of available physiological information also permitted study of the correlation between observed psychological and physiological changes during the bedrest periods. While there have been numerous studies concerned with the effects of sensory deprivation involving multiple modalities, there has been a paucity of studies concerned with the effects of physical inactivity and confinement per se. Since both of these factors have been commonly involved in more totalisitic deprivation studies, it is particularly important that their psychological and psychophysiological effects be evaluated. The few studies which are relevant have involved a restricted range of variables largely limited to psychomotor measures. Lacking precedence for studying the effects of extended bedrest, variables relevant to affective, preceptual and cognitive processes were examined in this study. A dual theoretical rationale contributed to the selection of variables. Some were chosen which might be sensitive to shifts of arousal away from optimal levels as a function of proprioceptive deprivation. Other variables were included which might reveal affective stress responses as a function of inactivity and confinement.

These criterion tests were administered prior to, during, and in some cases, immediately following the three 10 day periods.[1] A portion of the tests were administered to a control group matched for average age and education level. The control subjects followed their normal routine during the period in which the tests were administered. Otherwise, the circumstances within which the tests were presented were comparable to the experimental group. An asterisk after the variable listing indicates a similar assessment for the control group.

11.1.2.1 Mood Changes*. To obtain a subjective measure of daily mood fluctuations, the Clyde Mood Scale was administered once in the morning and once in the afternoon. The Mood Scale, a 48-adjective check list, was quantified in terms of the following dimensions obtained from previous factor analyses:

a. Sociability
b. aggressivity - hostility
c. intellectual dysfunction
d. arousal level
e. anxiety - depression
f. somatic expression (See test 11.2.5)

11.1.2.2 Overt Behavior. To assess behavioral changes, a rating scale was devised consisting of four dimensions which have relevance to

[1] See Schedule of Test Administration

the immobilization situation. The deminsions under observation were:

a. level of arousal
b. sociability
c. affective expression
d. positiveness of attitude toward experiment

Subjects were rated during periods that cover all their waking hours by a total of six raters. In order to determine the concordance among these raters, four of them made observations for the same period of the day. (See test 11.2.6)

11.1.2.3 Perceptual Functioning. Three measures of perceptual function were administered. These functions have been studied in previous investigations of short-term immobilization, and changes have been observed in some instances.

a. Two-point discrimination thresholds were determined to assess changes in tactile acuity. Measurements were obtained by applying needles to the forearm according to the "stair-case" psychophysical method. (See test 11.2.7)

b. *The rate at which an ambiguous figure (Necker Cube) was perceived to undergo apparent reversals during three 1-minute trials per testing session was monitored. (See test 11.2.8)

c. *Speed and accuracy of visual-motor response was tested by having the subject cross out those numbers in a given row which corresponded to a number encircled at the beginning of the row. (See test 11.2.9)

11.1.2.4 Mental Alertness. *Changes in word fluency were assessed to index the mental alertness of each subject. Two letters of the alphabet were presented at each session, and subjects were instructed to name as many words as possible beginning with that letter during a 1-minute interval. (See test 11.2.10)

11.1.2.5 Projective Apperception. *Both before and during the three bedrest periods, subsets of the Holtzman Inkblot Test were administered. Responses were analyzed for level of integration of the percepts to assess alterations in ideational organization and spontaneous investment of psychic energy. In addition, a corollary of one of the fundamental Rorschach postulates was tested. This hypothesis states that there is a reciprocal relationship between the opportunity for mobility and propensity to perceive apparent movement in an unstructured stimulus. (See test 11.2.11)

11.1.2.6 Attentional Orientation. A verbal projective technique was used to probe the salient content of the subjects' immediate awareness. The subject was required to list twenty items of which he was immediately aware, i.e., currently experiencing. Among other content areas, the subjects' reports were analyzed for extent of somatic preoccupation vs. orientation toward external environmental events. (See test 11.2.12)

11.1.2.7 Physiological Functioning. The following physiological variables were examined in terms of their relationship to cognitive, emotional, perceptual, and sensorimotor performance. Heart rate and pulse pressure were analyzed in terms of their direct relation to psychological measures, while blood volume and hematocrit were treated as indices of variables which affect overt behavior.

a. Cardiovascular responses to the tilt procedure, prior to and following the bedrest periods, were correlated with reaction time measures obtained immediately preceding and following the tilt test. Prolonged bed recumbency results in decreased demand for musculoskeletal supporting reflexes and cardiovascular postural reflexes—mechanisms involved in circulation of the body fluids. If these mechanisms are impaired, cerebal circulatory insufficiency may alter sensorimotor coordination. Heart rate and pulse pressure variables obtained before, during and after tilt were used as indices of cardiovascular functioning. In addition, comparisons of responses to tilt obtained prior to and following bedrest periods, reflecting the effects of bedrest on cardiovascular homeostatic mechanisms, were correlated with measures of psychological adjustment to bedrest.

The lability of heart rate and pulse pressure responses obtained during the simple and complex tilt procedures was scrutinized for correlation between lability and mean response latency obtained in reaction time measures. These physiological variables were also examined in relation to the temporal growth and decay of readiness to respond as determined by the latency associated with different foreperiod intervals.

b. Blood volume was used as an index of possible cerebral circulatory insufficiency which would affect measures of mental alertness.

c. Hematocrit was examined for changes indicating a state of physiological fatigue which could affect measures of perceptual, intellectual, and emotional behavior.

11.1.2.8 Subject Evaluation of the Experiment. At the termination of each 10-day bedrest period, a 148-item questionnaire was administered. The questions were grouped into seven categories:

a. attitudes toward the experiment
b. somatic preoccupations
c. evidence for cognitive dysfunction
d. affective responses
e. characteristics of time perception
f. types of dreams and fantasies
g. feelings of interpersonal isolation

(See 11.2.13)

TILT BATTERY

In addition to those variables listed in the original protocol, psychophysiological studies were conducted to evaluate those cardiovascular parameters which relate to a change in sensorimotor performance. It was recognized that studies of cardiovascular deconditioning are stimulated by concern that the astronaut's performance capabilities may be impaired during increased gravitational stress following prolonged confinement. Consequently, it seemed eminently desirable to assess sensorimotor performance both before and after passive tilt and to establish whether an increased impairment of performance was exhibitied following a period of prolonged inactivity. However, normal performance can be maintained or improved under conditions of stress due to activation of physiological and psychological compensatory mechanisms. Thus, it becomes necessary to note those aspects of performance which maintain stability in addition to those which are impaired when a marked change in cardiovascular functioning is observed.

Four performance variables were administered during the second and third bedrest periods. During the second bedrest period, a fifth variable was included. Control levels of performance were obtained before, during, and after each bedrest period for comparison with observations obtained immediately before and after each complex tilt procedure. The performance tasks listed below were administered for a total of seven occasions for each of the two bedrest conditions.

11.1.3.1 Reaction Time. The latency of a motor response immediately following a change in physiological functioning provoked by passive body tilt was analyzed for comparability with speed of response under normal conditions. Changes were expected as a function of this condition, particularly when preceded by a period of bed recumbency.

Mean reaction time was assessed, disregarding length of foreperiods which were randomly presented to eliminate establishment of a rhythmical response pattern. Six foreperiods (the interval between the ready signal and the presentation of the visual stimulus) were presented during each trial, with four replications per trial. The foreperiods were assessed for optimal interval and maintenance of readiness to respond. Studies suggest that the temporal growth and decay of readiness to respond may be a paradigm for impairment of broader adjustive capacities. This dimension of simple reaction time will be analyzed for change correlating with a change in physiological functioning under two conditions: a) prolonged recumbency, and b) the complex tilt procedure. (See test 11.2.14)

11.1.3.2 Number Facility. Possible changes in intellectual functioning was assessed by a task involving the addition of 1 and 2 digit numbers in sets of three. Interpretations based on factor analysis suggest the test represents an undifferentiated retentiveness and freedom from distractibility, which may be subject to change as a function of alteration of physiological functioning. (See test 11.2.15)

11.1.3.3 Speed of Closure. Speed of perception and discrimination was assessed by a task requiring selection of common English four-letter words from a heterogenous stimulus grouping—letters of the alphabet spaced at equidistant intervals—in which were imbedded additional four-letter words (proper nouns, foreign words, plural words), two-three-, and five-letter words. Factor analytic studies have reported this test to be a measure of the capacity to resist distraction as well as the capacity to organize discrete spatially perceived units into large configurations which may be affected by altered physiological changes which would influence performance on subsequent psychometric measures. (See test 11.2.16)

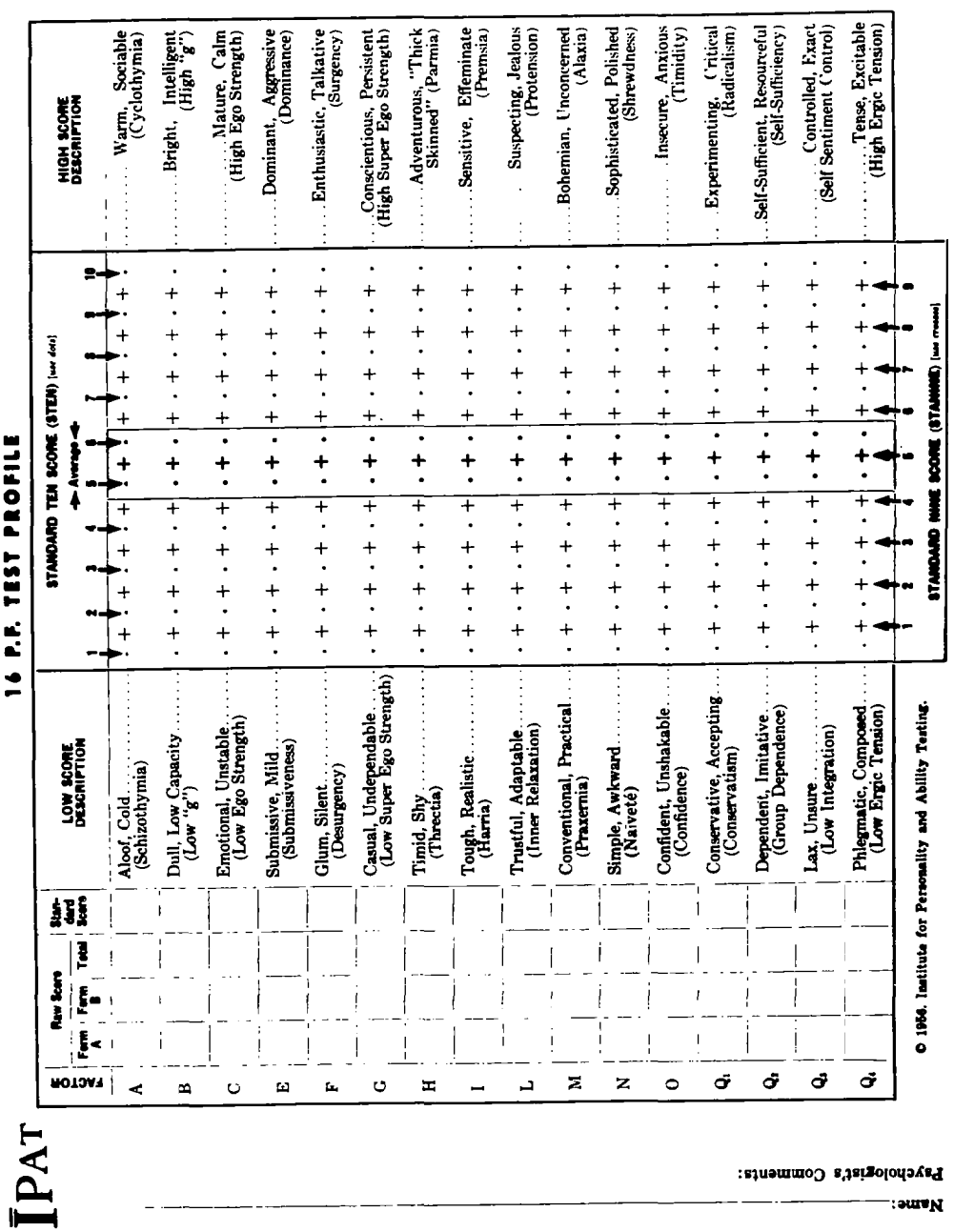
11.1.3.4 Visualization. The task, visual tracking of intersecting lines, was included to assess any blurring of vision resulting from physiological changes which would influence performance on subsequent psychometric measures. (See test 11.2.17)

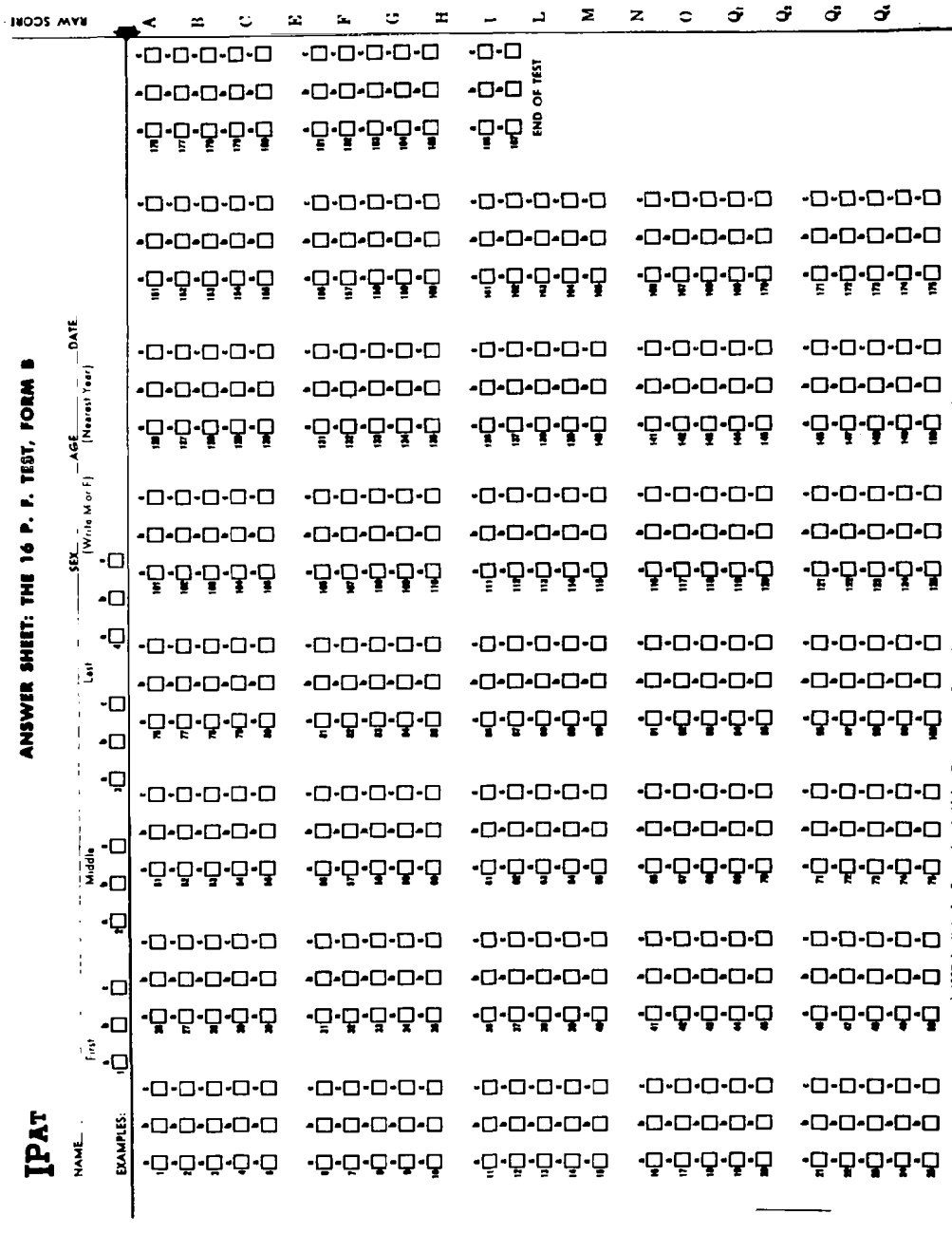
11.1.3.5 Aiming. The test requires precise visual-motor coordination—placement of a stylus point in a sequence of specified locations. Delay in attaining homeostatic equilibrium after exposure to physiological stress may be manifested by inability to perform exacting tasks.

Variables 2 through 5 were assessed for number attempted and errors of commission. These two dimensions of each variable were treated as separate variables in all analyses, thus providing a total of nine performance measures. Previous investigations report an increase in errors and in speed under conditions of physiological stress. (See test 11.2.18)

11.2 TESTS

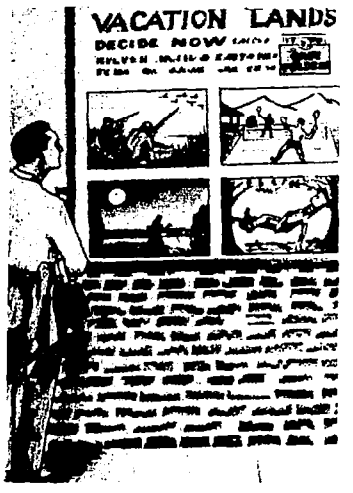
Cattell's 16 PF




IPAT
ANSWER SHEET: THE 16 P. F. TEST, FORM B
NAME
First
Middle
Last
SEX (Write M or F)
AGE (Nearest Year)
DATE
EXAMPLES:
RAW SCORE
A B C E F G H I L M N O Q1 Q2 Q3 Q4
END OF TEST
© 1957, Institute for Personality & Ability Testing, 1602 Coronado Drive, Champaign, Illinois, U.S.A. All rights reserved.

Appendix 11.2.2

FOCUS THEMATIC APPERCEPTION



GUILFORD - ZIMMERMAN PERSONALITY INVENTORY

Read each statement carefully. If the statement seems to be true or if you agree with it, mark answer "yes". If the statement is more false than true, or if you disagree with it, mark "no".

Be sure to answer every item.

Although each item should be read carefully, it is best not to spend excessive time thinking over a statement. Work fairly rapidly and answer with your first impression.

This is not a test; there are no right or wrong answers. The purpose of this survey will be best served if you describe yourself and state your opinions as accurately as possible.

Yes	No		
		1.	You start to work on a new project with a great deal of enthusiasm.
___	___	2.	When you eat a meal with others, you are usually one of the last to finish.
___	___	3.	You are happiest when you get involved in some project that calls for rapid action.
___	___	4.	You are often so much "on the go" that sooner or later you may wear yourself out.
___	___	5.	You often wonder where others get all the excess energy they seem to have.
___	___	6.	You find yourself hurrying to get places even when there is plenty of time.
___	___	7.	You work more slowly and deliberately than most people of your sex and age.
___	___	8.	You like to have plenty of time to stop and rest.
___	___	9.	You are the kind of person who is "on the go" all the time.
___	___	10.	People think you are a very energetic person.
___	___	11.	You are quick in your actions.
___	___	12.	You always seem to have plenty of vigor and vitality.
___	___	13.	You sometimes wish that people would slow down a bit and give you a chance to catch up.
___	___	14.	You seem to lack the drive necessary to get as much done as other people do. .
___	___	15.	You are able to work for unusually long hours without feeling tired.
___	___	16.	You talk more slowly than most people.
___	___	17.	You like to do things slowly and deliberately.
___	___	18.	You are inclined to rush from one activity to another without pausing enough for rest.
___	___	19.	You are less energetic than many people you know.

___	___	20.	You get things done in a hurry.
___	___	21.	At work or at play other people find it hard to keep up with the pace you set.
___	___	22.	You dislike to be hurried in your work.
___	___	23.	People sometimes tell you to "slow down" or "take it easy."
___	___	24.	You are slow and deliberate in movement.
___	___	25.	You can turn out a large amount of work in a short time.
___	___	26.	You often run upstairs taking two steps at a time.
___	___	27.	Others are often amazed by the amount of work you turn out.
___	___	28.	It irritates you to have to wait at a crossing for a long freight train to pass.
___	___	29.	Other people regard you as a lively individual.
___	___	30.	It is hard to understand why many people are so slow and get so little done.

KINESTHETIC AFTER EFFECTS
SENSITIVITY

PROCEDURE:

1. Blindfold subject.
2. Place subject's hands on the two stimuli, instructing him to lightly rule graduated variable stimulus and square standard stimulus simultaneously. Obtain size estimate from variable stimulus for baseline measure.
3. Repeat Step 2 to obtain pre-satiation size estimate.
4. Instruct the subject to rub large satiator block 90 seconds to produce satiation size estimate.

After 5-minute rest interval, repeat entire procedure.

	TRIAL 1	TRIAL 2
Base	_____	_____
Pre-satiation	_____	_____
Post-satiation	_____	_____

CLYDE MOOD SCALE

Test 11.2.1

	Not at all	A little	Quite a bit	Extremely
Good-natured	☐	☐	☐	☐
Troubled	☐	☐	☐	☐
Efficient	☐	☐	☐	☐
Dependable	☐	☐	☐	☐
Clearthinking	☐	☐	☐	☐
Lonely	☐	☐	☐	☐
Humorous	☐	☐	☐	☐
Rude	☐	☐	☐	☐
Kind	☐	☐	☐	☐
Daring	☐	☐	☐	☐
Considerate	☐	☐	☐	☐
Boastful	☐	☐	☐	☐
Defiant	☐	☐	☐	☐
Fatigued	☐	☐	☐	☐
Unhappy	☐	☐	☐	☐
Businesslike	☐	☐	☐	☐
Friendly	☐	☐	☐	☐
Grouchy	☐	☐	☐	☐
Sleepy	☐	☐	☐	☐
Sad	☐	☐	☐	☐
Bossy	☐	☐	☐	☐
Impulsive	☐	☐	☐	☐
Jittery	☐	☐	☐	☐
Bold	☐	☐	☐	☐

	Not at all	A little	Quite a bit	Extremely
Playful	☐	☐	☐	☐
Afraid	☐	☐	☐	☐
Able to Work Hard	☐	☐	☐	☐
Warm-hearted	☐	☐	☐	☐
Sick to the Stomach	☐	☐	☐	☐
Alert	☐	☐	☐	☐
Tired	☐	☐	☐	☐
Shaky	☐	☐	☐	☐
Demanding	☐	☐	☐	☐
Sociable	☐	☐	☐	☐
Nagging	☐	☐	☐	☐
Sarcastic	☐	☐	☐	☐
Pleasant	☐	☐	☐	☐
Quarrelsome	☐	☐	☐	☐
Independent	☐	☐	☐	☐
Depressed	☐	☐	☐	☐
Drowsy	☐	☐	☐	☐
Able to Concentrate	☐	☐	☐	☐
Dizzy	☐	☐	☐	☐
Reckless	☐	☐	☐	☐
Downhearted	☐	☐	☐	☐
Worried	☐	☐	☐	☐
Forceful	☐	☐	☐	☐
Polite	☐	☐	☐	☐

BEHAVIOR RATINGS

SUBJECT'S NAME _____ DATE _____

RATER'S NAME _____ TIME _____

HIGH AROUSAL
- Restless
- Tense
- Jittery
- Agitated

LOW AROUSAL
- Relaxed
- Drowsy
- Sluggish
- Listless

SOCIABLE
- Conversational
- Gregarious
- Mixing
- Companionable

UNSOCIABLE
- Quiet
- Reserved
- Aloof
- Seclusive

UNPLEASANT
- Unhappy
- Gloomy
- Down-hearted

PLEASANT
- Cheerful
- Gay
- Happy

POSITIVE ATT.
- Agreeable
- Patient
- Easy to please

NEGATIVE ATT.
- Complaining
- Irritable
- Hard to please
- Sarcastic

TWO POINT DISCRIMINATION

NAME _____ DATE _____ TIME _____

Series	Direction	Magnitude
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

NECKER CUBE

NAME _____ DATE _____ TIME _____

Trial	No. of Reversals	No. of Blinks
1		
2		
3		

PERCEPTUAL SPEED

INSTRUCTIONS

(PS)

PERCEPTUAL SPEED

Look at the rows of numbers below. A ring has been put around the first number in each row. The numbers in the row that are like the circled number are crossed out.

(3)	7	2	~~3~~	9	0
(7)	~~7~~	2	8	6	3
(1)	0	8	6	3	~~1~~
(4)	6	9	~~4~~	~~4~~	1

Cross out the numbers in the following rows that are like the circled numbers at the beginning of each row.

(2)	1	9	5	2	3
(8)	6	7	1	5	8
(5)	9	5	4	8	2
(3)	4	5	3	5	2

Here are more practice rows. Cross out each number in a row that is like the circled number at the beginning of each row.

(8) 7 6 0 3 5 2 1 0 5 8 4 7 9 3 2 6 5 8 5 3 8 0 1 1 8
(2) 5 9 1 0 7 9 4 2 0 0 8 3 4 2 0 8 6 1 6 9 3 5 8 6 1
(5) 5 8 2 5 9 7 3 4 6 8 5 3 2 0 1 9 6 7 4 5 6 7 2 4 3
(5) 3 5 8 0 1 8 1 0 7 4 2 5 7 5 8 7 4 3 2 7 9 0 1 8 7
(4) 5 3 6 9 1 2 2 5 3 7 5 8 0 3 8 6 0 5 3 4 2 1 9 7 5
(3) 8 3 4 7 1 8 2 0 2 7 4 3 6 8 0 1 8 6 3 6 4 7 9 6 5
(7) 4 5 8 5 7 4 5 8 7 3 2 6 8 4 5 9 1 1 0 7 8 4 2 7 6
(9) 6 4 5 4 7 5 8 0 1 8 3 2 5 4 5 7 9 6 8 0 1 7 5 3 9
(1) 0 7 9 5 3 3 4 7 9 1 7 0 4 0 2 3 7 5 8 1 5 3 7 9 0

When the signal is given (not yet), turn the page and cross out each number in a row that is like the circled number. Work Fast. Find as many numbers as you can in the time allowed.

PS-Form 12a Cross out each number in a row that is like the circled number.

(2)	2	1	7	6	8	6	5	8	4	6	8	9	4	2	3	9	2	3	5	8	6	0	2	2	2	5	7	5	1
(1)	9	3	6	2	7	6	9	4	6	1	3	7	9	9	3	3	7	5	5	3	9	7	7	3	2	7	7	0	9
(1)	6	7	7	2	3	0	2	7	7	0	9	6	1	8	7	2	5	2	1	2	8	0	6	2	5	0	4	9	3
(0)	3	2	8	2	8	2	6	0	8	7	3	3	7	3	2	0	4	0	5	6	9	3	0	1	6	9	0	0	5
(7)	8	4	3	7	6	7	1	6	1	2	0	4	4	9	0	3	2	6	4	9	7	6	7	6	3	9	9	6	1
(9)	3	2	2	5	3	6	4	3	9	0	7	1	0	6	3	7	6	3	5	8	7	0	3	0	4	7	9	8	8
(6)	1	9	6	4	8	9	5	0	3	0	7	1	6	3	9	3	3	6	6	9	8	5	6	1	0	5	6	7	9
(7)	8	7	6	5	8	5	4	7	4	9	2	3	8	7	0	9	6	9	2	5	2	0	6	7	9	7	9	4	5
(2)	3	6	8	3	5	2	6	0	0	9	9	5	3	9	3	6	1	2	8	5	2	7	0	0	5	4	8	3	4
(1)	5	3	9	2	4	7	0	9	9	9	3	8	6	5	2	7	7	6	4	1	5	3	3	5	9	0	5	2	8
(5)	8	7	1	9	6	3	0	2	4	1	8	4	6	2	3	3	4	2	7	8	5	1	3	9	9	2	3	4	4
(4)	8	5	0	8	6	5	4	4	8	2	2	0	6	4	3	7	2	5	2	8	2	2	1	1	5	6	5	2	0
(5)	7	3	5	2	7	3	3	7	2	2	4	5	3	6	3	9	4	0	9	4	1	1	0	7	6	4	7	9	1
(3)	6	9	3	8	9	4	1	2	6	2	9	7	0	8	3	6	3	5	1	9	9	7	4	2	0	5	2	3	6
(1)	8	8	7	0	0	4	2	3	1	5	7	9	0	1	2	0	2	0	7	2	3	4	7	3	7	1	7	3	1
(8)	8	5	6	5	3	2	7	5	9	3	3	3	5	7	2	6	7	4	7	7	7	3	4	5	5	4	5	7	0
(0)	9	7	2	9	5	8	4	2	9	4	9	4	1	2	1	0	6	7	0	4	2	3	8	0	6	4	5	1	8
(1)	2	9	6	8	8	1	7	3	1	6	5	1	9	6	9	0	2	8	3	6	0	7	4	8	6	9	0	6	8
(8)	5	9	4	5	7	2	4	1	6	9	2	0	9	9	4	3	8	7	6	2	2	0	0	2	7	6	9	9	5
(3)	8	6	4	4	3	5	9	9	8	9	8	7	7	9	7	6	8	0	7	9	1	5	1	7	8	6	2	4	4
(5)	3	4	4	0	9	4	2	7	2	0	0	4	1	8	6	7	9	7	9	6	8	4	7	2	2	0	0	2	0
(4)	0	7	6	6	6	2	6	8	4	5	7	9	9	9	0	3	9	7	3	6	6	3	3	2	0	8	4	5	8
(0)	2	1	7	7	9	1	8	0	5	1	2	5	9	5	2	5	7	0	2	2	2	0	7	9	0	4	7	0	3
(9)	5	1	7	8	2	0	6	5	3	3	1	5	1	1	0	9	6	4	6	9	2	0	6	8	8	0	7	7	7
(3)	5	7	6	2	2	4	2	9	2	9	6	1	1	8	3	4	4	8	0	3	4	6	8	3	5	4	8	7	7

Subject _____ Date _____ Examiner _____

WORD FLUENCY

Six letters of the alphabet— E, C, G, H, I, L — were presented to each subject during one bedrest period. The order of presentation was randomized for each subject. Responses to two letters were obtained for each of three trials administered during one bedrest period.

The following instructions were given: Two letters of the alphabet will be presented sequentially. Name as many words as possible which begin with letter presented when the signal to begin is given. Each trial will be one minute in duration, with a 30-second interval between the two trials.

HOLTZMAN INKBLOT TECHNIQUE
RECORD FORM

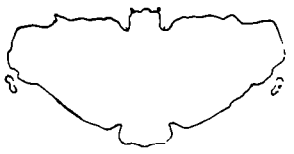
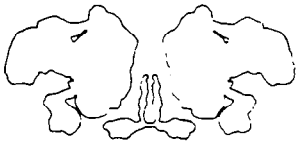
Form A

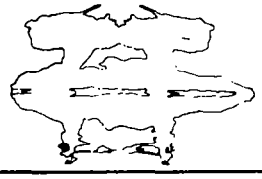
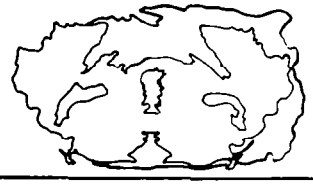
Name_____ Age_____ Sex_____ Date_____

Address_____ Phone_____ Educational Level_____

Examiner_____ Previous Administration (Form and Date)_____

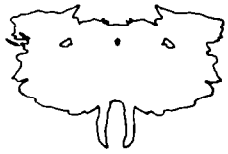
Symbols: Qu –question regarding location; Qc –question regarding characteristics; Qe –question regarding elaboration; >V< –change in card position; R.T. –reaction time in seconds.

X R.T. _____ 	
Y R.T. _____ 	
1A R.T. _____ 	
2A R.T. _____ 	
3A R.T. _____ 	

4A R.T. _____ 	
5A R.T. _____ 	
6A R.T. _____ 	
7A R.T. _____ 	
8A R.T. _____ 	
9A R.T. _____ 	

10A R.T. _____

11A R.T. _____

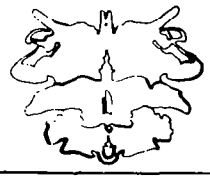


12A R.T. _____

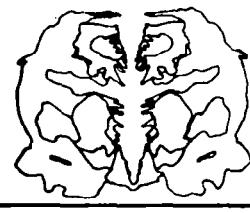
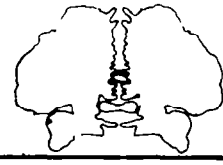
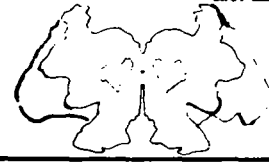
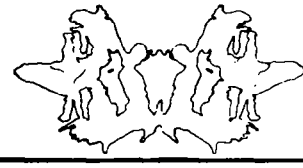
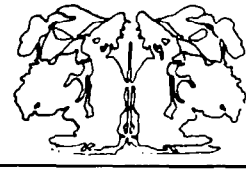
13A R.T. _____

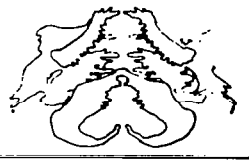
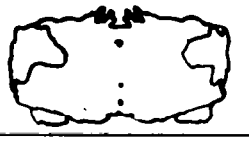
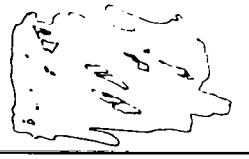
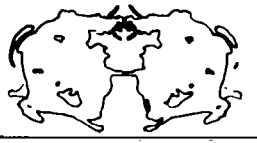
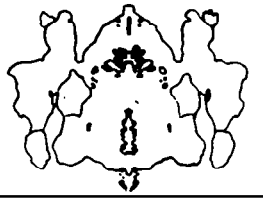
14A R.T. _____

15A R.T. _____

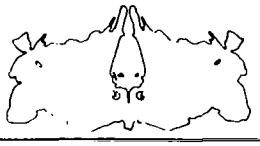
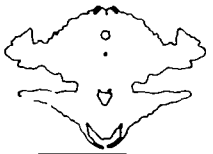


Appendix 11.2.11 (Cont'd)

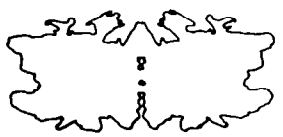
16A R.T. ____ 	
17A R.T. ____ 	
18A R.T. ____ 	
19A R.T. ____ 	
20A R.T. ____ 	
21A R.T. ____ 	

22A R.T. 	
23A R.T. 	
24A R.T. 	
25A R.T. 	
26A R.T. 	
27A R.T. 	

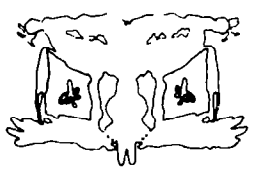
28A R.T. ____ 	
28A R.T. ____ 	
28A R.T. ____ 	
31A R.T. ____ 	
28A R.T. ____ 	
28A R.T. ____ 	

34A R.T. ____ 	
35A R.T. ____ 	
36A R.T. ____ 	
37A R.T. ____ 	
38A R.T. ____ 	
39A R.T. ____ 	

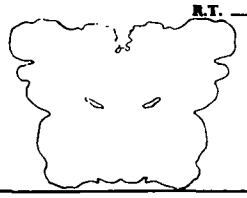
40A R.T. ____



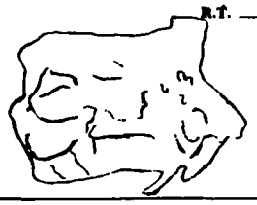
41A R.T. ____



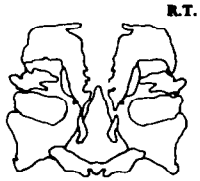
42A R.T. ____



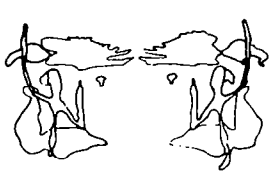
43A R.T. ____



44A R.T. ____



45A R.T. ____



HOLTZMAN INKBLOT TECHNIQUE
RECORD FORM

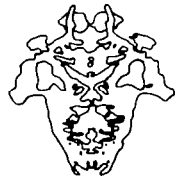
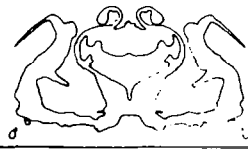
Form B

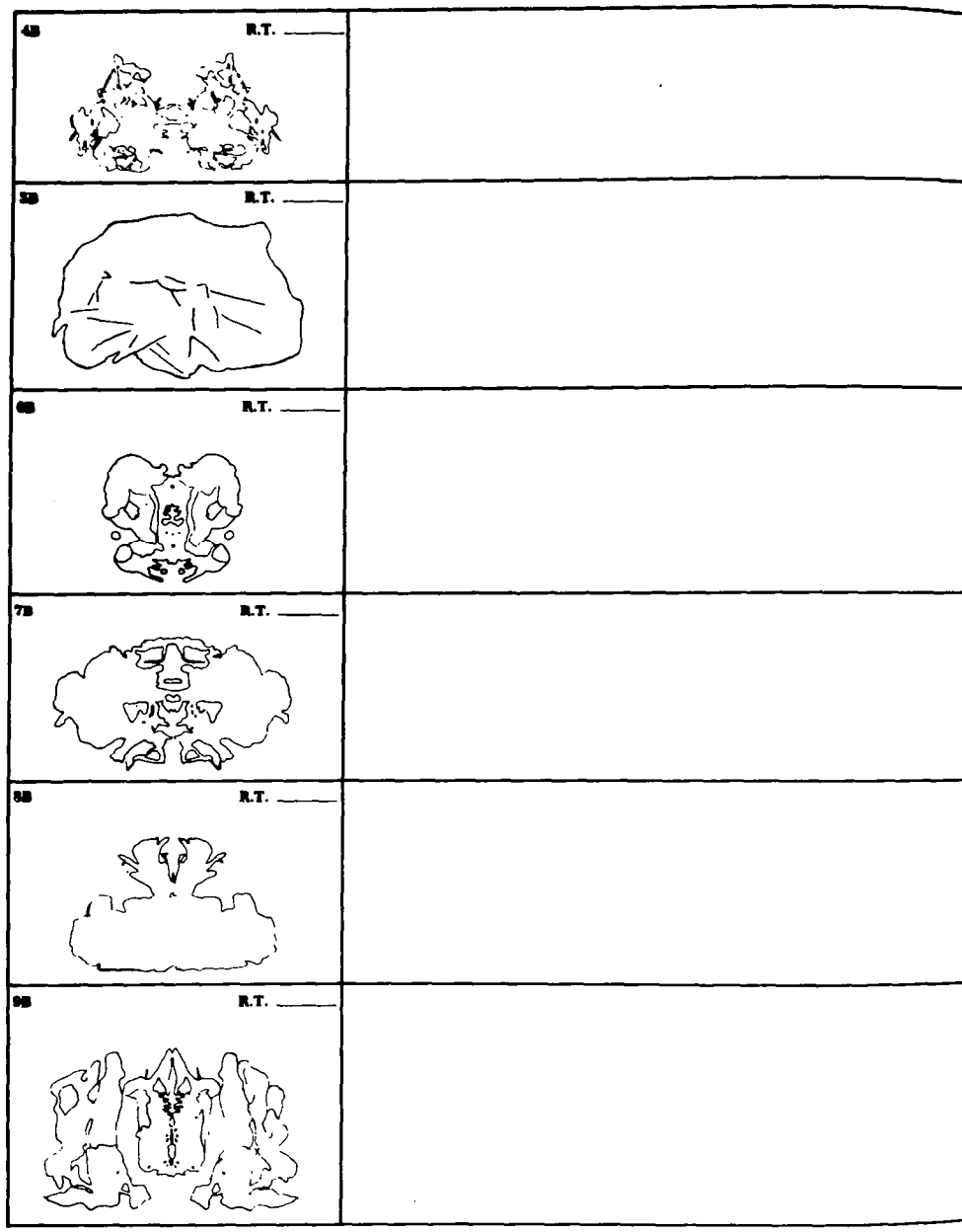
Name _____ Age _____ Sex _____ Date _____

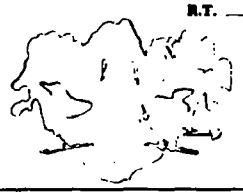
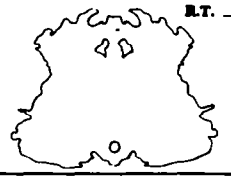
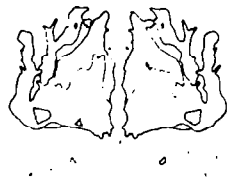
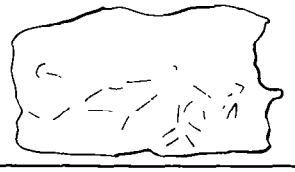
Address _____ Phone _____ Educational Level _____

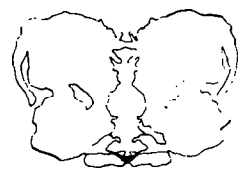
Examiner _____ Previous Administration (Form and Date) _____

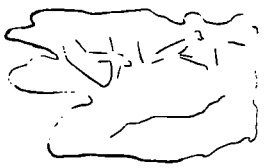
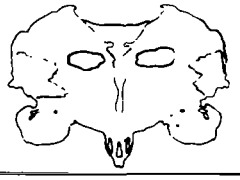
Symbols: QL —question regarding location; Qc —question regarding characteristics; Qe —question regarding elaboration; >V< —change in card position; R.T. —reaction time in seconds.

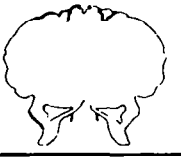
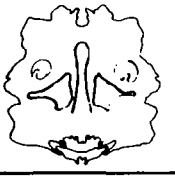
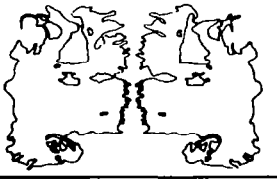
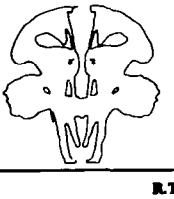
X R.T. _____ 	
Y R.T. _____ 	
1B R.T. _____ 	
2B R.T. _____ 	
3B R.T. _____ 	

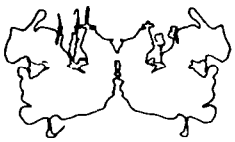
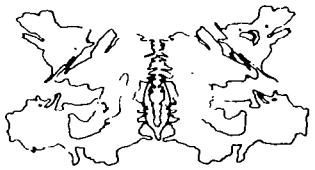

R.T. _____
R.T. _____
R.T. _____
R.T. _____
R.T. _____
R.T. _____

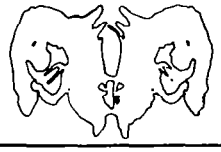
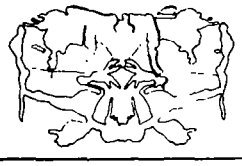
10B R.T. ____ 	
11B R.T. ____ 	
12B R.T. ____ 	
13B R.T. ____ 	
14B R.T. ____ 	
15B R.T. ____ 	

16B R.T. ____ 	
17B R.T. ____ 	
18B R.T. ____ 	
19B R.T. ____ 	
20B R.T. ____ 	
21B R.T. ____ 	

22B R.T. ____ 	
23B R.T. ____ 	
24B R.T. ____ 	
25B R.T. ____ 	
26B R.T. ____ 	
27B R.T. ____ 	

[illegible] R.T. _____ 	
[illegible] R.T. _____ 	
[illegible] R.T. _____ 	
[illegible] R.T. _____ 	
[illegible] R.T. _____ 	
[illegible] R.T. _____ 	

R.T. ____ 	
R.T. ____ 	
R.T. ____ 	
R.T. ____ 	
R.T. ____ 	
R.T. ____ 	

R.T. ____ 	
R.T. ____ 	
R.T. ____ 	
R.T. ____ 	
R.T. ____ 	
R.T. ____ 	

SUMMARY SHEET **HOLTZMAN INKBLOT TECHNIQUE** **Form: (circle) A B**

Name _____ Age _____ Sex _____ Date _____

Examiner _____ Previous Administration (Form and Date) _____

Card No.	RT	R	L	S	FD	FA	C	Sh	M	V	I	H	A	At	Sx	Ab	Ax	Hs	Br	Pn	B	P		
1																								
2																								
3																								
	RT	R	L	S	FD	FA	C	Sh	M	V	I	H	A	At	Sx	Ab	Ax	Hs	Br	Pn	B	P		
4																								
5																								
6																								
7																								
8																								
9																								
	RT	R	L	S	FD	FA	C	Sh	M	V	I	H	A	At	Sx	Ab	Ax	Hs	Br	Pn	B	P		
10																								
11																								
12																								
13																								
14																								
15																								
	RT	R	L	S	FD	FA	C	Sh	M	V	I	H	A	At	Sx	Ab	Ax	Hs	Br	Pn	B	P		
16																								
17																								
18																								
19																								
20																								
21																								
	RT	R	L	S	FD	FA	C	Sh	M	V	I	H	A	At	Sx	Ab	Ax	Hs	Br	Pn	B	P		
22																								
23																								
24																								
25																								
26																								
27																								
Sub-total: Items 1-27	RT	R	L	S	FD	FA	C	Sh	M	V	I	H	A	At	Sx	Ab	Ax	Hs	Br	Pn	B	P		

Fold the top of this page down to this line so that sub totals for Items 1-27 may be seen on this side

	RT	R	L	S	FD	FA	C	Sh	M	V	I	H	A	At	Sx	Ab	Ax	Hs	Br	Pn	B	P
28																						
29																						
30																						
31																						
32																						
33																						
	RT	R	L	S	FD	FA	C	Sh	M	V	I	H	A	At	Sx	Ab	Ax	Hs	Br	Pn	B	P
34																						
35																						
36																						
37																						
38																						
39																						
	RT	R	L	S	FD	FA	C	Sh	M	V	I	H	A	At	Sx	Ab	Ax	Hs	Br	Pn	B	P
40																						
41																						
42																						
43																						
44																						
45																						
	RT	R	L	S	FD	FA	C	Sh	M	V	I	H	A	At	Sx	Ab	Ax	Hs	Br	Pn	B	P
Uncorr. Total																						
Score																						
Per-centile*																						

Note. — Except for **RT, FD, FA,** and **V,** the **Score** for each variable is the total of the scores on each of the 45 cards. These totals should be entered in the row labeled **Score.** For **RT,** write the sum in the row labeled **Uncorrected Total,** divide this by 45, and enter the quotient as the **RT Score.** For **FD, FA,** and **V,** write the sum in the **Uncorrected Total** row, see Table 3 of the Guide, and enter the corrected total as the **Score.**

*Norms Group

Summary Sheet for
Holtzman Inkblot Technique

Printed in U.S.A. The Psychological Corporation, New York 17, N. Y. 62-1518

ATTENTIONAL ORIENTATION

NAME _____ DATE _____

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

SUBJECT QUESTIONNAIRE

Name: _____

Date: _____

Instructions

We wish to learn as much as possible about your experiences during the period in which you were immobilized. To help us do this, we will ask you to consider each of the statements below and indicate how it applies to you. Notice that to the left of each statement there are three columns: the first one is marked NEVER, the second ONCE or OCCASIONALLY, and the third FREQUENTLY. Put a check in the space under NEVER beside each statement that did not apply to you even once during the time you spent in this experiment. Put a check in the space under ONCE or OCCASIONALLY beside each statement that refers to experiences you had once or a few times during your time in the experiment. Put a check in the space under FREQUENTLY beside each statement that refers to things you experienced more than a few times or that was generally true about experiences during the experiment.

Many of these statements refer to very personal experience, but we assure you that your answers will be kept in utmost confidence, and they will be very useful to us in studying your reactions and experiences while participating in this experiment. So please consider each statement very carefully and mark it so that it will be a true statement about you

during the ten days of immobilization, excluding the tilting procedure.

Please do not fail to answer every statement.

Never	Once or Occasionally	Frequently		
____	____	____	1.	I was hungry.
____	____	____	2.	I was kind of mad.
____	____	____	3.	My feet and/or my hands were cold.
____	____	____	4.	I remembered plesant times I had had with a girl or my wife.
____	____	____	5.	I worried about something that really did not matter.
____	____	____	6.	I thought about food.
____	____	____	7.	I was very hungry.
____	____	____	8.	I felt as angry as I could get.
____	____	____	9.	I felt as though no one really cared about me as a person.
____	____	____	10.	I had dreams about food.
____	____	____	11.	I did not feel fresh and rested when I woke up.
____	____	____	12.	It was hard to keep my mind on one thing.
____	____	____	13.	I thought the personnel in the experiment were taking advantage of me.
____	____	____	14.	I felt a desire for some particular kind of food.
____	____	____	15.	I felt tense.
____	____	____	16.	I had diarrhea.
____	____	____	17.	I wished I could talk to people I was unable to talk to.
____	____	____	18.	I was constipated.

Never	Once or Occasionally	Frequently	
____	____	____	19. I felt a great desire for some particular food.
____	____	____	20. I had nightmares.
____	____	____	21. I had difficulty keeping warm enough.
____	____	____	22. I felt depressed.
____	____	____	23. I thought about my health.
____	____	____	24. I had unusual dreams.
____	____	____	25. I thought about the injustices people have to put up with.
____	____	____	26. I felt so restless I could not keep from moving around.
____	____	____	27. I could relax and not worry about anything.
____	____	____	28. I wanted to be able to be following my normal routine.
____	____	____	29. I thought the experimenters were wasting their time.
____	____	____	30. I felt the world was a pretty nice place to be in.
____	____	____	31. I found something entertaining to do.
____	____	____	32. I thought about sex.
____	____	____	33. My sleep was restless and disturbed.
____	____	____	34. I wondered why I volunteered for this experiment.
____	____	____	35. My head ached.
____	____	____	36. I had difficulty keeping cool enough.
____	____	____	37. I felt suddenly hot all over, without apparent cause.
____	____	____	38. I prayed.

Never	Once or Occasionally	Frequently	
___	___	___	39. I felt hopeful about the future.
___	___	___	40. I regretted having volunteered for this experiment.
___	___	___	41. I felt physically comfortable.
___	___	___	42. I gained some reasurrance from praying.
___	___	___	43. I was annoyed by the noises in the room.
___	___	___	44. I felt I was wasting my time.
___	___	___	45. I thought it would be nice to take part in more experiments.
___	___	___	46. I felt like a fool.
___	___	___	47. I tried to understand just what it was the experimenters were interested in finding out.
___	___	___	48. I was able to think clearly about something that had bothered me for some time.
___	___	___	49. I had pains in my back or shoulders.
___	___	___	50. I was unhappier than I was at any time in the past.
___	___	___	51. Some of the things I had to do in the experiment were very pleasurable.
___	___	___	52. I could not keep my mind on one thing.
___	___	___	53. I had dreams that were very upsetting.
___	___	___	54. I worried about my health.
___	___	___	55. I had unusual daydreams.
___	___	___	56. I was sweaty when I woke up.
___	___	___	57. I felt some discomfort in my legs.

Never	Once or Occasionally	Frequently		
____	____	____	58.	I made plans for the future.
____	____	____	59.	I was easily angered.
____	____	____	60.	Some muscles became stiff.
____	____	____	61.	I wanted to sleep.
____	____	____	62.	I could not rest comfortably because of annoying sensations in my body.
____	____	____	63.	I felt discouraged.
____	____	____	64.	I felt some envy for the fellows who did not volunteer for this experiment.
____	____	____	65.	I was discouraged by not being able to take any action on things I thought about.
____	____	____	66.	I felt unusually happy.
____	____	____	67.	I had a twitching or jumping muscle.
____	____	____	68.	I had some discomfort over my heart or in my chest.
____	____	____	69.	I felt a peculiar sensation in some part of my body.
____	____	____	70.	Parts of my body had feelings like "going to sleep."
____	____	____	71.	My head felt enlarged.
____	____	____	72.	I had dreams which were strikingly vivid.
____	____	____	73.	I felt a nervousness I can't explain very well.
____	____	____	74.	I had daydreams that I could not get out of my mind.
____	____	____	75.	I felt as though some part of my body had changed in size.
____	____	____	76.	I dreamt when I slept.

Never	Once or Occasionally	Frequently		
____	____	____	77.	I felt unhappy.
____	____	____	78.	Some of my dreams were repeated.
____	____	____	79.	I felt light-headed.
____	____	____	80.	I felt like fighting with someone.
____	____	____	81.	I looked forward to the tests that were given.
____	____	____	82.	I felt as though I needed a real bath.
____	____	____	83.	I ran out of things to think about.
____	____	____	84.	I found it difficult to remember clearly what I was thinking about only a short time earlier.
____	____	____	85.	My ability to concentrate was worse than usual.
____	____	____	86.	I could remember distant events and experiences much better than normally.
____	____	____	87.	My thoughts were jumbled.
____	____	____	88.	My ability to reason and engage in constructive thinking was better than usual.
____	____	____	89.	My thoughts moved faster than usual.
____	____	____	90.	My thoughts moved slower than usual.
____	____	____	91.	My judgment and ability to evaluate were worse than usual.
____	____	____	92.	My mind was a blank at times, so that I had no thoughts at all.
____	____	____	93.	At certain times thinking and reflecting seemed too much of an effort.
____	____	____	94.	My body felt strange in some way.

Never	Once or Occasionally	Frequently		
____	____	____	95.	At times I daydreamed about sexual matters.
____	____	____	96.	I had very strange daydreams.
____	____	____	97.	I could not rest comfortably because of annoying sensations in my body.
____	____	____	98.	I was quite restless.
____	____	____	99.	I started to sweat for no reason at all.
____	____	____	100.	I was physically uncomfortable.
____	____	____	101.	I found my experience stressful.
____	____	____	102.	I experienced tingling sensations in my body.
____	____	____	103.	I was more preoccupied with sex than usual.
____	____	____	104.	I felt lonely.
____	____	____	105.	At times I had to assure myself that I was all right.
____	____	____	106.	I was irritable a lot of the time.
____	____	____	107.	I felt depressed or sad.
____	____	____	108.	I felt especially happy.
____	____	____	109.	I was afraid or upset.
____	____	____	110.	I felt angry or annoyed.
____	____	____	111.	I sometimes lost control over my emotions and feelings.
____	____	____	112.	At certain times I experienced a state of serenity, peacefulness and an attitude of "all's well with the world."
____	____	____	113.	Time seemed to stand still.

Never	Once or Occasionally	Frequently	
____	____	____	114. I felt that I occasionally lost sense of time.
____	____	____	115. Time passed faster than usual.
____	____	____	116. Time passed slower than usual.
____	____	____	117. I felt that time had come to a standstill.
____	____	____	118. I experienced the following physical sensations during the immobilization period:
____	____	____	(a) dizziness
____	____	____	(b) numbness or tingling
____	____	____	(c) chills or a cold feeling
____	____	____	(d) felt hot or sweating
____	____	____	(e) funny taste in my mouth
____	____	____	(f) felt nauseous or sick at the stomach
____	____	____	(g) mouth dry or less saliva than usual
____	____	____	(h) pressure or ringing in ears
____	____	____	(i) felt weak physically
____	____	____	(j) body felt lighter or like it was floating in space
____	____	____	(k) body felt heavier
____	____	____	119. I was very anxious about the catheterization procedure.
____	____	____	120. I became personally involved in what the other subjects were doing and thinking.
____	____	____	121. I looked forward to getting back to my normal eating habits.

Never	Once or Occasionally	Frequently		
____	____	____	122.	I wished I had selected a different bed position.
____	____	____	123.	I was very anxious about receiving injections.
____	____	____	124.	I wanted to have more visitors.
____	____	____	125.	I felt the routine of the experiment became terribly monotonous.
____	____	____	126.	I felt I was being treated as an experimental animal.
____	____	____	127.	I was irritated by the psychological tests.
____	____	____	128.	I missed having people around with whom I could discuss ideas which interested me.
____	____	____	129.	I found myself worrying about how I would hold up on the tilt test.
____	____	____	130.	I felt the experiment was a pleasant change from my usual activities.
____	____	____	131.	I wanted to be able to devote more time to concentrated reading and study.
____	____	____	132.	I became annoyed with some of the other subjects.
____	____	____	133.	I felt the expeimenters did not do all they could to make our surroundings comfortable.
____	____	____	134.	I felt that life was passing me by.
____	____	____	135.	I wished the other subjects could be quiet.
____	____	____	136.	I felt I couldn't go on with the experiment.
____	____	____	137.	I felt extremely bored.
____	____	____	138.	I enjoyed the company of other subjects.
____	____	____	139.	I got fed up with the experiment.
____	____	____	140.	I wished I had something better to do to pass the time.

REACTION TIME

NAME _____ DATE _____ TIME _____

TRIAL	FOREPERIOD	LATENCY
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		

2	SS	2	
4	SS	4	
6	SS	6	
8	SS	8	
10	SS	10	
12	SS	12	

Total SS

$\bar{X}$ R. T.

NF-Form 14

NUMBER FACILITY

55	43	18	27	27	92	16	78	78	16
92	18	36	66	7	18	24	37	6	2
82	12	20	43	74	53	90	21	20	65
85	89	36	36	1	63	93	6	89	49
43	22	37	48	91	56	30	29	57	4
42	25	9	60	34	66	3	13	87	53
74	20	7	99	50	16	15	83	62	36
90	85	62	16	86	68	27	26	45	27
52	44	45	79	54	4	98	53	72	45
57	33	63	84	16	55	12	16	97	3
60	21	1	42	22	59	56	76	74	47
86	12	63	17	77	56	85	62	24	43
32	34	78	53	94	35	99	27	67	73
44	29	59	31	39	64	26	66	62	86
9	78	16	57	6	54	46	27	71	57
47	64	95	24	54	54	96	50	81	96
27	56	55	55	43	82	68	26	14	47
96	7	50	57	49	38	96	56	42	36
54	82	19	88	82	21	31	7	20	61
49	52	98	77	17	31	5	32	42	46
17	42	10	4	37	62	3	90	53	98
46	7	50	74	93	43	72	79	32	63
9	44	71	47	23	90	93	78	37	71
62	38	75	67	78	90	15	53	32	62
90	15	12	21	87	6	57	13	27	33
52	51	86	76	35	18	12	55	7	26
84	36	73	33	20	44	10	38	36	16

Subject_____ Examiner_____ Date_____

SPEED OF CLOSURE

SC-Form 6

Draw a circle around each four-letter word in the rows below

H F D E B C A S T P M B C B D F H G D S S U G Y E P L J G D H A U L F S Z R X M F P A S W T
F H G S D X C V B J K D A S H Q W D A X Z C V B D F T G I V E D G C F H K F L M B V C D R W
G R T Y X S K I P O W Q M N B G D R T L Z L U N G Q P R T Y R I S E M S C K X D Z C F W R Y
P L K H F M I S S U B N C F X E W R B R I M F H X G J L D V X Z F I S H L B F G D X S H O W
H K F S Y L O U D U P R F S V B O A T N S R Q T R A P B S R T U G A N G M W O Q S G F D H K
L H F D S A V E B D S G C X L T H A N Q L N G C D S O I L H G V M N S P S A O T R X Z C V B
G B C S R Q S T A Y G Q C W X V B P N W T A L L B R Y H D J R O M P D V X M B X Z S F H K P
K H F S D G J L P Y W Z C P L U M F H B M K S C X B V F M O N K P M V X B F H J D Q T P D X
L J G D S A F H F I V E F G V X O I L Y L E A K I G X S V W D T O I L M Y C G P K N G Y C D
K L G J H D F T Y V I N E Y H P G Z Q H M O N L Y S F X S G T A E F G D P I C K R S F D G J
G F D Y R A B L E V X P A F A S T V Q Y R D M L U C K Q A S T R A Y F S F D R W Q K B M K L
D S R G V R Y A T W P L J G H D Y O U R H S T R M V X F J K L P S I G N F B R W Q S F D C N
T E A M Y D O O M T S L A D Y R Q P O N M L K J I H R U M P F D E C E M A L X J P Z W Q Y A
B C A P M I W R X Z R G D C U Q X B M W A L K M Q P J D F S C L U B J E B C X V B N A C I D
M V R A I N J P Y T S R U L E R D Z P Y T H E Y H D C X B V N M E L T W X C B M K G D T P C
H F S P W Y S U D S G H J W K L P U E V B G R O W C X B K H F T O A D X M B V H E V A T Y E
F H K D G J P R W S F X U N V A S E J W Q X H K L P M B M E N D V E I N D K V N K S A Q U P
T R D G J K H F C B C U T E M C W Q P L M Z R I N G B G F V N J F B L K P Y R T S C X Y C V
P J L H F A R M P R T F H D B U C K L J K M V H U L L T F B V C P G R E Y G H B C X N M V K
P W Q F A S Z C X T I Q K B M V C X O N O O K G L A D P Q W S F P M U P V N G J H K F U L O
U Y W Q Z C X T I C K V M B X D R Z A P E A X B Q R U N G F H D X V C P Q S L S T O P K F G
H F J S Z X V C B R Q A R E A X B C G A N H I J F V C P W Z B L O T F T O R W Q Z X V P Y R

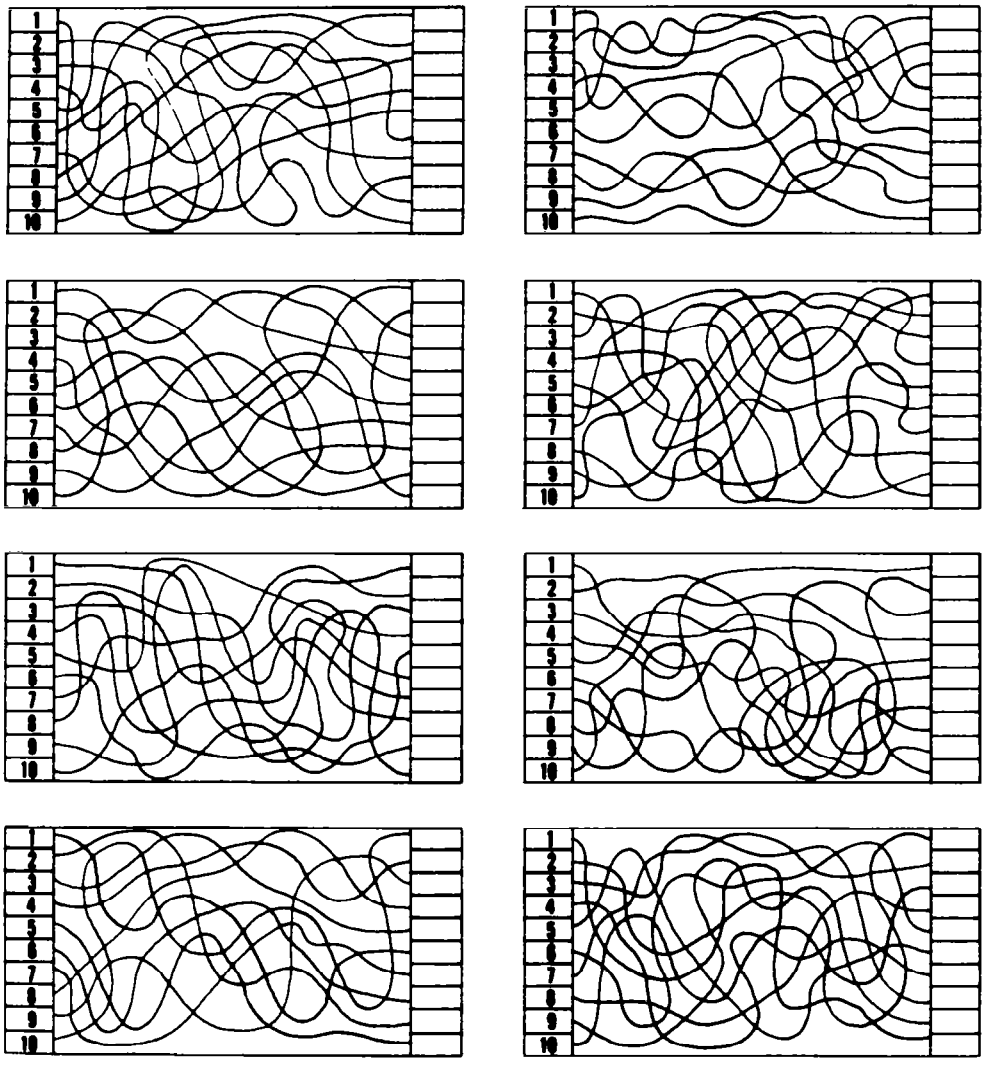
Date _____

Subject _____ Examiner _____

VISUALIZATION

V—Form 5

Follow each line with your eyes to its proper cell on the right and write the number of the line in the cell.

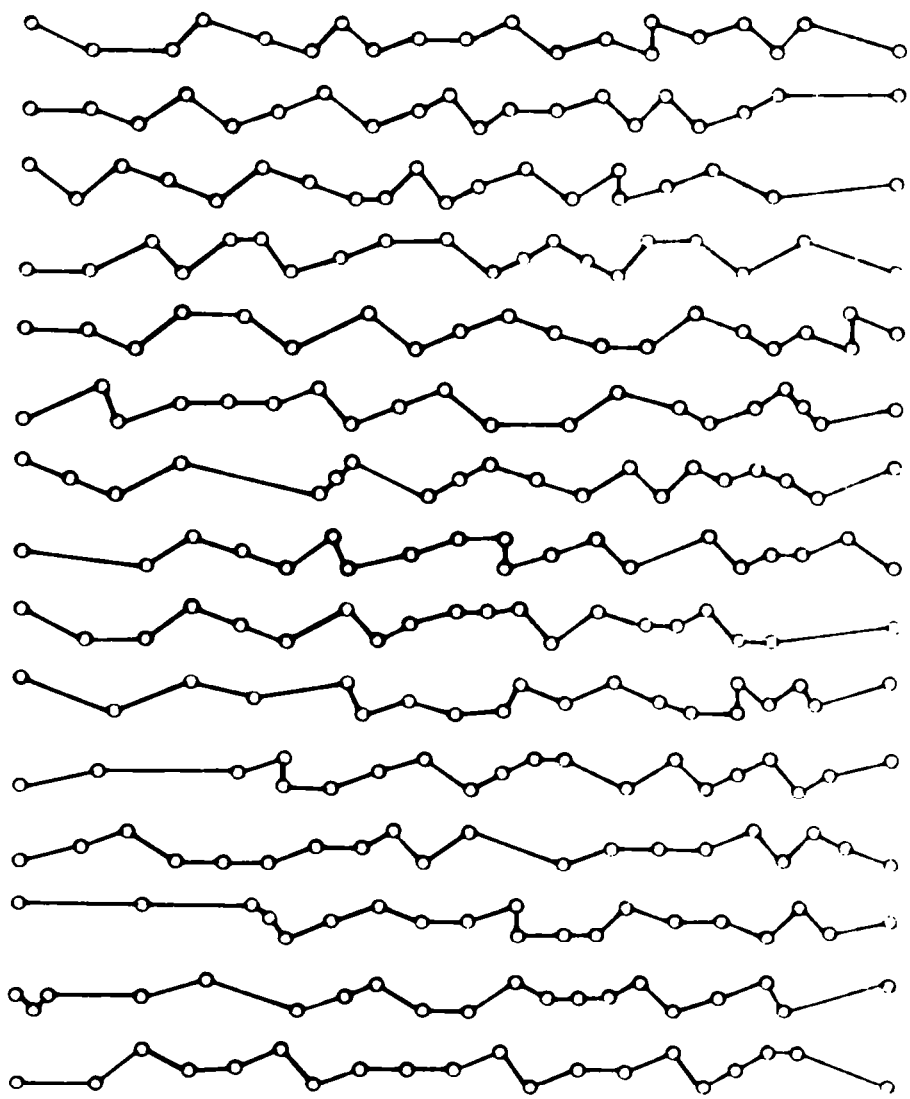


Subject _____ **Date** _____ **Examiner** _____

AIMING

A—Form 1

Put a dot entirely inside each circle.



Subject_____ **Date**_____ **Examiner**_____

PSYCHOLOGICAL TESTS SCHEDULE

DATE	SUBJECT NUMBER	TESTS
6-8-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	16 PF, GA, FTT, KAE
6-13-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	PS, WF, TPD, RC
6-14-64		HIT
6-15-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	TPD, RC
6-16-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	AO, *CMS, *BR
6-17-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	CMS, BR
6-18-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	CMS, BR
6-19-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	CMS, BR
6-20-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 1, 2, 3, 4, 5.....	CMS, BR HIT, RC
6-21-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 6, 7, 8, 9, 10.....	CMS, BR HIT, RC
6-22-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	AO, CMS, BR
6-23-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 1, 2, 3, 4, 5.....	CMS, BR PS, WF, TPD
6-24-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 6, 7, 8, 9, 10.....	CMS, BR PS, WF, TPD
6-25-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	HIT, RC, CMS, BR
6-26-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	CMS, BR
6-27-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 1, 2, 3, 4, 5.....	AO, CMS, BR PS, WF, TPD
6-28-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 6, 7, 8, 9, 10..... 1, 2, 3, 4, 5.....	CMS, BR PS, WF, TPD HIT, RC
6-29-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 6, 7, 8, 9, 10.....	CMS, BR HIT, RC
6-30-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	CMS, BR, R

PSYCHOLOGICAL TESTS SCHEDULE

7-1-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	CMS, BR, AO
7-2-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	CMS, BR
7-3-64	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	CMS, BR, IQ
7-16-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	RT, V, NF, A
7-20-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	HIT, RC, CMS, BR, RT, V NF, A,SC, TP
7-22-64	1, 2, 3, 4, 5.....	RT, V, NF, A,SC, CMS, BR
7-23-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	1, 2, 3, 4, 5.....	RT, V, NF, A,SC(Pre-Post Tilt)
	6, 7, 9, 10, 11.....	RT, V, NF, A,SC
7-24-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 11.....	RT, V, NF, A, SC(Pre-Post Tilt)
7-25-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	1, 2, 3, 4, 5.....	HIT, RC (CMS, BR)
7-26-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	HIT, RC (CMS, BR)
7-27-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	AO, CMS, BR
	1, 2, 3, 4, 5.....	RT, V, NF, A,SC
7-28-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	RT, V, NF, A,SC
	1, 2, 3, 4, 5.....	PS, WF, TPD, TP
7-29-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	PS, WF, TPD, TP
	1, 2, 3, 4, 5.....	HIT, RC
7-30-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	HIT, RC
7-31-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
8-1-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	1, 2, 3, 4, 5.....	PS, WF, TPD, TP
8-2-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	PS, WF, TPD, TP
	1, 2, 3, 4, 5.....	HIT, RC

PSYCHOLOGICAL TESTS SCHEDULE

8-3-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	AO, CMS, BR
	6, 7, 9, 10, 11.....	HIT, RC
	1, 2, 3, 4, 5.....	RT, NF, V, A, SC(Pre and Post Tilt)
8-4-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	RT, NF, V, A, SC(Pre and Post Tilt)
8-5-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR, R
8-6-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	RT, NF, V, A, SC, CMS, BR
8-7-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	AO, IQ, CMS, BR
8-24-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	HIT, RC, CMS, BR
8-25-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	AO, PS, WF, TP, CMS, BR
8-26-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	RT, NF, V, SC, CMS, BR
8-27-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	1, 2, 3, 4, 5.....	RT, NF, V, SC (Pre and Post Tilt)
8-28-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	RT, NF, V, SC (Pre and Post Tilt)
8-29-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	1, 2, 3, 4, 5.....	HIT, RC
8-30-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	HIT, RC
8-31-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	AO, CMS, BR
	1, 2, 3, 4, 5.....	RT, NF, V, SC
9-1-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	RT, NF, V, SC
	1, 2, 3, 4, 5.....	PS, WF, TP
9-2-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	PS, WF, TP
	1, 2, 3, 4, 5.....	HIT, RC
9-3-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	HIT, RC

PSYCHOLOGICAL TESTS SCHEDULE

9-4-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
9-5-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	1, 2, 3, 4, 5.....	PS, WF, TP
9-6-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	AO, CMS, BR
	6, 7, 9, 10, 11.....	PS, WF, TP
	1, 2, 3, 4, 5.....	HIT, RC
9-7-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	HIT, RC
	1, 2, 3, 4, 5.....	RT, NF, V, SC (Pre & Post Tilt)
9-8-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR
	6, 7, 9, 10, 11.....	RT, NF, V, SC (Pre & Post Tilt)
9-9-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	CMS, BR, R
9-10-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	AO, RT, NF, V, SC, CMS, BR
9-11-64	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	IQ, CMS, BR

*Administered AM and PM

A	Aiming
AO	Attentional Orientation
BR	Behavior Ratings
CMS	Clyde Mood Scale
FTT	Focused Thematic Test
GA	Guilford's Temperament Survey, Activity Dimension
HIT	Holtzman Inkblot Test
IQ	Immobilization Questionnaire
KAE	Kinesthetic After-effects
NF	Number Facility
PS	Perceptual Speed
R	Rankings
RT	Reaction Time
16PF	Cattell's Sixteen Personality Factor Inventory
SC	Speed of Closure
TP	Time Perception
TPD	Two-point Discrimination
V	Visualization
WF	Word Fluency

TEST BATTERY TABLE

DEPENDENT VARIABLES	Pre Bedr.	BEDREST PERIOD 1	2	3	4	5	6	7	8	9	10	Post Bedrest
Clyde Mood Scale	**	**	**	**	**	**	**	**	**	**	**	****
Holtzman Inkblot Test	/		/				/				/	
Reversible Cube	/		/				/				/	
Perceptual Speed	/// ///					/				/		
Two-point Discrimination	/// ///					/				/		
Word Fluency	/					/				/		
Attentional Orientation	*				*					*		**
Behavior Ratings	/	/// ///	/// ///	/// ///	/// ///	/// ///	/// ///	/// ///	/// ///	/// ///	/// ///	////
Immobilization Questionnaire												*
PREDICTOR VARIABLES												
Sixteen Personality Factors	*											
Guilford Activity Dimension	*											
Kinesthetic After-Effects	*											
Focus T.A. -T.	*											

The table above indicates the schedule for administering the test battery before, during, and immediately after each bedrest period. An asterisk(*) indicates group administration; a slanted line(/) indicates individual administration of the test. Predictor variables will be administered prior to the first bedrest period. The dependent variables will be repeated during each of the three bedrest periods. The number of symbols in the cell block is indicative of the number of presentations per day.

Appendix 12.1

12. TILT STUDIES

TILT SCHEDULE

DATE	TIME	SUBJECT NUMBER	TILT NUMBER	TYPE OF TILT
6-14-64	7:00	1	1	*
	8:00	2	1	*
	9:00	3	1	*
	10:00	4	1	*
	11:00	5	1	*
	12:00	6	1	*
	13:30	7	1	*
	14:30	8	1	*
	17:30	9	1	*
	18:30	10	1	*
6-16-64	7:00	1	2	*
	8:00	2	2	*
	9:00	3	2	*
	10:00	4	2	*
	11:00	5	2	*
	12:00	6	2	*
	13:30	7	2	*
	14:30	8	2	*
	15:30	9	2	*
	16:30	10	2	*
6-18-64	7:00	1	3	**
	9:00	2	3	**
	11:00	3	3	**
	13:00	4	3	**
	15:00	5	3	**
6-19-64	7:00	6	3	**
	9:00	7	3	**
	11:00	8	3	**
	13:00	9	3	**
	15:00	10	3	**
6-29-64	7:00	1	4	**
	9:00	2	4	**
	11:00	3	4	**
	13:00	4	4	**
	15:00	5	4	**
6-30-64	7:00	6	4	**
	9:00	7	4	**
	11:00	8	4	**
	13:00	9	4	**
	15:00	10	4	**

*Simple - ECG & Cuff Microphone Blood Pressure Measurements.
**Complete - Vectorcardiogram, Arterial Blood Pressure, Venous Pressure, Forearm and Leg Plethysmography, Abdominal EMG, Impedance Pneumograph Plasma Volume, Arterial Blood Saturation, Respiratory Gas Analysis.

TILT SCHEDULE Continued

DATE	TIME	SUBJECT NO.	TILT NO.	TYPE OF TILT
7-7-64	13:00	1	5	*
	14:00	2	5	*
	15:00	3	5	*
	16:00	4	5	*
	17:00	5	5	*
	18:00	6	5	*
	19:00	7	5	*
	20:00	8	5	*
	21:00	9	5	*
	22:00	10	5	*
7-14-64	13:00	1	6	*
	14:00	2	6	*
	15:00	3	6	*
	16:00	4	6	*
	17:00	5	6	*
	18:00	6	6	*
	19:00	7	6	*
	20:00	8	6	*
	21:00	9	6	*
	22:00	10	6	*
7-21-64	13:00	1	7	*
	14:00	2	7	*
	15:00	3	7	*
	16:00	4	7	*
	17:00	5	7	*
	18:00	6	7	*
	19:00	7	7	*
	20:00	8	7	*
	21:00	9	7	*
	22:00	10	7	*
7-23-64	7:00	1	8	**
	9:00	2	8	**
	11:00	3	8	**
	13:30	4	8	**
	15:30	5	8	**
7-24-64	7:00	6	8	**
	9:00	7	8	**
	11:00	8	8	**
	13:30	9	8	**
	15:30	10	8	**
8-3-64	7:00	1	9	**
	9:00	2	9	**
	11:00	3	9	**
	13:30	4	9	**
	15:30	5	9	**

Appendix 12.1 (Cont'd)

TILT SCHEDULE Continued

DATE	TIME	SUBJECT NO.	TILT NO.	TYPE OF TILT
8-4-64	7:00	6	9	**
	9:00	7	9	**
	11:00	8	9	**
	13:30	9	9	**
	15:30	10	9	**
8-11-64	13:00	1	10	*
	14:00	2	10	*
	15:00	3	10	*
	16:00	4	10	*
	17:00	5	10	*
	18:00	6	10	*
	19:00	7	10	*
	20:00	8	10	*
	21:00	9	10	*
	22:00	10	10	*
8-18-64	13:00	1	11	*
	14:00	2	11	*
	15:00	3	11	*
	16:00	4	11	*
	17:00	5	11	*
	18:00	6	11	*
	19:00	7	11	*
	20:00	8	11	*
	21:00	9	11	*
	22:00	10	11	*
8-25-64	13:00	1	12	*
	14:00	2	12	*
	15:00	3	12	*
	16:00	4	12	*
	17:00	5	12	*
	18:00	6	12	*
	19:00	7	12	*
	20:00	8	12	*
	21:00	9	12	*
	22:00	10	12	*
8-27-64	7:00	1	13	**
	9:00	2	13	**
	11:00	3	13	**
	13:30	4	13	**
	15:30	5	13	**
8-28-64	7:00	6	13	**
	9:00	7	13	**
	11:00	8	13	**
	13:30	9	13	**
	15:30	10	13	**

TILT SCHEDULE Continued

DATE	TIME	SUBJECT NO.	TILT NO.	TYPE OF TILT
9-7-64	7:00	1	14	**
	9:00	2	14	**
	11:00	3	14	**
	13:30	4	14	**
	15:30	5	14	**
9-8-64	7:00	6	14	**
	9:00	7	14	**
	11:00	8	14	**
	13:30	9	14	**
	15:30	10	14	**
9-11-64	13:00	1	15	*
	14:00	2	15	*
	15:00	3	15	*
	16:00	4	15	*
	17:00	5	15	*
	18:00	6	15	*
	19:00	7	15	*
	20:00	8	15	*
	21:00	9	15	*
	22:00	10	15	*

Appendix 12.2

TECHNIQUE FOR THE DETERMINATION OF FOREARM BLOOD FLOW, VASCULAR RESISTANCE AND VENOMOTOR TONE

Measurements of forearm blood flow, venomotor tone, and peripheral vascular resistance were determined as follows. Forearm circumference change to venous occlusion was determined by the method of Whitney which used a mercury-in-rubber strain gauge. Venous pressure was measured through a polyethylene catheter passed into a large forearm vein such that the tip of the catheter was located approximately 1 centimeter distal to the mercury-in-rubber gauge. Mean arterial blood pressure was obtained continuously from a needle in brachial artery of the opposite arm. From the simultaneous measurement of the forearm plethysmograph, mean arterial blood pressure, and venous pressure in response to venous occlusion, calculation of forearm blood flow, forearm vascular resistance and venomotor tone were made.

Two complete determinations were made at least five minutes apart prior to the tilt. Measurements were repeated at one minute, two minutes, four minutes, six minutes, eight minutes, ten minutes, fourteen minutes and eighteen minutes of the 70° head-up tilt. Since the position of the arm was not changed during the tilt procedure, venomotor tone measurements were not thought to be valid during the tilt because of the effect of venous stasis on pressure volume relationships. Determinations of venomotor tone measurements were made immediately after tilting down and at two minutes, four minutes, and eight minutes after the tilt-down procedure.

CLINICAL OBSERVATIONS RECORD

TILT OBSERVATIONS

DATE _____

SUBJECT _____ OBSERVER _____

EECO CODE HR	MIN	SEC	EXPERIMENTAL CIRCUMSTANCE	OBSERVATION

CODE:

Pallor	P	Sweating	Sw	Barrel Vision	B
Syncope	Sy	Vomiting	V	Double Vision	D
Nausea	N	Convulsion	C		

Appendix 13.1

13. BICYCLE ERGOMETER STUDIES

BICYCLE SCHEDULE

DATE	TIME	SUBJECT NUMBER	TEST NUMBER
6-9-64	8:30	6	1
	10:00	3	1
	11:00	10	1
	13:00	9	1
6-10-64	8:30	5	1
	10:00	7	1
6-11-64	8:30	2	1
	10:00	4	1
	11:00	1	1
6-12-64	8:30	8	1
	10:00	6	2
	11:00	3	2
6-15-64	8:30	1	2
	10:00	7	2
	11:00	10	2
6-16-64	8:30	2	2
	10:00	4	2
	11:00	9	2
6-17-64	8:30	5	2
	10:00	8	2
6-29-64	8:30	1	3
6-30-64	8:30	3	3
	10:00	2	3

BICYCLE SCHEDULE Continued

DATE	TIME	SUBJECT NUMBER	TEST NUMBER
7-1-64	8:30	10	3
	10:00	7	3
	11:00	5	3
	13:00	6	3
7-8-64	8:30	2	4
	10:00	3	4
	11:00	4	4
	13:00	5	4
7-9-64	8:30	1	4
	10:00	9	4
	11:00	10	4
7-10-64	8:30	6	4
	10:00	7	4
	11:00	8	4
7-15-64	8:30	2	5
	10:00	3	5
	11:00	4	5
	13:00	5	5
7-16-64	8:30	1	5
	10:00	9	5
	11:00	10	5
7-17-64	8:30	6	5
	10:00	7	5
	11:00	8	5
7-22-64	8:30	2	6
	10:00	3	6
	11:00	4	6
	13:00	5	6

BICYCLE SCHEDULE Continued

DATE	TIME	SUBJECT NUMBER	TEST NUMBER
7-23-64	8:30	1	6
	10:00	9	6
	11:00	10	6
7-24-64	8:30	6	6
	10:00	7	6
	11:00	8	6
8-3-64	9:30	1	7
	11:00	2	7
	12:30	3	7
8-4-64	8:00	4	7
	9:30	5	7
	11:00	6	7
8-5-64	8:30	7	7
	10:00	8	7
	11:00	9	7
	13:00	10	7
8-12-64	8:30	2	8
	10:00	3	8
	11:00	4	8
	13:00	5	8
8-13-64	8:30	1	8
	10:00	9	8
	11:00	10	8
8-14-64	8:30	6	8
	10:00	7	8
	11:00	8	8

BICYCLE SCHEDULE Continued

DATE	TIME	SUBJECT NUMBER	TEST NUMBER
8-19-64	8:30	2	9
	10:00	3	9
	11:00	4	9
	13:00	5	9
8-20-64	8:30	1	9
	10:00	9	9
	11:00	10	9
8-21-64	8:30	6	9
	10:00	7	9
	11:00	8	9
8-26-64	8:30	2	10
	10:00	3	10
	11:00	4	10
	13:00	5	10
8-27-64	8:30	1	10
	10:00	9	10
	11:00	10	10
8-28-64	8:30	6	10
	10:00	7	10
	11:00	8	10
9-7-64	9:30	1	11
	11:00	2	11
	12:30	3	11
9-8-64	8:00	4	11
	9:30	5	11
	11:00	6	11

Appendix 13.1 (cont'd)

BICYCLE SCHEDULE Continued

DATE	TIME	SUBJECT NUMBER	TEST NUMBER
9-9-64	8:30	7	11
	10:00	8	11
	11:00	9	11
	13:00	10	11

PROCEDURE OF THE BICYCLE ERGOMETER STUDIES

The bicycle ergometer test was performed as follows: Electrodes for the recording of the impedance pneumogram and the electrogram were placed on the chest of the subject and connected to the respective transducers. The signals generated by the transducers were recorded directly with a Sanborn recorder on a PI-600 magnetic tape recorder. These recordings were taken continuously at rest, during exercise and for 10 minutes after cessation of exercise. By visualization of tachometer the rate of pedalling was kept at 60 rpm. Recordings at rest were taken during 3 minutes. At the end of the third minute the subject was instructed to start to pedal the bicycle which had been set at a work load of 30 watts. The subject pedalled the bicycle at this work load for three minutes, this being used as a warming-up period. At the beginning of the seventh and each successive minute thereafter the work load was increased 10 watts until a heart frequency of 180 beats was approached. At that moment the subject suddenly ceased working but remained seated on the bicycle for ten minutes with the legs flexed and the feet on the bicycle box. During this time the electrocardiogram and the impedance pneumogram continued to be recorded. Samples of expired air were collected in Douglas bags by means of a undirectional Rudolph valve at 40, 80, 120 watts and at the final minute of exercise, that is, when the heart rate reached or approached a frequency of 180. The volume of air contained in the Douglas bags was measured with a wet gas meter. The concentrations of oxygen and CO_2 in the expired air were determined with the Scholander apparatus.

Appendix 14.1

14. ERKIN STUDIES

SCHEDULE

DATE	ERKIN PROTOCOL	RECORDING UNIT	SUBJECTS
6-13-64	4	Tape	All
6-15/16-64	3	Tape	All
6-17-64	3	Tape	All
6-17/18-64	2	Sanborn	All
6-20-64	5	Sanborn	All
6-21-64	5	Sanborn	All
6-22-64	5	Sanborn	All
6-23-64	5	Sanborn	All
6-24-64	5	Sanborn	All
6-25-64	5	Sanborn	All
6-26-64	5	Sanborn	All
6-27-64	5	Sanborn	All
6-28-64	5	Sanborn	All
6-28-64	6	Tape	All
6-29-64	5	Sanborn	Group Code 2**
6-30-64	3	Tape	Group Code 1*
7-1-64	3	Tape	Group Code 2**
7-3-64	6	Tape	All
7-6-64	3	Tape	All
7-10-64	6	Tape	All

* Group Code 1: 1st bedrest w/cuff; 2nd bedrest w/exercise; 3rd bedrest, none.
** Group Code 2: 1st bedrest w/exercise, 2nd bedrest w/cuff; 3rd bedrest, none.

Erkin Schedule Continued

DATE	ERKIN PROTOCOL	RECORDING UNIT	SUBJECTS
7-13-64	5	Sanborn	All
7-13-64	3	Tape	All
7-16-64	3-A	Tape	All
7-20-64	3	Tape	All
7-21-64	5	Tape	All
7-22-64	5	Tape	All
7-23-64	3-A	Tape	All
7-24-64	5	Tape	Group Code 1*
7-25-64	5	Tape	All
7-26-64	5	Sanborn	All
7-27-64	5	Sanborn	All
7-28-64	5	Sanborn	All
7-29-64	5	Sanborn	All
7-29-64	6	Sanborn	Group Code 1*
7-30-64	6	Tape	Group Code 2**
7-30-64	5	Tape	All
7-31-64	5	Sanborn	All
8-1-64	5	Sanborn	All
8-2-64	5	Sanborn	All
8-2-64	6	Tape	All
8-2-64	3	Tape	Group Code 1*
8-3-64	5	Sanborn	Group Code 2**
8-3-64	3	Tape	Group Code 2**

Appendix 14.1 (Cont'd)

Erkin Schedule Continued

DATE	ERKIN PROTOCOL	RECORDING UNIT	SUBJECTS
8-3/4-64	3-5	Sanborn	All
8-6-64	5	Sanborn	All
8-7-64	6	Tape	All
8-7-64	3	Tape	All
8-12-64	3	Tape	All
8-14-64	6	Tape	All
8-21-64	3	Tape	All
8-24-64	3	Tape	All
8-24-64	5	Sanborn	All
8-25-64	6	Tape	All
8-26-64	5	Sanborn	All
8-26-64	3	Tape	Group Code 1*
8-27-64	3	Tape	Group Code 2**
8-28-64	5	Sanborn	Group Code 1*
8-29-64	5	Sanborn	Group Code 2**
8-20-64	5	Sanborn	Group Code 1*
8-31-64	5	Sanborn	Group Code 2**
9-1-64	5	Sanborn	Group Code 1*
9-2-64	5	Sanborn	Group Code 2**
9-3-64	5	Sanborn	Group Code 1*
9-4-64	5	Sanborn	Group Code 2**
9-5-64	5	Sanborn	Group Code 1*
9-6-64	5	Sanborn	Group Code 2**
9-6-64	3	Tape	Group Code 1*

Erkin Schedule Continued

DATE	ERKIN PROTOCOL	RECORDING UNIT	SUBJECTS
9-7-64	3	Tape	Group Code 2**
9-8-64	3	Tape	Group Code 1*
9-9-64	3	Tape	Group Code 2**
9-9-64	5	Sanborn	All
9-10-64	6	Tape	All
9-10-64	5	Sanborn	All
9-11-64	3	Tape	All
9-11-64	6	Tape	All

Appendix 14.2

PROCEDURES OF ERKIN TESTS AND EXERCISES

Erkin I Protocol (Design Measurements):

This series of tests was designed to provide information on the individual's maximum pulling force at different points in the range of motion that was employed using the Bungie exerciser. The subject was positioned supine, with feet braced against a footboard. One end of an adjustable but nonyielding cable was attached to the footboard and the other end was fastened to a bar handle, which was grasped by the subject with both hands. A tensiometer was coupled in the cable line to register the axial force produced along the cable by the subject's pull. Measurements were taken with the arms in full extension, with the elbows flexed to 45°, and finally with elbows flexed to 90°. Measurements were taken of the distances between the handle and the footboard for each subject in each of these positions. These values were used to design the lengths and degree of Bungie stretch for each subject's exercise dose.

Erkin II protocol (Standardization Tests):

This series of tests was designed to standardize in advance the exercise dose for each subject. The objective of adjusti ng the exercise dose is to avoid severe fatigue while still obtaining moderate but not excessive cardiovascular response to the exercise, as measured by the increase in the heart rate during the exercises. It was decided to assign arbitrarily an exercise dose that would increase the heart rate 40-50 per cent over the resting level

in a two-minute exercise of 120 pulls on the Bungie at the rate of one pull per second.

Initially, each subject was given a dose of bungie pulling at 40 per cent of his maximum in the range of motion terminating at 90° elbow flexion. All subjects used the same length of Bungie rubber, with a variation in the length of the coupling cable to the foot piece made according to the height of the subject. The starting point for the pull was determined by the magnitude of Bungie stretch at this terminal tension. During this run, the ECG was monitored. If this exercise was too severe (i.e., producing excessive increase in heart beat rate) the terminal tension was reduced and another run was monitored. If the initial exercise was too easy, the terminal tension was increased until as desired increase in heart rate was achieved. In this manner a standard exercise dose and Bungie setting was determined in advance for each subject prior to the first bedrest period. This dose was retained for each man for the in-bed conditioning exercises, which was designated as the Erkin V protocol.

Erkin IV Protocol (Experiment):

This was an intermediate test for the purpose of identifying the preferred time of the precise series and for the purpose of making more precise the conditions of Erkin II.

Erkin VI Protocol (Criterion Test):

This test was performed with the Bungie exercise and was the same as Erkin V except that the ECG was monitored four minutes before exercise and five minutes after exercise. The exercise routine was 300 pulls on the

more prolonged exercise than that provided by Erkin V. Erkin VI was given before, after, and midway through bedrest periods.

15. DATA PROCESSING

TILT STUDIES

CODE SHEET TO MAGNETIC TAPE

DATE _____ MAGNETIC TAPE NO. _____

SUBJECT	TIME OF DAY	EECO CODE			EXPERIMENTAL CIRCUMSTANCE
		HR	MIN	SEC	

OBSERVER _____

STRIP CHART (OFFNER ETC.) RECORD MADE SIMULTANEOUSLY?

YES _____ NO _____

15.2 BICYCLE ERGOMETER STUDIES

ERGOMETRY TEST INPUT DATA SHEET

SUBJECT NAME _____ DATE OF TEST _____

IBM Number _____
Age _____
Sex _____
Height (Actual) _____
Weight (Actual) _____
B.S.A. (Actual) _____
Weight (Theo.) _____
B.S.A. (Theo.) _____

Barometric Pressure _____
Room Temperature _____
Water Vapor Pressure _____
Humidity _____
Duration of Test _____
Reference _____
Reason for Eval. _____
Time of Test _____

SAMPLE # 1

Work Load _____
Breaths/min. _____
Heart Rate _____
$\dot{V}_{E_{ATPS}}$ _____
O_2 _____
CO_2 _____
N_2 _____

SAMPLE # 2

Work Load _____
Breaths/min. _____
Heart Rate _____
$\dot{V}_{E_{ATPS}}$ _____
O_2 _____
CO_2 _____
N_2 _____

SAMPLE # 3

Work Load _____
Breaths/min. _____
Heart Rate _____
$\dot{V}_{E_{ATPS}}$ _____
O_2 _____
CO_2 _____
N_2 _____

SAMPLE # 4

Work Load _____
Breaths/min. _____
Heart Rate _____
$\dot{V}_{E_{ATPS}}$ _____
O_2 _____
CO_2 _____
N_2 _____

ERGOMETRY DATA CARDS

	Card	Column
Work Load	1	3
Time of Test (Military Time)	4	7
VEATPS	8	14
O_2 Concentration	15	20
CO_2 Concentration	21	26
N_2 Concentration	27	32
Barometric Pressure	33	37
Room Temperature	38	42
Partial Water Vapor Pressure	43	47
Humidity	48	50
Heart Rate	51	53
Number of Breaths	54	56

IDENTIFICATION CARD NUMBER 1

	Card		Column
Name	1	-	12
Date	13	-	18
Age	19	-	20
Sex	21		
Hospital Number	22	-	27
Height	28	-	32
Weight	33	-	37
Body Surface Area	38	-	41
Theoretical Weight	42	-	46
Theoretical Body Surface Area	47	-	50
Reference	51	-	56
Reason	57	-	62
Number of Phases	63	-	64

PHASE CARD

	Card	Column
Beginning of Tests (Military Time)	1	- 4
Number of Ergometry Samples	5	- 6
Number of Ventilation Samples	7	- 8
Number of BMR Samples	9	- 10
Position - Phase Code	11	- 12

CODE SHEET FOR BICYCLE ERGOMETRY ANALOG DATA

ON MAGNETIC TAPE

DATE _____ MAGNETIC TAPE NUMBER

MEASUREMENTS _____ _____

AIL CODE	SUBJECT	TIME OF DAY	EECO CODE HR.	MIN.	SEC.	EXPERIMENTAL CIRCUMSTANCE

OBSERVER _____

STRIP CHART (OFFNER, ETC.) RECORD MADE SIMULTANEOUSLY?

YES _____ NO _____

PHASE CARD

	Card		Column
Beginning of Tests (Military Time)	1	-	4
Number of Ergometry Samples	5	-	6
Number of Ventilation Samples	7	-	8
Number of BMR Samples	9	-	10
Position - Phase Code	11	-	12

CODE SHEET FOR BICYCLE ERGOMETRY ANALOG DATA

ON MAGNETIC TAPE

DATE _____ MAGNETIC TAPE NUMBER

MEASUREMENTS _____ _____

AIL CODE	SUBJECT	TIME OF DAY	EECO CODE HR.	MIN.	SEC.	EXPERIMENTAL CIRCUMSTANCE

OBSERVER _____

STRIP CHART (OFFNER, ETC.) RECORD MADE SIMULTANEOUSLY?

YES _____ NO _____

ANALOG TAPE DESCRIPTION FORM

DATE _____

SUBMITTER	RECORDED	SUBMITTED	DIGITIZED

TAPE NUMBER	PROPERTY OF

RECORDING SPEED	C F U	RECORDING HEAD

TAPE TRACK	FUNCTION RECORDED	MEASUREMENT CODE
01		
02		
03		
04		
05		
06		
07		
08		
09		
10		
11		
12		
13		
14		
15		
16		
SIDE TRACKS		

MICROSADIC REQUEST FORM

SUBMITTER	ANALOG TAPE NO.	PROPERTY OF
NO. OF FILES	START DECODER FT. AUDIO	REMARKS

TAPE SPEED	TAPE WIDTH	RECORDER			HEAD		CONDITION	
		Wide Band	Stan-dard	Irig Stand	Industry Standard		Re-wound	Not Re-wound

SAMPLING RATE(KSPS)				SCANS PER RECORD								DENSITY	NO CHANNELS MICROSADIC
.1	1	2	5	1	2	3	4	5	6	7	8	200 556	

CHANNEL CONSTANTS

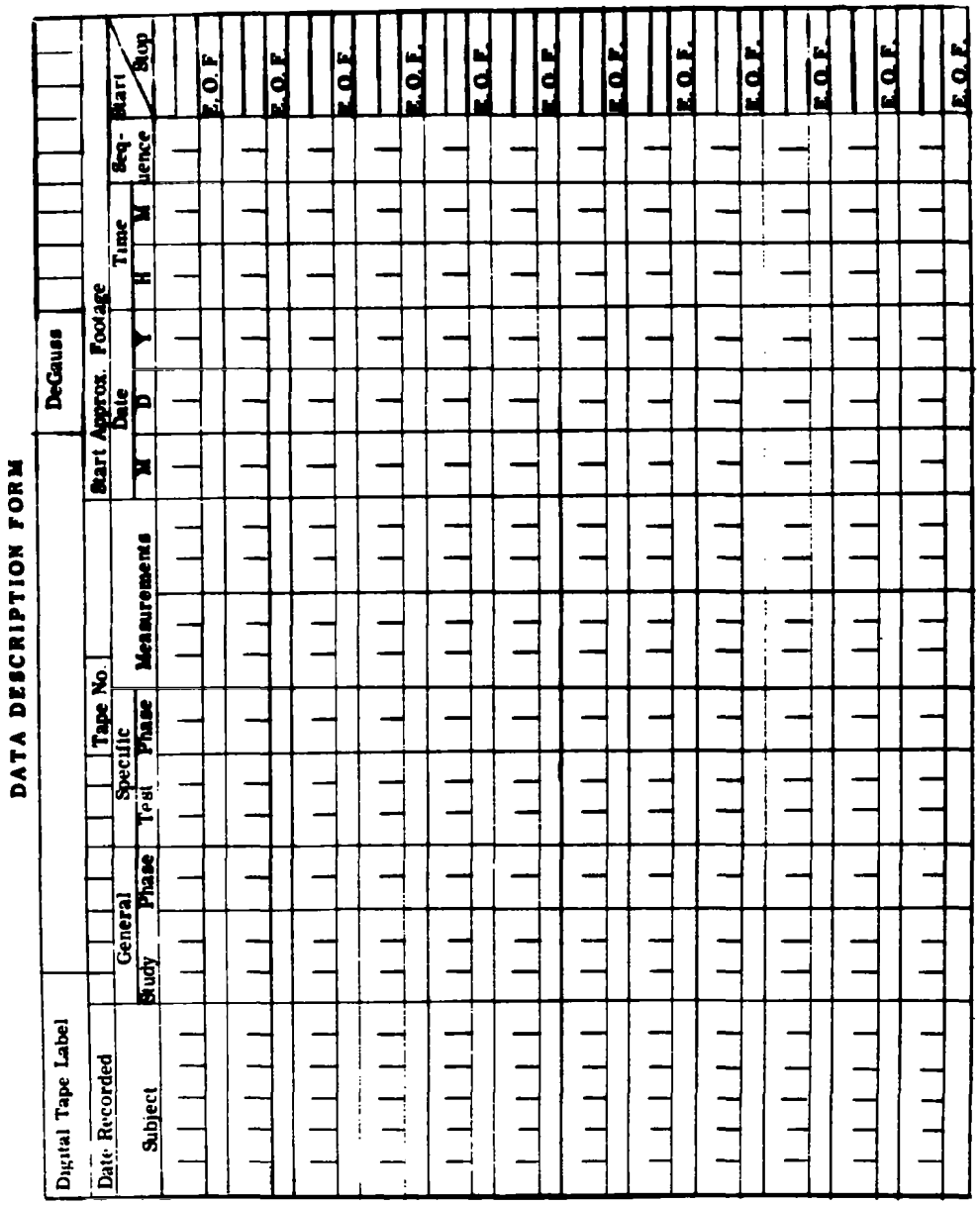
Rate	Scan	Channels	TapeSeq	Dig	Tape Reel#		Dens

TAPE TRACK	CHANNELS	TAPE TRACK	CHANNELS
01		08	
02		09	
03		10	
04		11	
05		12	
06		13	
07		14	

EDGE TRACK

DIGITAL TAPES PRODUCED	ORDER	REEL NUMBER	ORDER	REEL NUMBER
REMARKS:	1		8	
	2		9	
	3		10	
	4		11	
	5		12	
	6		13	
	7		14	

DATA DESCRIPTION FORM



ERKIN STUDIES:

CODE SHEET EXERCISE ANALOG DATA

ON MAGNETIC TAPE

DATE _____ MAGNETIC TAPE NUMBER

MEASUREMENTS _____ _____

SUBJECT	TIME OF DAY	EECO CODE HR.	MIN.	SEC.	COMMENTS

OBSERVER _____

STRIP CHART (OFFNER, etc.) RECORD MADE SIMULTANEOUSLY?

YES _____ NO _____