WATER REQUIREMENTS

FOR

PROLONGED SHELTER OCCUPANCY

by

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A REVIEW OF LITERATURE

As recently as 1965, A. R. Dasler and D. Minard[8] recognized a lack of literature useful in guideing research to determine survival requirements for shelter habitation. There was little information then available to yield a predictive scheme for the probability of healthy survival of a group of unacclimatized individuals. Dasler and Minard refer to the Navy Shelter Habitability Trials of 1962 which (in two sets of 14 day tests) information useful to devise such an experiment. Some of the basic questions addressed by Dasler and Minard were: how might the amount of water required be predicted and upon what environmental factors does it depend, and can man withstand prolonged exposure to 85°F. Effective Temperature[2] for two weeks continuously without adverse results? They found 82°F. E T to be a threshold value for heat rash, in the sense that treatment of heat rash was ineffective at some ET higher than 82°F., in the trials upon which they report.

Wyndham[26] reports that in South African mines, 82°F. ET is an acceptable temperature for 6 hour exposure for miners at an intermediate level of activity, providing the miners are acclimatized to the task.

R. Steinkamp[22] reports on the ability to estimate total body water by use of a skin-fold thickness measurement technique. This method has been shown to agree quite well with other means of assessing total body water.

An assessment of total body water on an individual basis together with a determination of metabolic rate would allow the design of an experiment to determine the relationship between these two measurements and some criterion defining success or failure in a shelter survival trial. Such a criterion might be 7% cumulative body water pool loss as a percentage of initial subject weight at the start of a shelter stay, as this value is suggested as "Very Severe" dehydration by Leithead and Lind[16].

E. F. Adolph, et. al.[1] refer to observations of subjects in desert conditions which yield guideing concepts for survival at high values of ET (Effective Temperature), however these tests are not generally concerned with shelter situations.

Leithead and Lind[16] have provided many references to other work applicable to a study of water requirements for shelter survival. They cite Bedford and Tredre[3] who recommended that even for men stripped to the waist, every effort should be made to keep the wet-bulb temperature at or below 26.7°C. (80°F.). They also reported on a survey in German mines which indicated that an ET of 28°C. (82.4°F.) might be considered the thermal limit for full production from acclimatized miners for short shifts.

The ASHRAE Handbook of Fundamentals[2] indicates that the effective temperature (ET) index is most applicable to warm atmospheres where radiation effects are not significant. This apparently limits the applicability of ET in a mine or other closed space unless some allowance is made for the effect of radiant heat exchange with the surrounding surfaces, especially if the mean radiant temperature (MRT) [ASHRAE Std. 55-66] is significantly different from the dry bulb temperature. Air velocity must also be considered.

Leithead and Lind[16] reported that in air temperatures ranging from 5 to 30°C. (41 to 86°F.), body temperature rose during work to an equilibrium level that was determined by the rate of work and was independent of the climate; the conclusion was presented that this rise of body temperature was a physiologically controlled response and was not in any way due to inadequacy on the part of the thermoregulatory system.

These guidelines provide an indication of the environmental conditions which might be applicable to a shelter situation, however much of the literature refers to physically fit, acclimatized individuals. These were classified as such by a clinical judgement which will be required to effectively evaluate further tests.

Leithead and Lind[16] in their summary on the pathogenesis of heat-stroke and heat hyperpyrexia state that thermal sweating may be reduced by water depletion, febrile infections or the injection of pyrogens, fatigue of the sweating mechanism, and possibly also by a rise in venous pressure.

There have been several methods proposed for determination of the effects of the evaporative heat transfer mechanism and this paper presents a determination by considering either the solids which leave the body (as in a physiological technique using the concept of clearance)[19] or the water which leaves the body by various means, as these two approaches have been found to be at least mathematically equivalent[28].

Leithead and Lind[16] indicate a functional description of evaporation as a means of heat exchange as: The present concept of heat lost by sweating is more complicated than heat exchanges by other channels. Humphreys, et. al.,[12] McNall[17], Webb[24], and Woodcock[25] and others allude to the complexity of other heat exchange mechanisms, and indeed all mechanisms are complex. In the case of evaporative heat exchange, other materials on the skin may affect the evaporation of water, especially in environments where the partial pressure of water vapor in the surrounding atmosphere approaches (from below) the partial pressure of water vapor at the temperature at which sweat exists on the skin.

INTRODUCTION

Prolonged occupancy of Civil Defense Shelters may impose Physiological and psychological effects on the occupants. Since the internal environments of these shelters is expected to be hot and humid, it is likely that the thermoregulatory mechanisms of the body will be stressed. Under these conditions, heat loss would have to be increased to maintain a constant body temperature. As a major avenue of heat loss in the human is through sweating, water must be available to replace this loss or dehydration will occur.

Because of their importance to human life, water requirements in normal and adverse environments have been the subject of numerous studies. One class of such work contains the survival studies conducted primarily by military organizations[1,8,18*]. In these studies, the subjects, typically, were allowed as much water and food as they desired. With limitless water and food, their physiological response was measured as a function of the uncontrolled environment to which they were subjected. Another class of studies treated the combination of uncontrolled environment and limited food and water supply[1].

However, it seems that no information is available in the literature dealing with the combination of closely controlled environment and limited food and water intake. Although nothing specifically applicable to this problem was located, it was possible, from the literature, to identify and isolate some factors in addition to water availability, which influence water requirements in shelter-type environments.

The studies noted above indicate the effects on "health" of a number of parameters which are listed at the top of the following page.

*The superscript numbers refer to the list of references.

1) Environmental Conditions

   a) Dry Bulb Temperature
   b) Mean Radiant Temperature
   c) Wet Bulb Temperature or Dew Point Temperature
   d) Air Velocity

2) Age, Sex and General Health of Participants

3) Activity Level

4) Length of Exposure

5) Psychological Effects

6) Nutrition

Obviously, the water ration stocked in shelters appears to be a primary factor determining shelter occupancy levels or occupancy length. Thus, the intent of the present study is to provide the following information on water requirements for shelter occupancy: Following the guidelines of the Office of Civil Defense, the specific purposes of this study are to determine, for a sample population of human subjects in a simulated shelter environment at 82°F Effective Temperature --- (1) whether a water ration limited to 1 quart per day per person is adequate for a 14 day exposure; and, if not, (2) to find an adequate water ration for 14 days and to determine its physiological value; and also, (3) to find the total days of exposure for which 1 quart per person per day is adequate, as well as the total resident time in days for which $3\frac{1}{2}$ gallons of water per person is adequate, as this is the current storage amount.

The tests were designed to allow observable water depletion to occur but were limited in duration to effect no long term damage to the subjects. Moreover, because the test purpose was to determine water requirements in shelter-type conditions; test chamber environment, voluntary population sample, activity level and length of exposure were chosen as typical of those which would be encountered in shelter usage[8,17,18].

Details of the test chamber and its capabilities have been described elsewhere[13,21]. It is the KSU-ASHRAE test chamber located in the Institute for Environmental Research at Kansas State University.

MATERIALS AND METHODS

Details of the test chamber have been previously noted[13,21]. It was equipped with 16 bunks, 16 folding chairs, 2 folding card tables, and a portable toilet (Fig. 1). The portable toilet was set up in one corner of the room and was surrounded by a privacy sheet hung from the ceiling. A buzzer was installed to alert the monitor when a specimen was collected. Color TV was provided, but the viewing hours were restricted. Cards, games, and magazines also were provided.

The temperature and humidity conditions were selected as those most likely in a shelter environment. Thus, in all of the six tests reported herein, the test chamber was maintained at 82±0.3°F. ET (86°F. dry bulb temperature, 80°F. wet bulb temperature, and air velocity approximately corresponding to 37.5 air changes per hour). The walls, floors, and ceiling were maintained at about 86°F. This condition was held from the time the subjects entered the room at the start of each test, until the end of the test. During tests of 5 to 10 days duration, there were short periods of power interruption and equipment malfunction experienced. However, in six tests, there were only five such cases, the longest (15 minutes) occuring in the first test resulting in cooled walls (5 to 10°F lower than DBT) which provided only a brief period of total darkness with wet walls. The effect on the tests of these occurances was felt to be small and was disregarded in the analysis. Table I shows descriptive information for the individual tests.

<u>Subjects</u>: The 16 subjects for each test included: 8 between the ages of 17 and 25 years, and 8 between the ages of 40 and 50. Both male and female subjects were used, but only one sex for each test. The younger group was selected from volunteers of the Kansas State University student body, with

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North End

South End

Figure 1: Test Room Arrangement

TABLE I

DESCRIPTION OF PARAMETERS FOR TESTS OF WATER REQUIREMENTS FOR SHELTER SURVIVAL, AND SUMMARY OF RESULTS

TEST	SEX	FOOD (kcal)		WATER (ml.)		LENGTH OF TEST (days)	FOOD TYPE	RELATIVE* COMPLETION	CDPLF (see text) %	CPDWT (see text) %
		OFFERED	EATEN	OFFERED	DRUNK					
1	M	1760	543	960	960	5	OCD I	13/16	5.73	6.91
2	M	1760	923	1920	1791	5	OCD I	16/16	2.28	3.15
3	F	800	512	960	952	5	OCD I	15/16	3.10	4.23
4	F	1517	1517	1616	1616	5	TURKEY**	16/16	2.44*†	2.27
5	M	959	872	1440	1440	9	OCD I	13/16	3.18/3.45	4.04/5.07
6	M	921	866	1200	1200	10	OCD II	13/16	4.26/5.53	5.11/7.30

*Relative completion refers to the (number of subjects completing the test)/(number of subjects starting the test). In test 1, one subject left because the test conditions were worse than he had expected, and the other two who did not complete the test were removed by the physician's order. In test 3, one subject was removed the first day, due to her inability to withstand the confinement as manifested by physiological reactions which led to her removal by the physician. In test 5, one subject left early on his own decision, while the other two were removed by the physician's order. In test 6, one subject left because his mother died, while the other two were removed by order of the physician.

**TURKEY refers to a special diet which was used only in test 4. This test was run as a baseline study using a diet about which component utilization data is available. The diet included turkey white meat, butter, white bread, raisins, orange segments, apple slices, and milk, coffee, tea, and water. Actually only 480 ml. of fluid was offered, but the water in food is included in the water offered column. For the other tests, the water in food is excluded from this table. The OCD rations tested, included only about 2 percent water by weight.

*†See text: **Page 26.**

NOTE: In tests 5 and 6, the double figures in the % columns refer to those values at the end of 5 days and the values at the end of the respective test.

their department's permission. The older group was recruited from volunteers from the community at large, including the Fort Riley Army Post 15 miles distant.

All subjects signed a notarized release (Appendix A). They provided their own shoes and suitable underclothing. They were provided with a pair of socks, trousers, and a shirt. They were allowed to adjust their clothing during the test within the limits of decency. They were provided with one set of clean sheets to cover their plastic-enclosed mattress and one turkish bath towel for the duration of the test. Facial tissues were available for local cleaning purposes. No general tooth or skin cleaning was permitted except for medical reasons. Less than 20% of the subjects needed special mouth wash or skin rash attention, etc.

Activity Levels: The activity levels of the subjects were considered to be between basal and sedentary, with a weighting of 16 hours each day allotted to sedentary activity, and 8 hours considered to be basal. The metabolic rate was related to that of a standard man having a metabolic rate of 372 BTUH, and using a form of the Standard Metabolic Rate Equation[15], the estimated metabolic rate of the individual subjects was calculated on the basis of their arithmetic mean weight during a 24 hour period.

Length of Exposure: As can be noted from Table I, the tests were run for variously 5, then 9, then 10 days. The tests were set up this way to allow for experience to guide the longer tests based upon the records of the shorter tests. It also allowed the various research teams to establish safe procedures for administration of the several areas of interest of the tests, which included studies by Engineers, Nutritionists, Physiologists, and Psychologists. These procedures are reported in Appendix B.

Rations: Water and food were dispensed four times each day. Rations were dispensed on a per person basis only, taking no account of variation in body weight or metabolic rate. This was felt to be the most practical simulation of a real confinement. Appendix B shows the approximate procedure schedule followed in all tests.

Monitor: There was a registered nurse in attendance at all times as well as two monitors, who were students. In addition, one person who operated the environmental chamber was available for emergencies or peak periods. A physician was on call at all times, and he visited the subjects each day. The investigators were also on call on a scheduled basis.

Pre-test Procedure: The subjects were recruited and signed up at least one week prior to the test. Appendix C shows the orientation information given to them, and the subject card information. Each subject received a physical examination during the week prior to the test. The physician was also asked to comment on the subject's general condition. A blood sample was taken and among other tests, a protein bound iodine test was run as in indicator of basal metabolic rate.

Test Procedure: Upon arrival for the test, the subjects were weighed in their issued clothing. Oral temperatures and blood pressure were recorded. Then the subjects were admitted to the test room. During the test, oral temperatures, blood pressure, and heart rate were observed every four hours; weights were taken every 12 hours; and other data was taken as ennumerated in Appendix B. All inputs to each subject (food, water) and all outputs which are observable (urine, feces, saliva, blood samples, menses, vomitus, etc.) were measured and their volume (or weight or number) recorded along with the time of the particular sample, for each individual subject.

Psychological tests were administered by a psychologist during the tests to determine the changes in group functions and relations.

No physical exercise equipment was provided. Physical exercise was ad lib, and less than 5 percent of the subjects sustained any regular calesthenics. The tests concluded after breakfast on the final day. Post-test data were taken and all subjects were given physical examinations before being released.

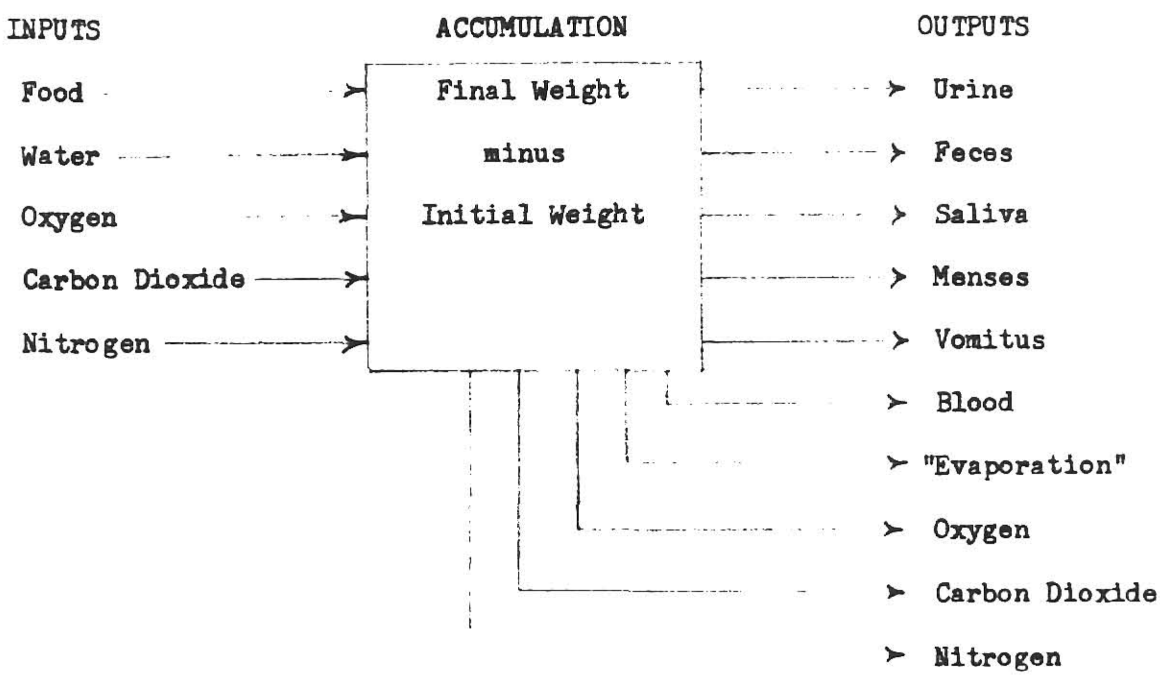
BODY WATER POOL LOSS ANALYTICAL MODEL

For purposes of data organization and analysis and reporting of results, an analytical model of the human water pool was developed. The primary difficulty in developing the model for the change in water pool was to decide if the pool described by the engineering approach is the same pool to which reference is made in physiological literature[16]. The approaches to analysis are markedly different, and yet it has been confirmed that, with the proper substitutions the resulting definitions are in fact identical[27,28]. The model used material balances and an energy balance to define the change in the body water pool. It was not concerned with the absolute size of that pool, but only with the changes in its size over a chosen period of time.

First Material Balance: Assuming conservation of mass, for the body:

$$\text{INPUT} - \text{OUTPUT} = \text{ACCUMULATION}, \qquad (I.1)$$

where INPUT refers to masses which enter the body, OUTPUT refers to all masses which leave the body, and ACCUMULATION refers to the change in mass of the body. Taking an individual subject as the system, and 24 hours as a reference time period, the inputs, outputs, and accumulation are defined as follows:



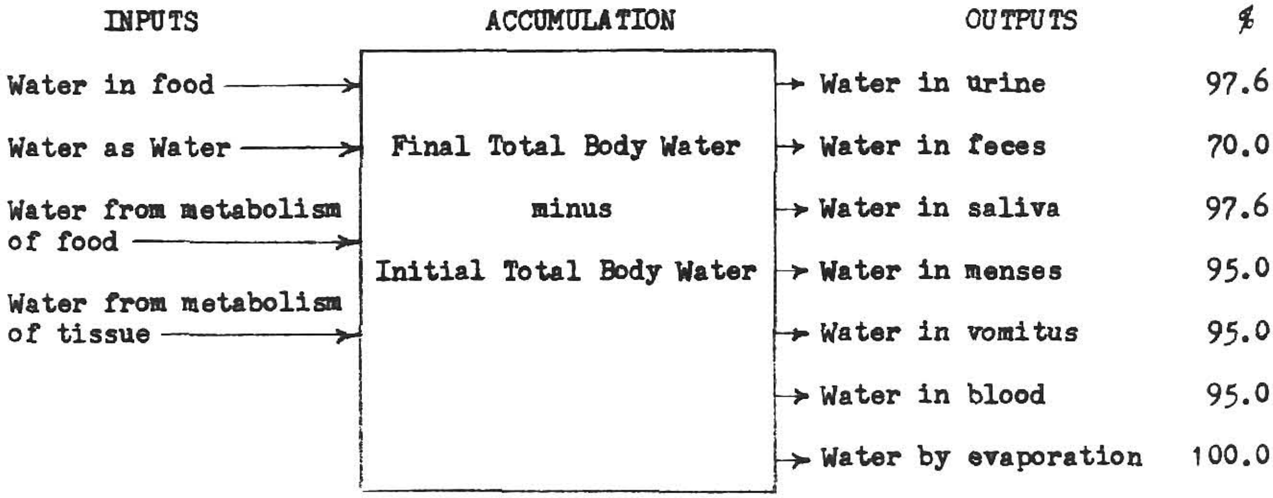
Since all of the quantities in the diagram can be measured directly, except the gas exchanges and the "Evaporation", this balance was used to determine the "Evaporation". Since the values for the oxygen and carbon dioxide may be calculated from the energy balance described below, only net effects were considered. Oxygen was considered an input, carbon dioxide an output, and nitrogen was ignored. Other changes which occur in the mass of the system which were not included in the list as inputs, outputs, or accumulation appear as part of the "Evaporation" which was determined by difference. It is felt that the error in this approach is small. Hence the quotes on "Evaporation".

Energy Balance: All of the metabolic energy produced in the body arises from the use of some fuel. In a situation of starvation, the amount of energy which can be generated by utilizing food is not sufficient to make up the total metabolic requirement. The remainder comes from the metabolism of tissue.

$$\text{METABOLIC ENERGY} = \text{ENERGY FROM FOOD} + \text{ENERGY FROM TISSUE} \quad (I.2)$$

Since the nutritional composition of the food was known, the utilization of each component could be estimated[15] and the energy from food could be approximated. The subject's metabolism was estimated from his weight and general activity level[15]. This yielded an estimate of the energy from tissue. Assuming a composition for metabolized tissue[27](which can be verified by nitrogen balance), the mass of the metabolized tissue was found from energy considerations. With the composition of the food metabolized and the tissue metabolized, the oxygen consumed and the carbon dioxide produced were calculated. This, then, allowed calculation of the "Evaporation" term in the first material balance.

Second Material Balance: Using equation I.1, for a system defined as the total amount of water in the body and the chosen time period as 24 hours, it was possible to find the accumulation of the body water pool. The accumulation in this case was usually negative, and as plotted in the results it is referred to as depletion (a positive quantity).



Water by evaporation as used here was determined from the result of the first material balance. It has been assumed that evaporation is all water. It is known that perspiration is composed of many body wastes[4], but the error introduced by this assumption is thought to be small. Other than this term, the only unknowns in equation I.1 applied to this system are the accumulation and the water from metabolism terms. The % column lists the assumed or measured percentages (by weight) of water in the outputs, which were used for the treatment of all subjects' data[28].

The water from metabolism of tissue and food was calculated in a manner similar to that used in the determination of the energy provided by the food. Using the average composition of the food, its fractional utilization, and the assumed composition of the metabolized tissue, and using average values for the water produced by each component (e.g. - grams H_2O produced/gram fat metabolized), the water from metabolism was calculated. This, then, led to the determination of the BODY WATER POOL accumulation term.

The analytical model so far described, then, is made up of three equations. At the conception of the analysis, these three equations include at least thirteen unknown quantities. By application of several assumptions, the system of equations was reduced to one equation with one unknown.

Energy Balance: Acceptance of the principle of the conservation of energy, allows the observation that the difference between the amount of energy entering a closed system, and the amount of energy which leaves that system must be equal to the energy stored in that system during any chosen time interval. In the form of an equation, for a selected time interval;

ENERGY INPUT - ENERGY OUTPUT = ENERGY STORED.

Applying this to the human, energy comes from (input): the catabolism of a fraction of the food that is consumed; the energy content due to the temperature of the masses which are added to the system; and possibly input by radiation and convection. Energy is released (output) from the body as: heat by convection, radiation, and evaporation; and heat contained in the excreta from the body. Energy can be stored in the body by changing the temperature of the body, or by the anabolic processes which occur in the body. In this model, the following assumptions have been made with regard to this energy balance: (1) The food was analyzed to determine its composition (CHO,Fat and Protein), coefficients of digestion were taken from the literature for each of the components as they occured in the rations used, and the literature also yielded accepted energy values (from bomb calorimetry studies) of typical components. Application of the coefficients of digestion to the calorimeter values then yielded the total of input energy from food. All other energy inputs were considered negligible. (2) The result of the altered Standard Metabolic Rate Equation was assumed to account for the total energy production. This model was developed, assuming that a male subject who weighed 160 lbs., had an average activity level which dictated that he produced 2250 kcals/day (372 BTUH).

In metric units, as the Standard Metabolic Rate Equation is, this can be stated as the product of some constant and the 0.75 power of the subject's weight in kg. e.g.- Constant x $(72.576)^{0.75}$= 2250 kcal/day. Determination of the constant allowed calculation of the individual subject's daily energy production. The main assumption in this regard, in addition to the use of the Standard Metabolic Rate Equation, was that all of the energy calculated by this method was considered to be output. (3) Energy can be stored in the body as heat, which would increase the body temperature. Energy can also be stored as a result of anabolic processes (glycogenesis, gluconeogenesis, fatty acid synthesis, etc.). Energy storage can also be negative, as in the case when the body temperature falls, or when stored energy in the form of tissue is released. The assumptions in this regard were: body temperature variation as it related to the energy stored, was negligible; (those subjects who did not meet this criterion were the ones who were eventually removed from the test, therefore this may be reasonable) and that most of the energy storage was in fact negative, i.e. tissue was catabolized, its composition was 10% protein and 90% fat. This assumption was indicated to be in error by the results of a nitrogen balance study, but when the test sequence started, the assumption was the best data available. A better figure would have been 20% protein, 80% fat.

Summarizing, the energy balance was assumed as follows: the energy which results from the calculation using the Standard Metabolic Rate Equation is the net energy output from the subject and it came from the oxidizing of some fuel, which could only be made up of the food the subject ate, and if this was not enough, some of the tissue of the subject. In some cases, subjects gained weight on a given day and even throughout the whole test period. The only justification of the "no anabolism" assumption in this case, if this did in fact occur, is that those subjects generated tissue in the ratio of 9/1, fat/protein. This was undoubtedly not the case. Probably their metabolic rate was lower than predicted.

Specifically, the equation used in the model was, for a time interval of 24 hours,

QMETM — Constant x (Mean subject weight for the day)$^{0.75}$ =
=
EAFIM — Energy available from the catabolism of the food consumed +
+
ETISMM — Energy from the catabolism of tissue.

EAFIM was developed from (or by) the following relation:

EAFIM = Number of Crackers x Average Mass per Cracker x (Cracker Protein Mass Fraction x (Energy Value/Mass of Protein) x Coefficient of Digestion of Protein + Cracker Carbohydrate Mass Fraction x (Energy Value/Mass of Carbohydrate) x Coefficient of Digestion of Carbohydrate + Cracker Fat Mass Fraction x (Energy Value/Mass of Fat) x Coefficient of Digestion of Fat) x (1.0 - cracker Moisture Fraction) + Number of Candies x Average Mass per Candy x Candy Mass Fraction Carbohydrate x (Energy Value/Mass of Carbohydrate) x Coefficient of Digestion of Carbohydrate x (1.0 - Candy Moisture Fraction).

The constants required for this calculation are shown in the computer summary sheets in Appendix E.

Application of this equation then permitted the calculation of ETISMM. From this value, the mass of the tissue metabolized was calculated with the assumption of its composition, and assumptions made regarding the energy contribution of the two components. For example:

MTISMM = Mass of Tissue Metabolized = ETISMM/(Energy produced per Mass Unit of Metabolized Tissue) = ETISMM/(Fraction of Metabolized Tissue which is Fat x Energy Value/Mass of Fat + Fraction of Metabolized Tissue which is Protein x Energy Value/Mass of Protein).

It can be seen from the equation that it was assumed that all tissue which was metabolized, was completely metabolized. Hence, no coefficients of digestion were necessary in the equation.

<u>Overall Mass Balance</u>: The first material balance was developed to allow the determination of "Evaporation". Most of the terms are obvious enough

not to require further explanation. The primary assumptions related to this portion of the model relate to the evaporation (which is somewhat of a net catchall term), and to the calculation of the masses of exchange of oxygen and carbon dioxide. This gas exchange was at least as significant as the feces on a mass basis. It was assumed that every net exchange not otherwise accounted for in this balance, was evaporation.

Carbon Dioxide and Oxygen were determined in the following manner:

GMO2 = Mass of Oxygen Consumed per Subject for a given Day = the same expression as that for EAFIM except that the term "Mass of Oxygen/Mass of Component" replaced the term "Energy Value/Mass of Component", and additionally, a similar expression accounted for the Oxygen consumed by the tissue MTISMM, which was metabolized.

GMCO2 = Mass of Carbon Dioxide Produced per Subject for a given Day = the expression above with "Mass of Carbon Dioxide/Mass of Component" used.

When a subject gained weight, or at least when the calculation showed that he ate more food than was needed to provide the energy required for his activity level, the resulting anabolism of tissue, resulted in the production of oxygen and the comsumption of carbon dioxide, according to this model. This seems impossible.

Body Water Pool Balance: The second material balance calculated the change in the body water pool. Of the terms involved in this equation, all but water from the metabolism of food and from tissue were either discussed or are straightforward in their determination. It was assumed that the water mass fraction of urine, feces, menses, vomitus, saliva, and blood did not vary between subjects or with respect to time. The values of these fractions were shown on page 15. The physiological data not yet presented, will allow the use of better values in future analyses. The water was assumed to have a specific gravity of 1 gram/cc, and the food moisture figures were taken from determinations run on cracker and candy samples.

The other two terms, AAFIM being the "Aqua Available from Food Input, Metric", and AATMM being the "Aqua Available for Tissue Metabolism (which probably should be referred to as catabolism), Metric", were derived in a manner similar to the GMO2 and GMCO2 terms. AAFIM was determined by substituting the term "Water Produced/Mass of Component" in place of the "Energy Value/Mass of Component" term in the equation of EAFIM. AATMM was determined by placing the "Water Produced/Mass of Component" term in an equation utilizing the components of MTISMM.

The mnemonic variable names are presented here so that they can be recognized in the computer program appearing in Appendix E.

The change in the body water pool was calculated from the second material balance. It was represented by the accumulation portion of that model.

The question of keeping track of where the water was exchanged, by substances both from without the cell and from within, is moot. It was ignored in this development. The model has not accounted for the separation that may exist between the extracellular and intracellular pools. The literature[19,29] indicates that these pools are in rapid dynamic equilibrium.

RESULTS OF BODY WATER POOL LOSS

A description of the test parameters (food, water, length of test, etc.) is presented in Table I. This table compares the food offered with the actual food consumed on an average basis. It also shows the relative completion (the number of subjects completing the test compared to the number who started), food type, average cumulative body water pool loss as percent of initial subject weight at the start of the test (hereafter referred to as CDPLF), and average cumulative weight loss as percent of initial subject weight at the start of the test (CPDWT). The food type refers to the diet as follows: OCD I was composed of crackers which were packed in cans and stored for about 80 months, complemented by the standard carbohydrate supplement; the special turkey meal is described in the table; OCD II refers to the individual crackers that were made available by Mr. Bob Hahl of OCD, plus the standard carbohydrate supplement. The crackers in OCD II were of an experimental composition and were produced in late 1969, according to Mr. Hahl.

Appendix E consists of copies of output from the main computer program for all male tests. For each test there is an outline sheet, a sheet describing the average daily values of selected variables for all subjects completing the test, and a sheet which shows cumulative values for all days of applicable observations using the figures from the daily average values. The pool loss data in Appendix E is presented for each male test in Figures 2, 3, 4 and 5. The average of those subjects completing the test, along with the standard deviations and the performance of the individual subjects who fared best and worst under the particular test conditions are shown on these figures. The figures are presented in order of increasing water ration.

It should be noted here that the results of the tests run on female subjects are not presented except in Table I. Because of the indication from

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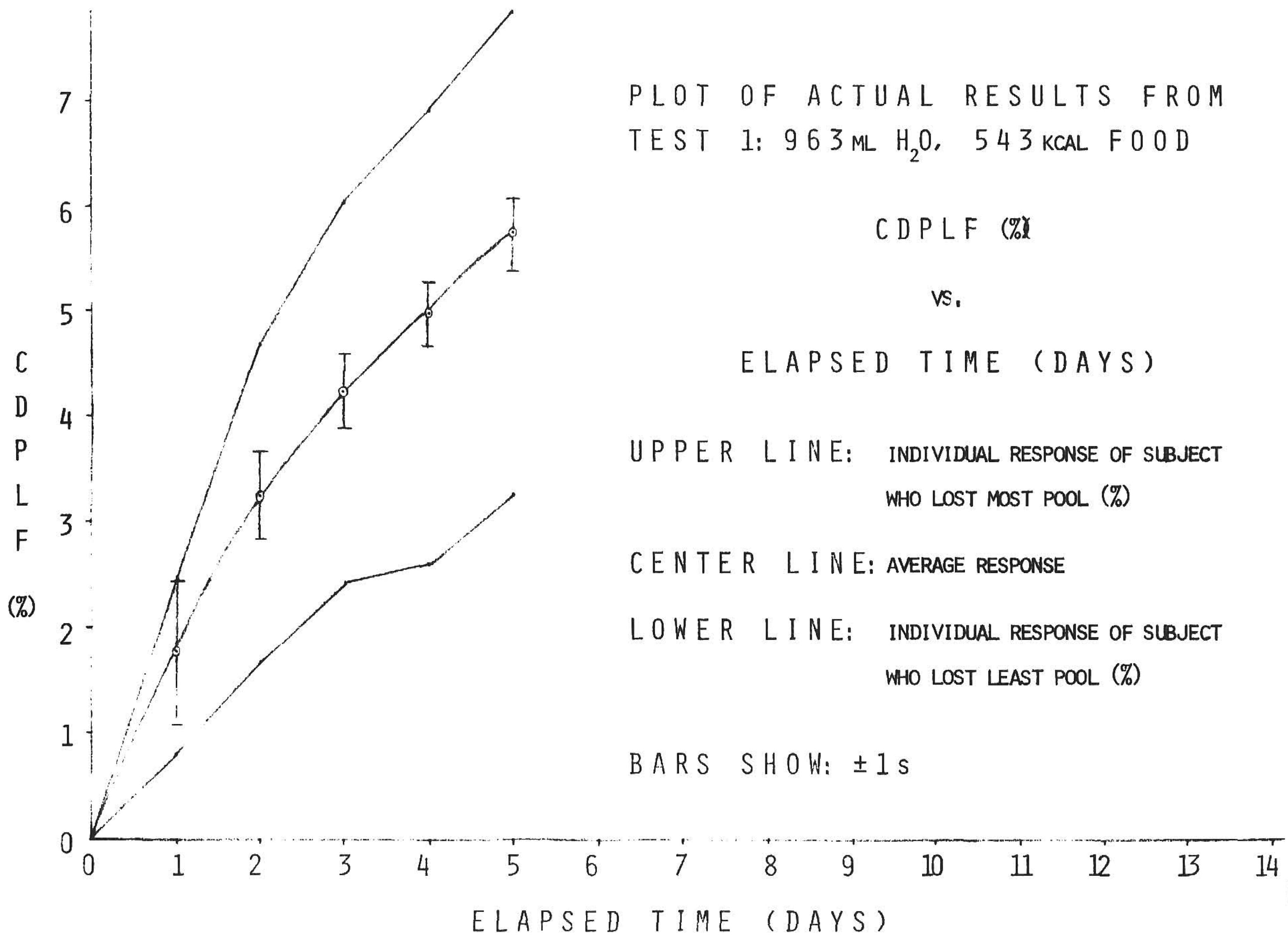
PLOT OF ACTUAL RESULTS FROM
TEST 1: 963 ML H_2O, 543 KCAL FOOD
CDPLF (%)
VS.
ELAPSED TIME (DAYS)
UPPER LINE: INDIVIDUAL RESPONSE OF SUBJECT WHO LOST MOST POOL (%)
CENTER LINE: AVERAGE RESPONSE
LOWER LINE: INDIVIDUAL RESPONSE OF SUBJECT WHO LOST LEAST POOL (%)
BARS SHOW: ±1s
CDPLF (%)
0
1
2
3
4
5
6
7
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
ELAPSED TIME (DAYS)

Figure 2

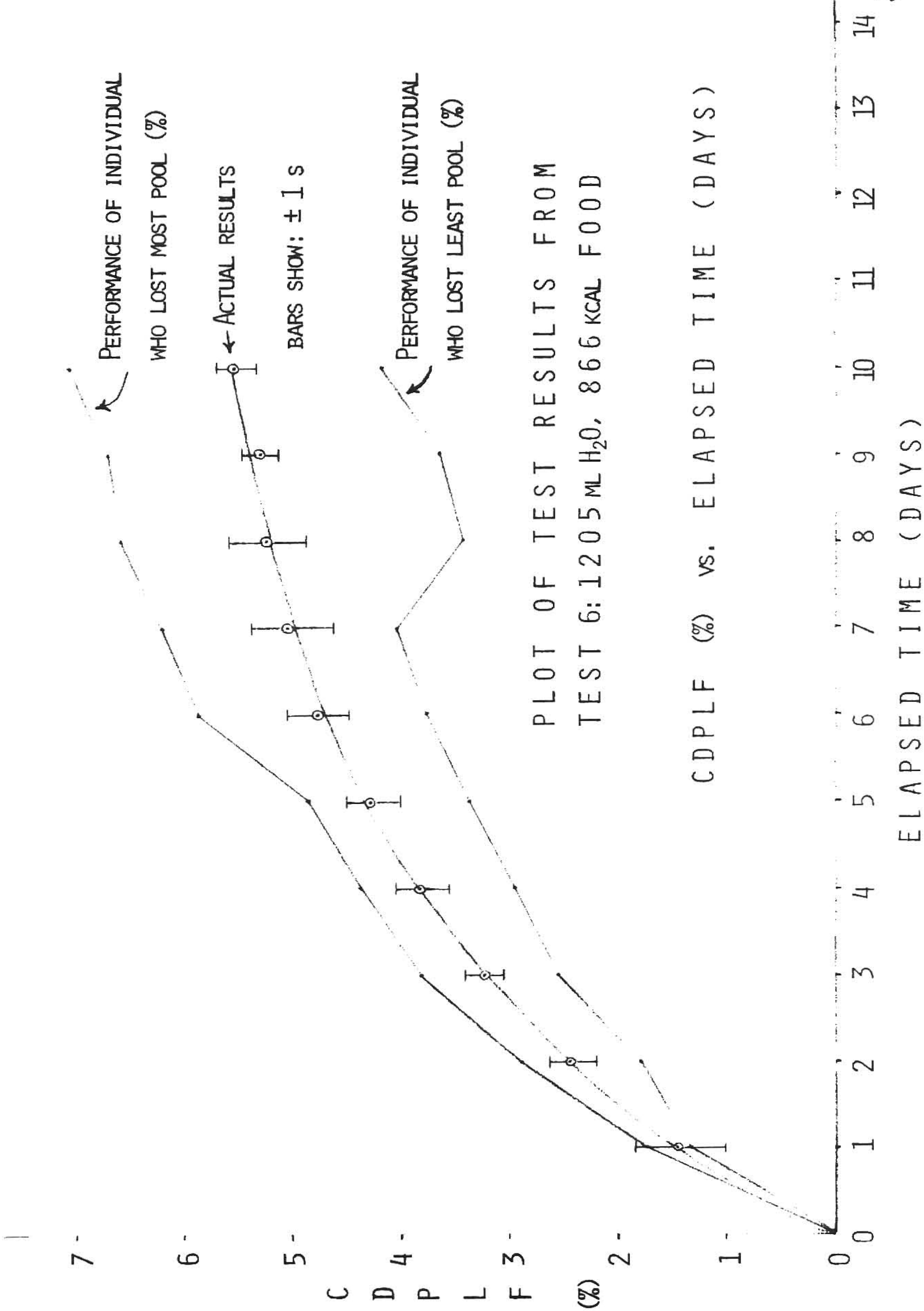
PERFORMANCE OF INDIVIDUAL WHO LOST MOST POOL (%)
← ACTUAL RESULTS
BARS SHOW: ± 1 s
PERFORMANCE OF INDIVIDUAL WHO LOST LEAST POOL (%)
PLOT OF TEST RESULTS FROM TEST 6: 1205 ML H2O, 866 KCAL FOOD
CDPLF (%) VS. ELAPSED TIME (DAYS)
ELAPSED TIME (DAYS)
CDPLF (%)
0 1 2 3 4 5 6 7
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Figure 3

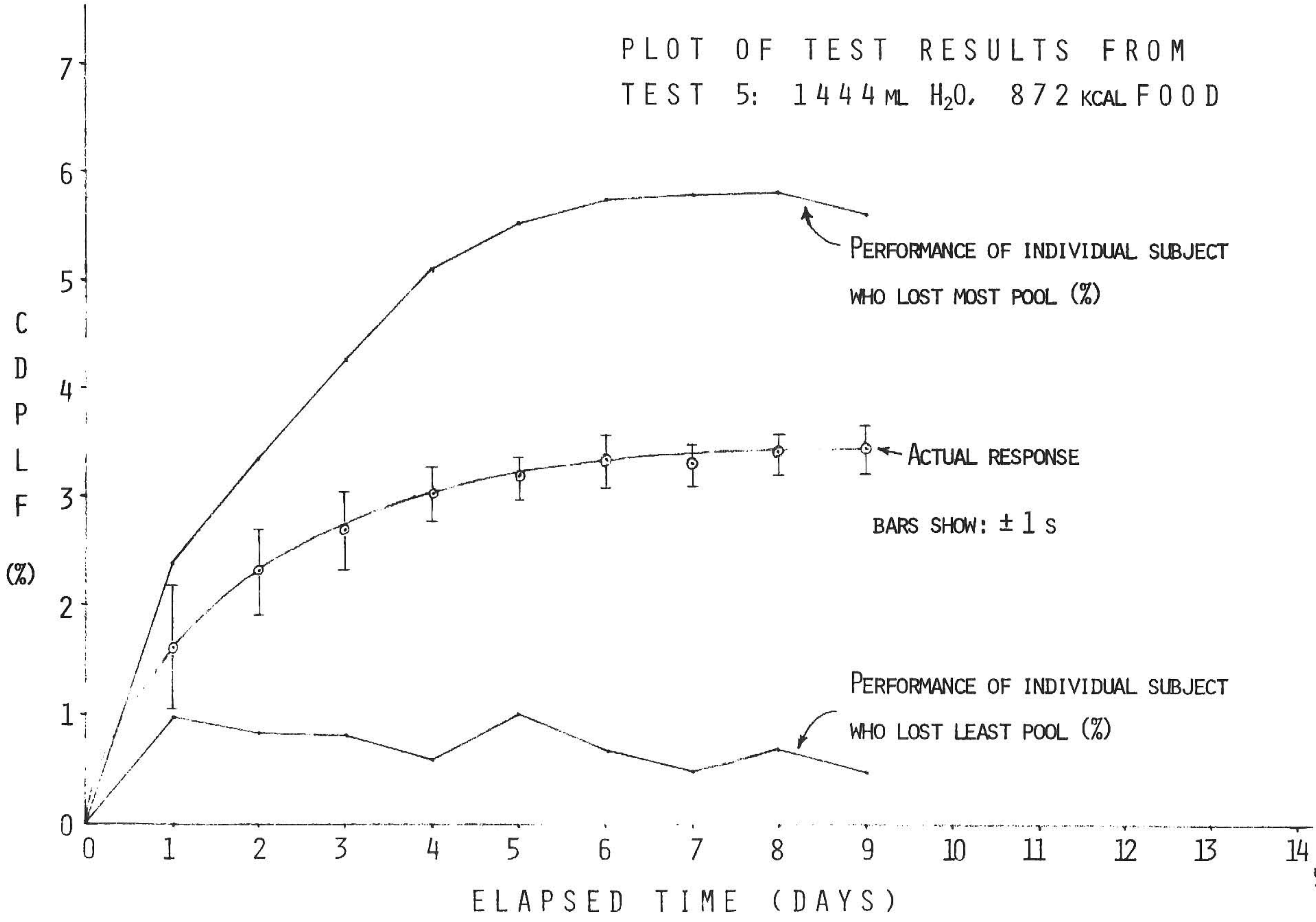
PLOT OF TEST RESULTS FROM
TEST 5: 1444 ML H2O, 872 KCAL FOOD
PERFORMANCE OF INDIVIDUAL SUBJECT
WHO LOST MOST POOL (%)
ACTUAL RESPONSE
BARS SHOW: ± 1 s
PERFORMANCE OF INDIVIDUAL SUBJECT
WHO LOST LEAST POOL (%)
C
D
P
L
F
(%)
0
1
2
3
4
5
6
7
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
ELAPSED TIME (DAYS)

Figure 4

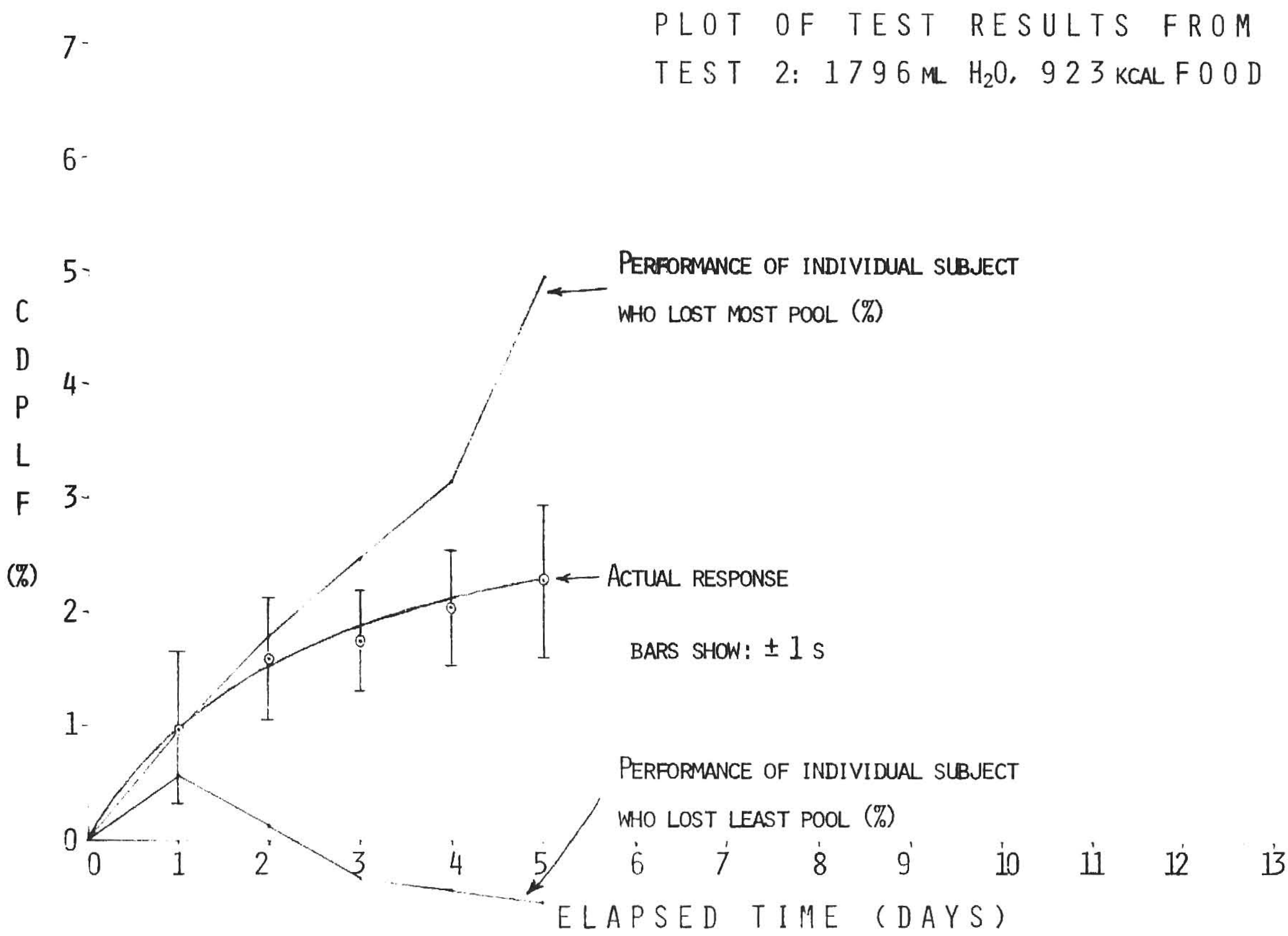
PLOT OF TEST RESULTS FROM
TEST 2: 1796 ML H2O, 923 KCAL FOOD
CDPLF
(%)
0
1
2
3
4
5
6
7
PERFORMANCE OF INDIVIDUAL SUBJECT
WHO LOST MOST POOL (%)
ACTUAL RESPONSE
BARS SHOW: ± 1 S
PERFORMANCE OF INDIVIDUAL SUBJECT
WHO LOST LEAST POOL (%)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
ELAPSED TIME (DAYS)

Figure 5

these tests that females will in general do better on a given water/food ration than men, the hypothesis has been made that providing an adequate ration for men will be the more critical goal. This can be justified several ways, including references to the literature regarding the response of women to adverse environments[9,11]. In addition to these observations, in both the tests with females, considerable difficulty was involved in analyzing the data. In test 3, the days were not easily defined, and as a result, daily data does not correspond to that of other tests. In this same test, some urine samples were misplaced. It was possible to calculate the average effect over the term (5 days) of the test, but it had to be corrected for urine which could not be assigned to any particular subject and for the fact that the data appeared to be taken from 6 days. The first and last day were actually of such a length that their sum added up to a 24-hour period. The data presented in Table I from test 4 is somewhat suspect, due to the fact that the initial weights were taken on a scale which failed after the first day. An attempt was made to calibrate the original weights to values obtained on the scale used during the remainder of the test, but this calibration is also suspect. It is felt that the average results from test 3, along with the literature[11] provide sufficient evidence that the welfare of the men will be the deciding factor in determining an acceptable water/food ration.

Figure 6 presents the average results of all male tests on the same plot for comparison. Table II shows the average rations (consumed/offered) which were used in these male tests.

Regarding those subjects who did not complete the tests, except for those who left due to disenchantment, the one physiological response most observable was that shortly prior to being taken out, they exhibited stumbling behaviour. This has been previously reported as an effect of dehydration[8].

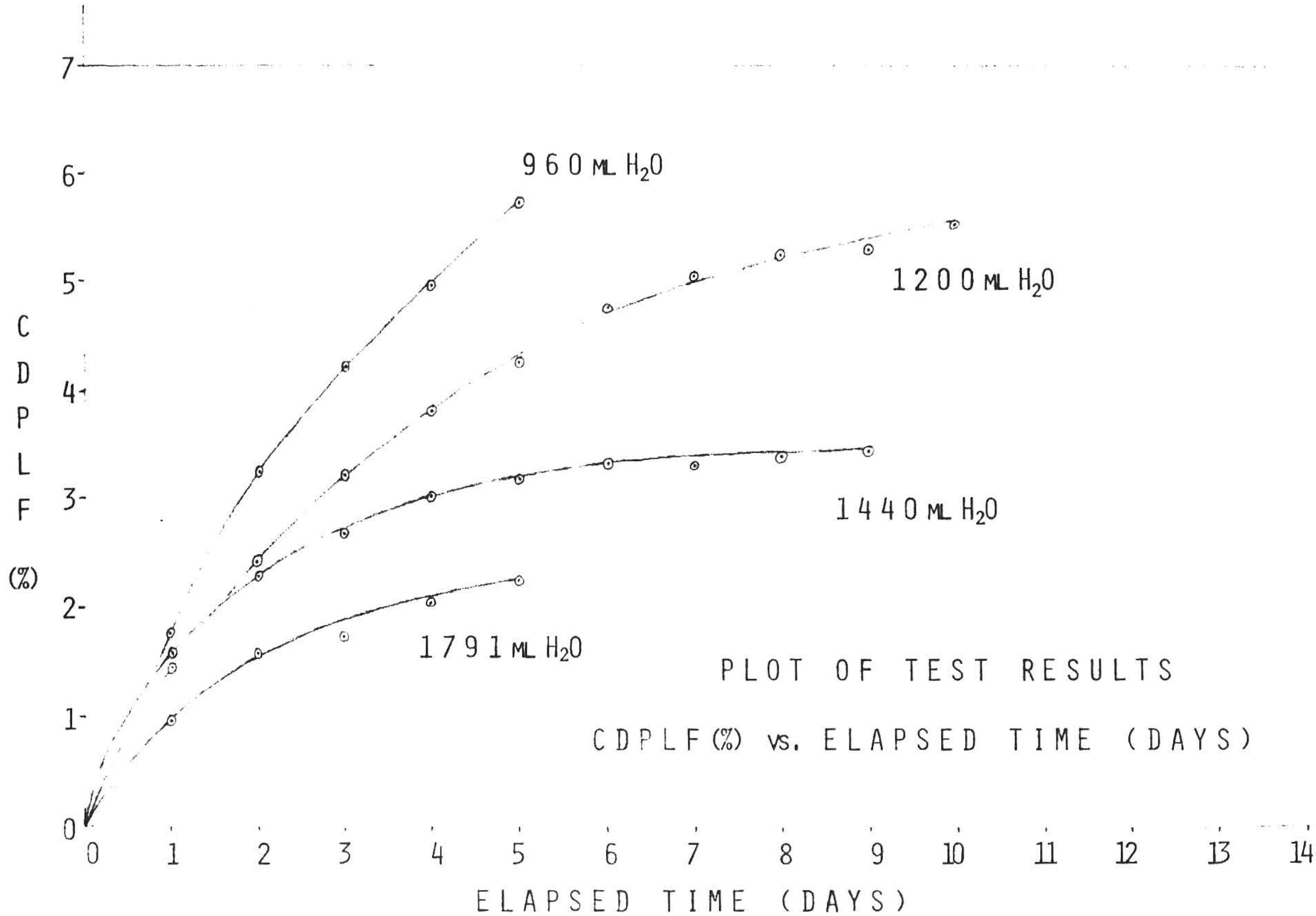
PLOT OF TEST RESULTS
CDPLF(%) vs. ELAPSED TIME (DAYS)
960 ML H_2O
1200 ML H_2O
1440 ML H_2O
1791 ML H_2O
CDPLF (%)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
ELAPSED TIME (DAYS)

Figure 6

TABLE II

ACTUAL RATIONS TESTED - MALE TESTS

TEST	---- WATER ----		------------- FOOD ------------		
	ml. CONS./OFF.	qt.* CONS./OFF.	CRACKERS CONS./OFF.	CANDIES CONS./OFF.	KCAL. CONS./OFF.
1	963/963	1.018/1.018	23.16/84.0	4.00/4.00	543/1760
2	1796/1930	1.898/2.040	42.22/84.0	3.90/4.00	923/1760
5	1444/1444	1.529/1.529	28.43/32.0	15.21/16.0	872/959
6	1205/1205	1.275/1.275	26.11/28.0	15.25/16.0	866/921

* 1 quart = 57.75 cubic inches ≐ 946 cubic centimeters

PREDICTIONS

Table III presents the regression equation developed from a linear regression analysis of the data from the male tests. The variables presented are all developed from values which would probably be known before a shelter confinement. The equation is intended as a planning tool, rather than as a diagnostic aid. The variables are presented in the order of their contribution to the best fit.

CDPLF is presented since the literature refers to the severity of dehydration in these terms. Leithead and Lind[16] refer to 7% as a very severe water depletion and this value has been chosen as a suggested criterion for physiological acceptability for average male healthy subjects under the age of 50 years.

Visual examination of the curves shown in Figure 6, indicate that possibly some function of food and water, involving the square root of elapsed time, might be an appropriate matching function. Much time and many dollars were spent with various combinations of variables including different functions of time. The regression equation as it is presented is the best fit that was obtained.

Figure 7 shows the predictions from the regression equation using the average rations consumed, presented in Table II, and Figures 2, 3, 4, 5 and 6. This plot is primarily for comparison with Figure 6, which is also replotted on Figure 7. The comparison shows that except for test 1, the prediction is slightly conservative (i.e.- the regression equation predicts that the subjects will experience a greater pool loss than they actually did in the tests). Also noted on Figure 7 is the day of an exposure during which a subject with average response would reach 7% CDPLF, for each test condition.

TABLE III

PREDICTION REGRESSION EQUATION

CDPLF (%) is expressed as a function of elapsed time and ration (normalized to subject condition at start of stay: initial weight or intial metabolic rate). - Variables are listed in the order of their contribution to the "goodness of fit".

$$CDPLF = 6.6957 + 4.4246 \times \frac{Day^{0.5} \times MR}{H_2O} - 1.5444 \times \frac{E_{food}}{MR} - 96.7486 \times \frac{Day^{0.5} \times WT}{H_2O}$$

$$- 0.4434 \times \frac{H_2O}{WT} - 61.64 \times \frac{WT}{H_2O} - 1.0953 \times Day^{0.5} + 10.3001 \times \frac{H_2O}{MR}$$

Where: CDPLF = (Cumulative water loss/initial weight) x 100 (%)
Day = Elapsed time (days)
MR = Metabolic rate at start of stay (Kcal/Day)
WT = Subject weight at start of stay (Kg.)
H_2O = Daily water ration (ml)
E_{food} = Daily food ration (Kcal)

This regression accounts for 74.45% of the variance of the dependent variable. (Multiple correlation coefficient = 0.86286)

The standard error of the estimate is 0.9869

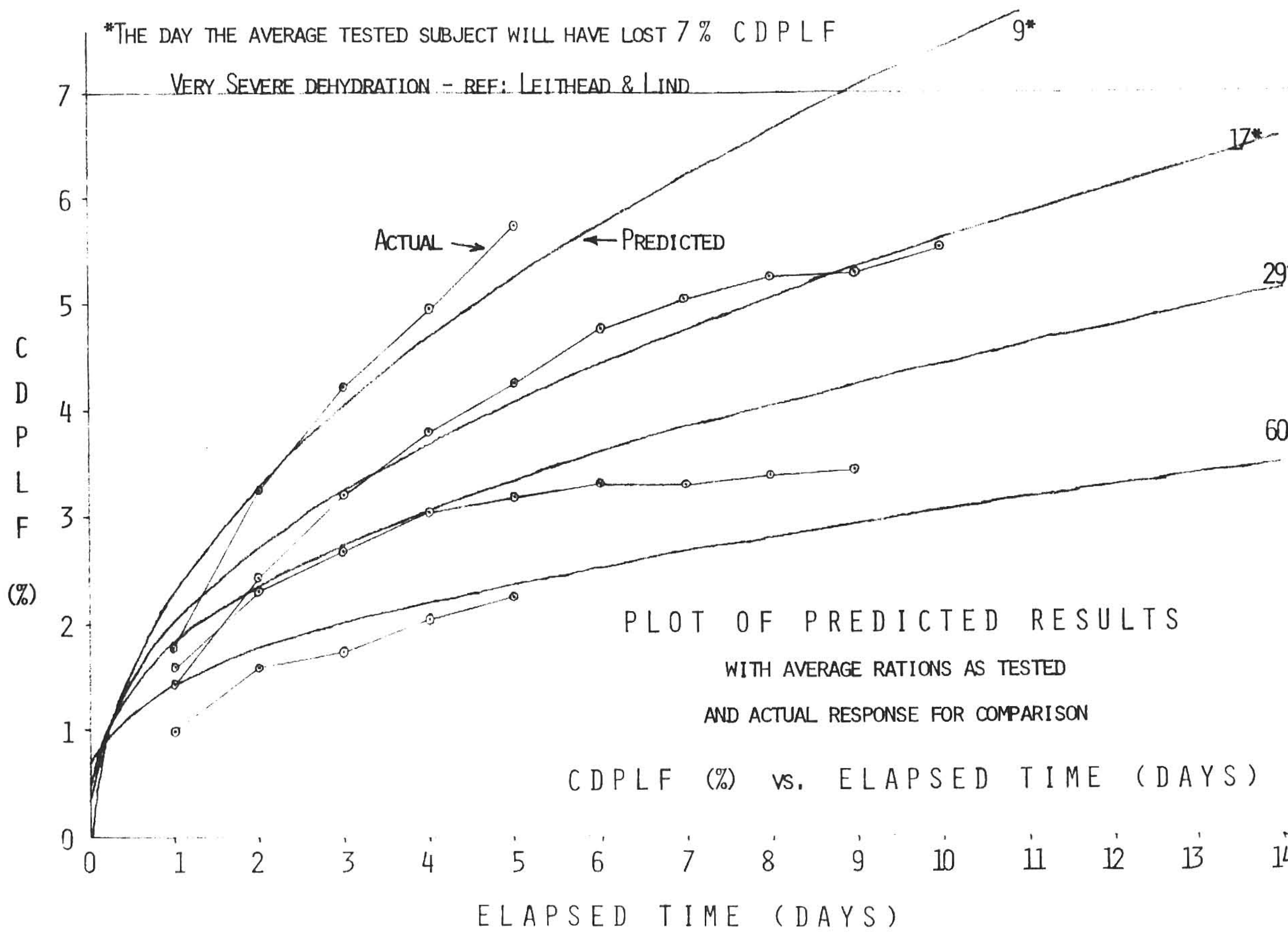
*THE DAY THE AVERAGE TESTED SUBJECT WILL HAVE LOST 7 % CDPLF
VERY SEVERE DEHYDRATION - REF: LEITHEAD & LIND
ACTUAL
PREDICTED
9*
17*
29*
60*
C D P L F (%)
0
1
2
3
4
5
6
7
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
PLOT OF PREDICTED RESULTS
WITH AVERAGE RATIONS AS TESTED
AND ACTUAL RESPONSE FOR COMPARISON
CDPLF (%) vs. ELAPSED TIME (DAYS)
ELAPSED TIME (DAYS)

Figure 7

Figure 8 shows the results of the regression equation applied to 1, $1\frac{1}{4}$, $1\frac{1}{2}$, and 2 quarts of water per day per subject with 960 kcal. of OCD ration. These were not the exact quantities actually used in the tests (See Table II). The standard error of the estimate is known to be 0.99 (CDPLF %). The numbers in parentheses indicate the day during which 50% of the sampled population would reach 7% CDPLF. This is substantiated in the statistical appendix (D). Figure 8 also shows the limit of advisability for $3\frac{1}{2}$ gallons per person. From Figure 8, one might erroneously deduce that it would be possible for subjects to last 9 days on 1 quart of water per day. This may not be true since it may not be possible for people with a water ration of less than $1\frac{1}{4}$ quarts of water per day to consume 960 kcal. of OCD ration. Since at the $1\frac{1}{4}$ quart level, some subjects asked for more food, it is assumed that on the OCD II ration, with $1\frac{1}{4}$ quarts of water, nearly all of the subjects would be able to eat 960 kcal. of food if properly motivated (See Table I for food consumed vs. food offered at 1 quart). Figure 8 does show the recommendation of this study at $1\frac{1}{4}$ quarts of water per person per day for a 14 day occupancy requirement for adult subjects 50 years of age or less.

Figure 9 compares the actual test data from test 6 (1.275 quarts) with the predictions from the regression equation for $1\frac{1}{4}$ quarts plus 960 kcal., as well as the prediction from the regression equation if no food at all were consumed. Since the food term in the regression equation contains no time dependence, the difference between the as tested predictions and the no food predictions is simply a constant. It can be noted from this comparison that the prediction is conservative toward the end of the test. The effect of 960 kcal./day of food is predicted to lengthen the residence time about 3 days before a particular dehydration limit is reached, over that where no food at all is consumed. As stated above, it seems that with the use of the OCD II

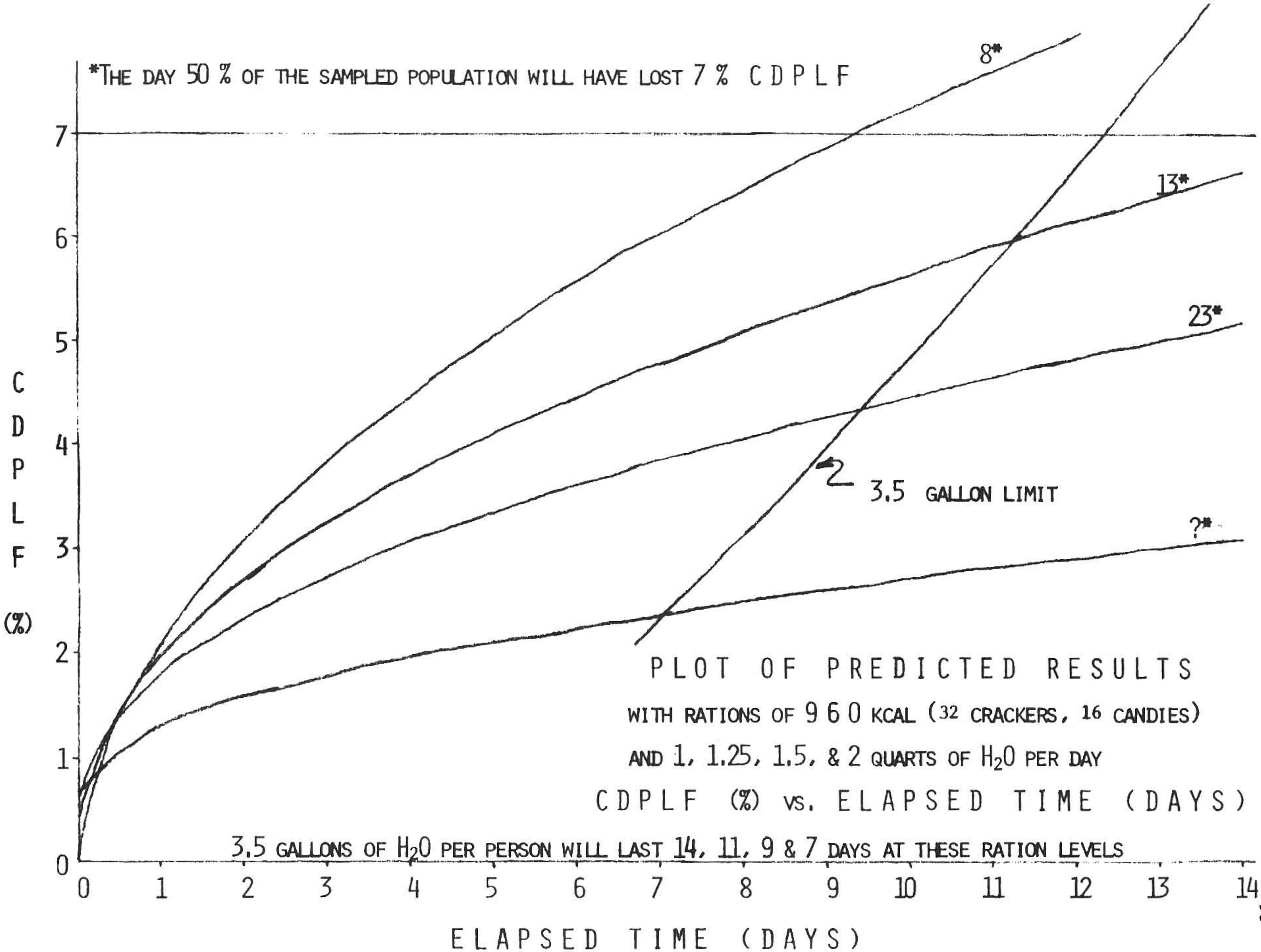
*THE DAY 50 % OF THE SAMPLED POPULATION WILL HAVE LOST 7 % CDPLF
8*
13*
23*
?*
3.5 GALLON LIMIT
PLOT OF PREDICTED RESULTS
WITH RATIONS OF 960 KCAL (32 CRACKERS, 16 CANDIES)
AND 1, 1.25, 1.5, & 2 QUARTS OF H2O PER DAY
CDPLF (%) VS. ELAPSED TIME (DAYS)
3.5 GALLONS OF H2O PER PERSON WILL LAST 14, 11, 9 & 7 DAYS AT THESE RATION LEVELS
C D P L F (%)
0
1
2
3
4
5
6
7
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
ELAPSED TIME (DAYS)

Figure 8

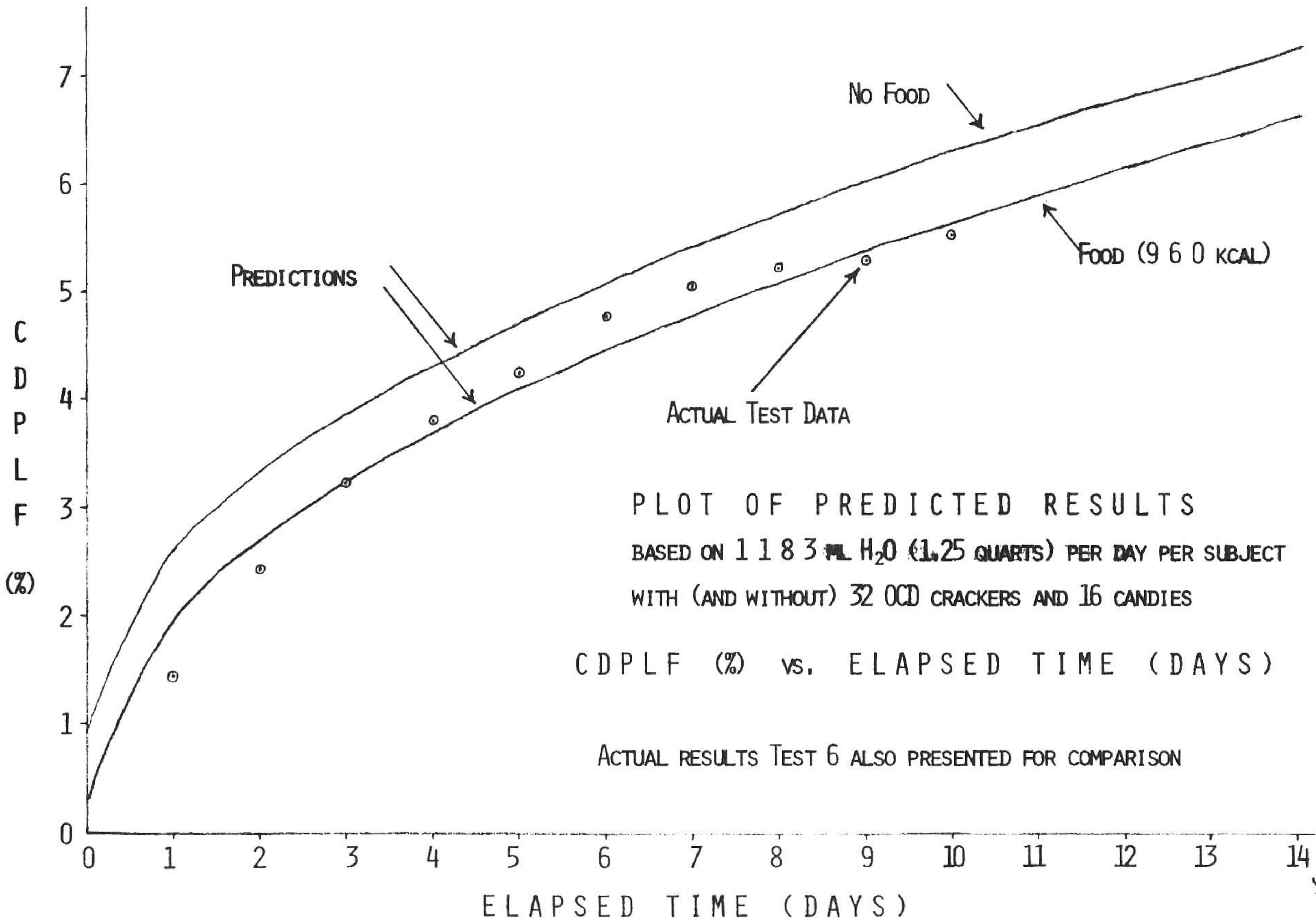
No Food
Food (9 6 0 kcal)
Predictions
Actual Test Data
PLOT OF PREDICTED RESULTS
based on 1 1 8 3 ml H_2O (1.25 quarts) per day per subject
with (and without) 32 OCD crackers and 16 candies
CDPLF (%) vs. ELAPSED TIME (DAYS)
Actual results Test 6 also presented for comparison
C D P L F (%)
0
1
2
3
4
5
6
7
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
ELAPSED TIME (DAYS)

Figure 9

ration, that with $1\frac{1}{4}$ quarts of water, the subjects will be able to eat the prescribed ration (32 crackers, 16 candies per day) if properly motivated. This is the diet (ration) recommended by this study.

SUMMARY

The body water pool loss model was developed on the basis of an engineering approach, and was found to correspond to the definition of the body water pool that is found in the physiological literature[16]. The primary basic assumptions which have been made are those concerning the metabolic energy production and its determination; the definition of "evaporation" as it is presented in this model; the assumption of catabolized tissue as being composed entirely of protein and fat in a constant ratio of these components, which are catabolized completely in a starvation situation; and the assumption that net oxygen consumption and carbon dioxide production can be calculated from the food eaten and the calculated amount of tissue that the subject catabolizes.

It is thought that the error in the calculation of metabolism is not great. This has been checked by altering the coefficient of the metabolism equation within the computer program to determine its effect on pool loss. Keys, et. al.[14] refer to the possibility that metabolic rate decreases during confinement in a starvation situation to an extent not entirely attributable to the decrease in weight of the subject. It appears difficult to verify this in this analysis, but it is felt that it would also be helpful to be able to make this assumption. However, this phenomenon has not been accounted for. Comparison of the evaporative losses in this model with predicted evaporative losses based wholly on heat transfer calculation are in relatively good agreement. There is no statistically significant difference between the predicted and the calculated values. The Nitrogen balance determination which was done as part of the nutrition study, has indicated that the estimate of 10% protein, 90% fat in catabolized tissue is in error. A better figure would have been

20% protein. This would increase the calculated body water pool loss, compared to the values shown. Time has not been available to include this refinement in this report. A sample calculation was made which showed the difference to be slight. The study of protein utilization does not show a difference between OCD I and II ration, but the OCD II ration used in test 6 received better acceptance than OCD I.

The physiological data fails to show by the normal indications of stress, that the level of dehydration that we have calculated is actually occuring. However, significant observations have been made regarding bilirubin and 17-Hydroxycorticosteroids. More work than is presented in this report has been done in this area, but it is not yet complete.

Psychological examinations made in this study tend to support the results of the model, and those of the physiological study. However, as was related by the psychologists, if better examination methods were available, or if they were devised specifically for this type of study, more definitive results could be obtained[23].

Referring to the specific purpose of this study, it can be concluded that (1) 1 quart of water per person per day is not adequate for a 14 day shelter occupancy, (2) 1¼ quarts of water per person per day combined with 960 kcal/day of OCD ration can be adequate for a 14 day term, and (3) that 1 quart of water per person per day might be enough for an 8 day term and that 3½ gallons of water per person together with the food ration would probably allow an 11 day occupancy.

The current recommendation of this study is a 960 kcal. diet, consisting of 32 of the OCD crackers and 16 of the carbohydrate supplements per subject per day with 1¼ quarts of water per subject per day. This is presented as a minimum acceptable ration of a 14 day shelter stay. Reference to Figure 8 indicates that two quarts of water per day with a 960 kcal diet would allow a 60 day stay for 50% of the sampled population to accumulate 7% CDPLF. This prediction assumes that CDPLF is linear with time beyond 28 days at the rate of 1.02%/14 days.

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PRIVATE COMMUNICATIONS

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28. Gronwall, R. Associate Professor of Physiological Sciences, Kansas State University

29. Clarenburg, R. Associate Professor of Physiological Sciences, Kansas State University

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APPENDIX A

AGREEMENT AND RELEASE

AGREEMENT AND RELEASE

1. I, ____

volunteer to participate in a project in connection with research studies to be conducted by Kansas State University.

2. I realize that participation may impose physical and/or mental stresses upon me and/or the other subjects. I believe that I am physically and mentally fit to withstand any such stresses.

3. I understand that I will be observed during by participation and that my conduct and/or voice may be recorded by photographic and/or recording devices. I may have attached to my person sensors to measure temperature, pulse, blood pressure, etc. I also realize that public reports and articles may be made of the experiments and all of the observations and I consent to publication of such, including the use of photographs.

4. I hereby authorize the Kansas State University to remove me from the evaluation exercise at any time and for any reason. I agree to leave said exercise willingly when asked to do so.

5. I understand that I will be permitted to leave the evaluation exercise at any time that I find that I am unable to withstand the conditions and request to be relieved, but, depending upon the nature of the experiment, I may forfeit compensation for previous participation.

6. As compensation for my voluntary services as a participant in the aforesaid studies, Kansas State University will pay me. It is clearly understood and agreed, however, that in no event am I to be considered an employee of Kansas State University during such participation. Therefore, no Social Security, income tax, retirement or other benefits of employment will be deducted or accrue.

7. I hereby agree, under penalty of forfeiture of all compensation due me, not to give information regarding these studies to any public news media nor to publicize any articles or other accounts thereof without prior written approval by Kansas State University.

I have signed the herein Agreement and Release, this ________________ day of ______________________, 19___.

____
Signature

State of Kansas

County of Riley

On the ____ day of ___________, 19___, before me personally came ____, to me known, and known to me to be the individual who executed the foregoing instrument, and duly acknowledged to me that he executed the same.

(Signed)_________________________________
Notary Public

My commission expires:__________________________
Date

APPENDIX B

GENERAL DAILY SCHEDULE

The following schedule outline is an example of the general procedure used in all of the tests. There were differences from test to test, but generally the procedures were similar. The first schedule is for pre-test procedures, from the time of recruitment, up to the time of the first day of the test. The second schedule is concerned with the first day of the test and the process of getting started into a routine. The third schedule is the general test schedule used during the tests, and the fourth schedule is that used for the last day of the test and for the follow-up procedures.

FIRST SCHEDULE

One week prior to the test, all subjects were given a physical examination. This process served as the initial screening and allowed selection of eight subjects for each age group as well as an alternate for each age group.

Three days prior to the beginning of the test, all subjects and alternates were called in for a briefing in which they were given essentially the same information as is shown in Appendix C under subject orientation information.

Two days prior to the test, all subjects and alternates were called in for the pre-test blood samples[23]. Psychological pre-test interviews were conducted at this time.

SECOND SCHEDULE
(Beginning of Test)

TIME	ACTIVITY DESCRIPTION	COMMENTS
0630	Subjects Arrive Test Room brought to Test Conditions Uniforms Distributed	
0645	Subjects asked to void prior to initial weighing	
0700	First Weight taken for all subjects Height, Blood Pressure, Oral Temperature, and Pulse observed of all subjects	--- Subjects attired in Standard Uniforms, empty pockets.
0730	Test Subjects admitted to Test Room Alternates Dismissed Subject Orientation Presented	

SECOND SCHEDULE
(continued)

TIME	ACTIVITY DESCRIPTION		COMMENTS
0800	First Meal dispensed	---	Carmine Capsules were given at this time to aid in following fecal material for nitrogen balance determination
0845	Meal and Food Evaluation completed		
0900	Additional Orientation Medical Histories reviewed		
0930	Blood Samples taken	---	Day 1, 4, 7, & 10 only (differs for each test)
1000	Saliva Samples taken		
1045	Blood Pressure, Oral Temperature, and Pulse observed for each subject.		
1100	Psychological Testing		
1145	Towelettes dispensed prior to meal.		
1200	Noon Meal dispensed		
1245	Meal and Food Evaluation completed		
1300	Psychological Testing		
1500	Blood Pressure, Oral Temperature, and Pulse observed for each subject		
1600	Saliva Samples taken		
1645	Towelettes dispensed prior to meal Physician makes rounds		
1700	Afternoon meal dispensed		
1745	Meal and Food Evaluation completed		
1900	Evening Weight taken		
1930	Saliva Samples taken, B/P, Temp, Pulse		
2055	Towelettes dispensed prior to meal		
2100	Evening Meal dispensed		
2145	Meal and Food Evaluation completed		
2400	Lights Out		

THIRD SCHEDULE

TIME	ACTIVITY DESCRIPTION	COMMENTS
0645	Lights On Subject asked to void prior to weigh-in Blood Pressure, Oral Temp., Pulse	
0700	Morning Weigh-in	
0755	Towelettes dispensed	
0800	First Meal dispensed	
0845	Meal and Food Evaluation completed	
0900	Psychological Testing	--- Not every day
0930	Blood Samples taken	--- Not every day
1000	Saliva Samples Taken	
1100	Blood Pressure, Oral Temp., Pulse	
1155	Towelettes dispensed	
1200	Noon Meal dispensed	
1245	Meal and Food Evaluation completed	--- Random Time, Subject Sequence
1300	Psychological Testing	--- Not every day
1500	Blood Pressure, Oral Temp., Pulse	
1600	Saliva Samples taken	
1655	Towelettes dispensed	
1700	Afternoon Meal dispensed	
1745	Meal and Food Evaluation completed	
1900	Evening Weight taken	
1930	Blood Pressure, Oral Temp., Pulse Saliva Samples taken	
2055	Towelettes dispensed	
2100	Evening Meal dispensed	
2145	Meal and Food Evaluation completed	
2400	Lights Out	

Note: On the day preceding the last full day of the test, an additional orientation session was held in the morning, for the purpose of impressing the aims of the test and their importance on the subjects.

FOURTH SCHEDULE
(End of Test)

TIME	ACTIVITY DESCRIPTION	COMMENTS
0645	Lights On Subjects asked to void prior to weigh-in Blood pressure, Oral Temp., Pulse	
0700	Morning Weigh-in	
0755	Towelettes dispensed	
0800	First Meal dispensed	
0845	Meal and Food Evaluation completed	
0900	Psychological Testing	
0930	Blood Samples taken	
1000	Saliva Samples taken	
1030	Subjects released from Test Room Test Room Conditions returned to Comfortable Range Subjects Fed (Orange Juice, Sweet Rolls, Coffee) Subjects sent to Health Center for Final Physical Examination Psychological Interviews conducted	
1130	Subjects Released	

APPENDIX E

Topic

Subject Card Information (Sample Card)

Subject Orientation Information (written)

Subject Orientation Information (oral outline)

Nurse Orientation Information

Monitor Orientation Information

Criteria for Removal of a Subject from the Test

Institute for Environmental Research
Subject Data Card

1. ____ 2. ______________
Last Name First Name Initial Date

3.Address ______________________________________ 4.Phone No. ______________

5.Height ____________ 6.Weight ____________ 7.Age ____________ 8.Sex ____________

9.Race ____________ 10. College and Class ______________________________

11.Job (if any) ________________ 12. Physical Factors and Activity ________________

____

____

13.Physical Exam ____

14.Residence last 5 years (City & State, Air Conditioned) ______________________

____

- -

Office Use Only:

15. IER Test Record ____

SUBJECT ORIENTATION INFORMATION

February 1970

The Office of Civil Defense has renewed a contract to the Institute for Environmental Research, Kansas State University to study the physiological effects of survival shelter environments. The present investigation, which constitutes the ________in a series is designed to measure human reactions under simulated survival shelter conditions.

This is the ________ in a series of ________ tests. Test I and test II use male subjects. Test III and test IV use female subjects and are five day tests. Test V and test VI use males and are for ten days. All subjects are to be volunteers who have passed a physical examination and have agreed to participate in the test to their fullest extent unless removed by sickness or unforeseen emergency.

A registered nurse is on duty at all times and a doctor is on call. The subjects who are selected will be furnished a uniform consisting of a shirt, trousers and socks. They will provide their own shorts, shoes, halter tops, etc. Books, writing materials, magazines, etc., should be brought to the test room beforehand, as once the room is entered, subjects will not be allowed to leave until the test is terminated. This test will take ________ days and nights. During this period, the subjects will eat, sleep and live in the test room.

The temperature in the room will be ____°F and _____% relative humidity throughout the ________ day period. The subjects will be given survival rations amounting to 960 calories per day. Drinking water will be provided (________ quarts) to each subject for each 24 hour period. All urine and feces will be collected and given to the nurse. No bathing or toothbrushing facilities will be available. A portable toilet will be furnished in the test room.

No cosmetics or other articles with possible food value will be allowed in the test room. No water will be used for washing, however at mealtime we will dispense towelettes to each subject for washing hands before eating.

From time to time, you will have some duties to perform such as sweeping, making beds, straightening furniture, etc. and participating in group discussions.

Blood samples will be taken periodically, the first, two days before the test at 0900 hours, once at the start of the test and periodically during the test and again upon completion of the test. Oral temperature, blood pressure and pulse will be taken periodically throughout the test and weights will be taken twice daily.

Subjects will not eat breakfast previous to entering the test room, the morning the test begins.

All subjects who successfully complete the tests, that is, spend ________ days in the test room and cooperate in the test will receive $__________. A reasonable bonus will be paid for your time spent in orientation and physical examinations. Anyone leaving the test voluntarily will receive no pay whatsoever, persons who are removed because of sickness or emergency will be paid according to the length of time they have spent in the test room. It is imperative that you understand fully all of the conditions of the test before volunteering to participate. Once an individual is assigned for a test, it is assumed that he is fully aware of the test conditions and is willing to participate in the test for the full __________ day period. Only with complete cooperation can the test be successful. The conditions of this test are stressful and will impinge to a certain degree upon your personal privacy and complete awareness of these facts is imperative before volunteering.

Upon conclusion of the test, subjects will be given a carmine dye capsule, plus containers for bringing in fecal samples after the test. These samples must be brought in until you are told to stop by Mr. Corn, when the dye (red) begins to show in your feces. This is a vital part of the test and must be complied with before payrolls can be submitted.

ORAL ORIENTATION

(Information given when subjects enter room)

1. Stipend agreement
2. Important to cooperate, test very expensive.
3. Nurse in charge of your health 24 hrs. a day. A physician is on call at all times.
4. Problems of a personal nature should be brought to the attention of the nurse or test monitor.
5. Each person's personal hygiene, bunk area, etc., is his own responsibility. Clothing may be adjusted according to your own needs within the limits of decency.
6. No shaving or toothbrushing facilities are available, the only shaving will be upon the authority of the physician for medical reasons if any.
7. Foul language will not be tolerated at any time.
8. Room cleanliness is to be worked out by you as a group, however a good level of order and cleanliness is expected.
9. There will be adequate time for leisure and recreation - including TV. These activities will be regulated by you as a group. Again, reasonableness of these activities is expected.
10. During certain periods you will be asked to engage in some ordered activity, which will take precedence over recreation.
11. There will be a mandatory lights out period from midnight to 0645 each night. However, if there is a movie on which all persons want to see, the nurse may approve extension of the lights out time.
12. Any unruly activity which is not controlled can result in forfeiture of pay.
13. Do not touch any measuring equipment in the test room.
14. Select your bunks in any way you choose.
15. Any questions?

NURSES

1. Take weights before breakfast in the morning. Subjects must try to void first. The second weight is to be taken 12 hours after the first weight.

2. Blood pressure, pulse and temps. are to be taken every 4 hours during the lights on period. Use discretion during lights out. Keep the patient's peace of mind and his physical condition in mind.

3. The following criteria for removal are guidelines. Anything in excess of these limits constitutes grounds for removing the subject from the test.

PARAMETER	UPPER LIMIT*
Body Temperature (Oral)	Increase of 2°F above pretest level
Pulse Rate	180 Beats/min.
Blood Pressure - Systolic	160 MM Hg.
Diastolic	20 MM Hg.
Water Weight Loss	5% of pretest body weight (Leithead & Lind)
Illness	Clinical judgement - Nurse & Physician
Exhaustion	Clinical judgement - Nurse & Physician

*Exceeding this limit constitutes grounds for removing the subject from the test.

4. The Nurses are responsible for overseeing the help but command still remains with the Research Assistant in charge. Any questions concerning food handling should be directed to Miss Beatrice Finkelstein if possible. Questions about the health of the subjects in the tests are to be resolved by the doctor on call and your own professional training. Questions concerning the logistics of the experiments such as data, equipment, etc., should be directed to the Research Assistant in charge.

PROCEDURE

1. 0630 - Subjects arrive
2. Have subjects dress in standard uniform
3. Weigh subjects, check heights, temperature and pulse
4. Blood samples
5. Dye capsules
6. 0700 - Subjects into test room
7. Nurse instruct all subject that they must bring in Fecal samples after the test until the Carmine dye shows in Feces prior to being paid.

The pretest room and data collection areas should appear neat and orderly at all times.

There are always a few details which pass us by while setting up an experiment as complicated as this. Through casual conversation and observation these are usually corrected. Feel free to ask questions at any time.

NOTES

Nurses - Should ask each subject what their age is at the initial weigh-in and mark it on the weight chart. Heights should also be taken and recorded at this time.

Take weights at the same time each day corresponding to the initial weigh-in time and other weights as required by other researchers.

Note date and time on any data taken on any subject - put birth date on your file cards.

ACTIVITIES

1. Use of toilet
2. Label Cups

   Note: Urine, feces and pads must each be placed in separate cups. Notify helper to remove samples immediately.

3. Weight of subjects

   Note: Must have tried to void first
   Must have same clothing as at initial weight
   Sensitivity of scale.

4. No breakfast before test
5. Breakfast 0800 hrs.
6. All time will be recorded as military time on the 24 hour clock.
7. Any leftover food will be weighed and recorded.
8. Meals - Breakfast 0800 Lunch 1200 Dinner 1700 Snack 2100

POSITION: Data Collector

Hours: Continuous Coverage, 24 hours/day

GENERAL: The duties of the Data Collector shall include the following:

a. Issuance of containers to the subjects for urine and feces collection.
b. Responsibility for collection of the containers immediately after use by a subject and issuance of a clean replacement.
c. Measurement of the volume of urine voided and the weight of the feces deposited by each subject. Record values, weight and time.
d. Preparation of sample vials of each urine specimen for analysis by the Physiology Department.
e. Collection of a 24 hours total urine sample and all fecal matter from four pre-designated subjects for analysis by the Foods and Nutrition Department.
f. Act as general assistant to the nurse and perform any other assigned duties in connection with data collection, logging, etc.
g. Assist with special needs of the test such as condition of the room, T.V., etc.

Urine 24 hour collection - Change to the next days bottles after A.M. weight.

SPECIFIC DUTIES:

1. Urine Samples:

a. Check to insure that subject has recorded his identification number, the date, and the time on the container label.
b. By checking the individual's data sheet, assign and record a three position sample number to each specimen.

First Position:	Subject's Identification Number
Second Position:	"U" - indicating urine sample
Third Position:	The next consecutive number in the "U" series

c. Measure and record the total urine volume. (take out 10%)
d. After urine volume is determined, place a stopper in the graduated cylinder and shake urine 25 times before taking 5cc urine sample.
e. From the total urine volume, pour approximately 5 ml into a small plastic vial. Using a felt marking pen, write the three position sample number on the vial which should then be stored in the refrigerator.

2. Feces:

a. Check container label to insure that the subject has recorded his identification number, the date and the time.
b. Assign a three position sample number to each sample.

First Position:	Subject Identification Number
Second Position:	"F" - indicating fecal sample
Third Position:	The next consecutive number in the "F" series

c. Weigh the fecal sample and record the weight on the individual's data sheet.

3. Period Discharge Pads:

a. Weigh a group of 4 to 5 pads to get an average weight. Indicate this value at top of data sheet.
b. By checking the subject's data sheet, assign and record a three position sample number to each specimen.
c. After recording weight on data sheet, the pads can be disposed of.

4. At the end of each 24 hours period, the Data Collector will record each individual's total urine output volume and total feces weight for that day.

5. Also at the end of each 24 hour period, a 50 ml sample of the total urine output from the special subjects will be prepared for pickup by the Foods & Nutrition Department. The remainder of the 24 hour sample can be disposed of. Each 50 ml sample should have on its label the subject's name and the date.

6. If, at the end of a 24 hour period a subject has not had a bowel movement, his individual data sheet should have an appropriate entry in the remarks column.

7. In addition to the duties outlined above, the Data Collector should also assist the Chamber Nurse.

8. Keep accumulated trash picked up and carried out.

CRITERIA FOR REMOVING A SUBJECT FROM A TEST†

PARAMETER	UPPER LIMITS*
Temperature (Oral)	101.5°F
Pulse Rate	180 Beats/minute
Blood Pressure	
Systolic	160 MM HG
Diastolic	20 MM HG
Water Weight Loss**	5% of Pretest Body Weight (Clinical Judgement-Physician)
Illness	Clinical Judgement Nurse and Physician
Exhaustion	Clinical Judgement Nurse and Physician

*Exceeding this limit constitutes grounds for removing the subject from the test for medical reasons.

**Subjects were permitted losses in excess of 5% if the physician approved.

†Based partly on information from Leithead and Lind (1964) and partly on medical recommendations.

APPENDIX D

STATISTICAL DISCUSSION

STATISTICAL DISCUSSION

Observation of Figure 6 indicates that CDPLF is not a linear function of time. To test this hypothesis, a Least Significant Difference test was run on the derivative of this curve for each test. H_o (The slope of the line is constant, given that the daily variances are equal) vs. H_a (Not H_o). This hypothesis was rejected for all tests, with the probability of rejecting a true hypothesis of less than 0.0005. Bartlett's test indicates that the variances are marginally homogeneous, yet it is known that the LSD test is very powerful even when the variances are relatively inhomogeneous. The results of the LSD test indicate that in fact the response is not linear.

Regarding the derivation of the statement about the time required for 50% of the sampled population to reach 7% CDPLF, the basis follows: the physician who performed our physical examinations stated that about 80% of the general population would be able to pass the exam required for participation in the tests. Conservatively considering both men and women, about 84% of the subjects were able to complete the tests. The test subjects who completed the tests then represent about 67% of the general population (80% of 84% = 67%). For a given regression line based on a given ration, 50% of the test subjects will perform within $\pm$ 0.67 x (Standard Error of the Estimate) at any given time. Twenty-five percent of the subjects will perform better than this, and for them, there is no cause for concern. Twenty-five percent will perform worse than the mean prediction + 0.67 x (S.E.E.). This then indicates that 75% of the subjects tested will lose less than the mean prediction + 0.67 x (S.E.E.), at any chosen time. If the tested group represents 67% of the general population, then 75% of 67% = 50% of the general population.

The regression equation is presented in Table III. Leithead and Lind[36] present pool loss as a fraction of initial body weight. To compare the results of this study with their data, this same relation (CDPLF) has been used. Values of the independent variables in the regression equation can be determined from: the caloric value of a daily food ration composed of OCD crackers and OCD carbohydrate supplements; the amount of the daily water ration; and the average weight of the individuals to be submitted to the test. These values then allow prediction of the CDPLF response.

If the water pool change is presented as a fraction of subject initial weight, it seems reasonable to present the water and food inputs either as a fraction of the body weight (i.e. - "normalized" to individual subject initial weight), or as some function of it. Common sense indicates that the more water a subject drinks, the less the body pool will decrease. This also applies (albeit somewhat less directly) to food. Much has been written about the deleterious effect of high protein diets with cabric values less than 900 kcals, on water pool maintenance[5,6,7,10,14,16,20,27]. Dimensional analysis suggests that the caloric value of food should be normalized to metabolic rate. The terms included, in the regression equation, indicate normalization of: Water input rate to Subject Weight; Water input rate to Subject Metabolic Rate; rate of energy production from food consumed to metabolic rate; the product of some of the relationships with a time function; the reciprocals of some terms; and a time function alone. It seems that CDPLF should be directly proportional to some function of time, inversely proportional or directly proportional to the negative of some function of food consumption. This normalization allows the comparison of subjects on a common basis.

The statistical model was developed by including all reasonable combinations of the variables. A better model could probably be derived from a differential analysis of the change in pool, but continuous monitoring of data could not be performed within the scope of the project. With a differential model, a functional relationship could probably be developed which might point to either an exponential or an asymptotic response. Further tests might indicate a time factor in the response to food.

APPENDIX E

COMPUTER PROGRAM AND COMPUTER SUMMARIES

```
$JOB            JMR,RUN=FREE,TIME=1C,PAGES=300
C     SURVIVAL WATER REQUIREMENTS     OCD CONTRACT DAHC20-68-C-0173
C     THIS DATA ANALYSIS SYSTEM DEVELOPED BY JON M. RUECK
C
C     DEFINITION OF CONTROL PARAMETERS
C
C
C     NTEST   =  TEST NUMBER IN SEQUENCE - RELATED TO DATE OF TEST
C     NSUBS   =  NUMBER OF SUBJECTS STARTING THE TEST
C     NTDAYS  =  DURATION OF TEST (DAYS).
C
C     DIRECT  =  EXTERNAL PROGRAM FLOW GUIDE.
C
C     WTUNIT  =  INDICATOR OF UNITS OF SUBJECT WT IN TEST  1-KG,  2-LB.
C     SEX     =  INDICATOR OF SUBJECT SEX IN TEST.  1-MALE,  2-FEMALE.
C
C     EXM     =  EXPONENT USED ON WT IN METABOLIC RATE EQUATION.
C     METAB   =  AVERAGE METABOLIC RATE (BTU/HR) OF AVG. SUB. IN NTEST.
C
C
C     MPCRM   =  MEAN MASS OF SURVIVAL CRACKER
C      CRFP   =  DRY BASIS CRACKER MASS FRACTION DIGESTABLE PROTEIN
C      CRFF   =  DRY BASIS CRACKER MASS FRACTION DIGESTABLE FAT
C      CRFC   =  DRY BASIS CRACKER MASS FRACTION DIGESTABLE CARBOHYDRATE
C     CRFH2C  =  H2O MASS FRACTION OF SURVIVAL CRACKER
C
C     MPCNM   =  MEAN MASS OF SURVIVAL CANDY
C      CNFC   =  DRY BASIS CANDY MASS FRACTION DIGESTABLE CARBOHYDRATE
C     CNFH2C  =  H2O MASS FRACTION OF SURVIVAL CANDY
C
C     TSFF    =  MASS FRACTION OF METABOLIZED TISSUE WHICH IS FAT.
C
C     CODP    =  COEFFICIENT OF DIGESTION OF PROTEIN
C     CODF    =  COEFFICIENT OF DIGESTION OF FAT
C     CODC    =  COEFFICIENT OF DIGESTION OF CARBOHYDRATE
C
C     FVP     =  FUEL VALUE (BOMB CALORIMETER) OF PROTEIN
C     FVF     =  FUEL VALUE (BOMB CALORIMETER) OF FAT
C     FVC     =  FUEL VALUE (BOMB CALORIMETER) OF CARBOHYDRATE
C
C     AMETP   =  WATER PRODUCED UPON METABOLISM OF 1 GM OF PROTEIN
C     AMETF   =  WATER PRODUCED UPON METABOLISM OF 1 GM OF FAT
C     AMETC   =  WATER PRODUCED UPON METABOLISM OF 1 GM OF CARBOHYDRATE
C
C     GMO2P   =  OXYGEN CONSUMED BY METABOLISM OF 1 GM OF PROTEIN
C     GMO2F   =  OXYGEN CONSUMED BY METABOLISM OF 1 GM OF FAT
C     GMO2C   =  OXYGEN CONSUMED BY METABOLISM OF 1 GM OF CARBOHYDRATE
C     GMCO2P  =  CO2 PRODUCED BY METABOLISM OF 1 GM OF PROTEIN
C     GMCO2F  =  CO2 PRODUCED BY METABOLISM OF 1 GM OF FAT
C     GMCO2C  =  CO2 PRODUCED BY METABOLISM OF 1 GM OF CARBOHYDRATE
C
C     SPGURO  =  SPECIFIC GRAVITY OF URINE (OVERALL SUBJECT AVERAGE)
C
C     URFH2C  =  MASS FRACTION OF H20 IN URINE (NTEST AVERAGE)
C     FEFH2C  =  MASS FRACTION OF H20 IN FECES (NTEST AVERAGE)
C     MSFH2O  =  MASS FRACTION OF H20 IN MENSES(NTEST AVERAGE)
C     VOFH2C  =  MASS FRACTION OF H20 IN VOMIT (NTEST AVERAGE)
C
C
C
```

```
C
C
C     DEFINITION  AND/OR DESCRIPTION OF OBSERVED VARIABLES
C
C
C     WTI      =  SUBJECT WT AT START OF A GIVEN DAY
C     WTM      =  SUBJECT WT AT MIDDLE OF A GIVEN DAY
C     WTF      =  SUBJECT WT AT END OF A GIVEN DAY
C     VH2OI    =  VOLUME OF WATER DRUNK IN A GIVEN DAY
C     FCUI     =  NUMBER OF TOTAL FOOD UNITS (CRACKERS+CANDIES)/DAY
C     CANDY    =  NUMBER OF SURVIVAL CANDIES EATEN/DAY
C     VURO     =  VOLUME OF URINE VOIDED/DAY
C     MFECO    =  MASS OF FECES EXCRETED/DAY
C     MENSES   =  MASS OF MENSTRUAL FLOW/DAY
C     VOMIT    =  MASS OF VOMIT EXPELLED/DAY
C     SBNMAG   =  NAME AND AGE OF SUBJECT AT TIME OF TEST
C
C
C
C
C     DESCRIPTION OF VARIABLES CALCULATED WITHIN THIS PROGRAM
C
C
C     WM       =  AVERAGE WT OF A SUBJECT DURING A GIVEN DAY
C     DWTM     =  WT CHANGE OF A SUBJECT DURING A TIME PERIOD
C     QMETM    =  METABOLIC ENERGY RATE (KCAL/DAY)
C
C     OTHER VARIABLES ARE DESCRIBED IN THE PROGRAM AND IN THE REPORT
C     WHICH ACCOMPANIES THIS PROGRAM.
C-----------------------------------------------------------------------
C
C     *****      INPUT CARD SEQUENCE      *****
C
C   ***   $ENTRY STARTING IN COLUMN 1     ***
CAVERAGE SUBJECT CUM AVG SUBJECT                     FIRST CARD
C     ***   COMMUNAL URINE FOR TEST 3 .  ***         SECOND CARD
C   ***   IDENTIFICATION AND CONTROL PARAMETERS   ***  THIRD CARD
C   ***   ID & CONTROL    ***                        FOURTH CARD
C   ***   ID & CONTROL    ***                        FIFTH CARD
C   ***   COMMENTS   ***                             SIXTH CARD
C   ***   MORE COMMENTS THROUGH COLUMN 68    ***     SEVENTH CARD
C
C     *****      SUBJECT DATA DECK      *****
C
C
C
C   ***   BLANK CARD   ***                           FIRST END CARD
C   ***   BLANK CARD   ***                           SECOND END CARD
C   ***   99 IN COLUMNS 1 & 2   ***                  THIRD END CARD
C   ***   BLANK CARD   ***                           FOURTH END CARD
C   ***   BLANK CARD   ***                           FIFTH END CARDD
C   ***   $STOP STARTING IN COLUMN 1    ***          SIXTH END CARD
C
C
C   ***   $STOP STARTING IN COLUMN 1    ***
C   ***   /* STARTING IN COLUMN 1    ***
C
C-----------------------------------------------------------------------
C
C
```

```
C
C
C     THE FOLLOWING TABLE EXPLAINS THE USE OF THE PROGRAM DIRECTOR VAR-
C     IABLE   "DIRECT."
C
C          NEAR THE BEGINNING OF THE PROGRAM (STATEMENT #2) IS AN IF
C          STATEMENT WHICH DETERMINES WHETHER NEW INPUT DATA SHALL BE:
C               A)  READ AND WRITTEN, OR
C               B)  READ ONLY, OR
C               C)  IGNORED AND THE FOLLOWING CALCULATIONS DONE ON DATA
C                   WHICH HAS BEEN PREVIOUSLY READ IN.
C
C          JUST BEFORE STATEMENT # 21 IT IS POSSIBLE TO CHOOSE WHETHER
C          TO:
C               P)  PRINT INDIVIDUAL SUBJECT DAILY SUMMARIES, OR
C               S)  DO NOT PRINT THESE SUMMARIES.
C
C          IN THE SUBROUTINE "TREAT", IT IS POSSIBLE TO CHOOSE IF:
C               1)  ALL MEANS ARE CALCULATED, OR
C               2)  INDIVIDUAL MEANS ARE CALCULATED, OR
C               3)  MEAN & SUM COLUMNS ARE SET = ZERO.
C
C
C     -PRINT INDIVIDUAL DAILY SUMMARIES-
C
C                    READ   AND        READ DATA        CONTINUE WITH
C                    WRITE DATA          ONLY             PAST DATA
C
C     CALCULATE
C     ALL MEANS       DIRECT=0          DIRECT=1          DIRECT=2
C
C     CALCULATE
C     INDIVIDUAL      DIRECT=3          DIRECT=4          DIRECT=5
C     MEANS ONLY
C
C     SET ALL
C     MEAN & SUM      DIRECT=6          DIRECT=7          DIRECT=8
C     COLUMNS TO
C         ZERO
C
C
C
C     -DO NOT PRINT INDIVIDUAL DAILY SUMMARIES-
C
C                    READ   AND        READ DATA        CONTINUE WITH
C                    WRITE DATA          ONLY             PAST DATA
C
C     CALCULATE
C     ALL MEANS       DIRECT=9          DIRECT=10         DIRECT=11
C
C     CALCULATE
C     INDIVIDUAL      DIRECT=12         DIRECT=13         DIRECT=14
C     MEANS ONLY
C
C     SET ALL
C     MEAN & SUM      DIRECT=15         DIRECT=16         DIRECT=17
C     COLUMNS TO
C        ZERO
C
C
```

```
1       199 FORMAT(3(I2,1X),F3.0,2X,16I2,9X,3F5.0,2X,2I1,2(1X,I2))              OCDW1790
2       198 FORMAT(15F5.0)                                                       OCDW1800
3       197 FORMAT(3I2,3F7.0,F6.0,F5.0,F3.0,1X,4F5.0,2X,4A4)                     OCDW1810
4       499 FORMAT(1H1)                                                          OCDW1820
5       498 FORMAT(1H-)                                                          OCDW1830
6       497 FORMAT(1H0)                                                          OCDW1840
7       496 FORMAT(1H )                                                          OCDW1850
8       196 FORMAT(20A4)                                                         OCDW1860
9       195 FORMAT(1H-,/,33A4,/,33A4,/)                                          OCDW1870
10      189 FORMAT(1H1,///,T2,'WATER REQUIREMENT DATA PRESENTATION --- OCD CONOCDW1880
           1TRACT DAHC20-68-C-0173 --- TEST NUMBER ',I2,'.  --  ',I2,    ' SUBOCDW1890
           2JECTS FOR ',I2,' DAYS.',//,T2,F3.0,' OF THE ',I2,' SUBJECTS COMPLEOCDW1900
           3TED THIS TEST. ',//,          T2,'THE UNITS OF INPUT SUBJECT WEIGHT OCDW1910
           3ARE ',3A4,//,T2,'THE AVERAGE SUBJECT IS ASSUMED TO BE A ',4A4,', WOCDW1920
           4ITH AN AVERAGE METABOLIC RATE OF ',F4.0,' BTU/HOUR.',/,T2,'THE ABOOCDW1930
           5VE METABOLIC RATE MIGHT ALSO BE EXPRESSED AS ',F6.0,' BTU/DAY OR 'OCDW1940
           6,F5.0,' KILOCALORIES/DAY.',/,T2,'KLEIBERS LAW IS USED TO DETERMINEOCDW1950
           7 METABOLIC RATE, USING AN EXPONENT OF ',F5.3,///,                OCDW1960
           9T2,'FOOD DATA',/,T12,'SURVIVAL CRACKER: TOTAL MASS =',F6.0,' GRAMSOCDW1970
           A.  MOISTURE FRACTION =',F7.4,'.',/,T22,'DRY BASIS FRACTIONAL COMPOOCDW1980
           1SITIONS HAVE BEEN FOUND TO BE:  PROTEIN (',F5.3,')    FAT(',F5.3,')OCDW1990
           2   CARBOHYDRATE (',F5.3,').',/,T12,'SURVIVAL CANDY: TOTAL MASS =',OCDW2000
           3F6.3,' GRAMS.  MOISTURE FRACTION =',F7.4,'.')                      OCDW2010
11     1891 FORMAT(1H ,T22,                                  'DRY BASIS FRACOCDW2020
           4TIONAL COMPOSITIONS HAVE BEEN FOUND TO BE:  CARBOHYDRATE (',F5.3,'OCDW2030
           5).',/,T12,'IN BOTH CRACKERS AND CANDY THERE IS SOME ASH.',//,T2,'MOCDW2040
           6OST SUBJECTS METABOLIZED TISSUE.  FOR MASS DETERMINATIONS, THIS TIOCDW2050
           7SSUE HAS BEEN ASSUMED TO BE ',F4.2,' FAT, THE REMAINDER PROTEIN.',OCDW2060
           8///,                                                             OCDW2070
           9                                                                 OCDW2080
           BT2,'SEVERAL METABOLIC PARAMETERS FOR:  PROTEIN, FAT AND CARBOHYDRAOCDW2090
           1TE',/,T5,'COEFFICIENT OF DIGESTION      ',F8.2,F9.2,F12.2,/,T5,'FUELOCDW2100
           2 VALUE          (KCAL/GRAM)',F9.3,F9.3,F12.3,/,T5,'OXYGEN REQUIRED  (OCDW2110
           3GRAM/GRAM)',F9.3,F9.3,F12.3,/,T5,'CO2 PRODUCED      (GRAM/GRAM)',F9OCDW2120
           4.3,F9.3,F12.3,/,T5,'WATER PRODUCED    (GRAM/GRAM)',2F9.3,F12.3,///,OCDW2130
           5T2,'ASSUMED VALUES FOR EXCRETED MATERIALS:',/,T5,'SPECIFIC GRAVITYOCDW2140
           6 OF URINE =',F6.3,' AND ITS WATER MASS FRACTION IS',F6.3,/,T5,'THEOCDW2150
           7 WATER MASS FRACTION OF FECES =',F6.3,/,T5,'THE WATER MASS FRACTIOOCDW2160
           8N OF MENSES =',F6.3,/,T5,'THE WATER MASS FRACTION OF VOMIT =',F6.3OCDW2170
           9,///,    T2,'THIS IS RUN NUMBER ',I2,//)                         OCDW2180
      C                                                                      OCDW2190
      C                                                                      OCDW2200
      C                                                                      OCDW2210
12      188 FORMAT(1H1,///,T3,'T S D   INIT     EVE     END  VH2OI FDUI CANDY VUOCDW2220
           1RO MFECO MENSES VOMIT NAME & AGE'/)                              OCDW2230
      C                                                                      OCDW2240
      C                                                                      OCDW2250
      C                                                                      OCDW2260
13      187 FORMAT(1H0,3I2,F8.3,2F7.3,F6.0,F5.2,F6.2,F6.1,F5.0,F7.1,F6.1,1X,4AOCDW2270
           14)                                                               OCDW2280
      C                                                                      OCDW2290
      C                                                                      OCDW2300
      C                                                                      OCDW2310
      C                                                                      OCDW2320
      C                                                                      OCDW2330
      C                                                                      OCDW2340
      C                                                                      OCDW2350
      C                                                                      OCDW2360
      C                                                                      OCDW2370
      C                                                                      OCDW2380
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 14       186 FORMAT(1H1,///,T2,'TEST NUMBER ',I2,'.   DATA FROM ',4A4,'.  SPECIOCDW2390
             1AL NOTES: ',16A4,/,48X,21A4,//,T2,'VARIABLE NAME (UNITS) DAY 1  DAOCDW2400
             2Y 2  DAY 3  DAY 4  DAY 5  DAY 6  DAY 7  DAY 8  DAY 9 DAY 10 DAY 11OCDW2410
             3 DAY 12 DAY 13 DAY 14   MEAN   SUM',//,T2,'-----INPUT DATA-----') OCDW2420
 15      1861 FORMAT(1H ,T2,'INITIAL WEIGHT  (KG)',(15(-3PF7.2)),/,T2,'EVENING WOCDW2430
             1EIGHT  (KG)',(15(-3PF7.2)),/,T2,'FINAL WEIGHT    (KG)',(15(-3PF7.2OCDW2440
             2)),//,T2,'WATER CONSUMED  (ML)',(16(0PF7.0)),/,T2,'FOOD UNITS EATEOCDW2450
             3N (#)',(16(0PF7.2)),/,T2,'CANDY BITS EATEN (#)',(16(0PF7.2)),/,T2,OCDW2460
             4'URINE VOIDED    (ML)',(16(0PF7.0)),/,T2,'FECES VOIDED    (GM)',(1OCDW2470
             56(0PF7.0)),/,T2,'MENSES VOIDED   (GM)',(16(0PF7.0)),/,T2,'VOMITUS OCDW2480
             6VOIDED  (GM)',(16(0PF7.0)),//,T2,'-CALCULATED RESULTS-',/,T2,'AVEROCDW2490
             7AGE WEIGHT  (KG)',(15(-3PF7.2)),/,T2,'WEIGHT CHANGE    (%)',(16(0POCDW2500
             8F7.2)),/,T2,'WEIGHT CHANGE    (GM)',(16(0PF7.0)),/,T2,'METABOLISM(KOCDW2510
             9CAL/DAY)',(16(0PF7.0)),/,T2,'METABOLISM(BTU/HOUR)',(16(0PF7.0)),/,OCDW2520
             AT2,'RESPIRATORY QUOTIENT',(15(0PF7.2)),//,T2,'OVERALL MASS BALANCEOCDW2530
             1',/,T2,'FOOD    MASS IN (GM)',(16(0PF7.0)),/,T2,'WATER   MASS IN (OCDW2540
             2GM)',(16(0PF7.0)),/,T2,'OXYGEN  MASS IN (GM)',(16(0PF7.0)))       OCDW2550
 16      1862 FORMAT(1H ,T2,'URINE  MASS OUT (GM)',(16F7.0),/,T2,'FECES  MASS OUOCDW2560
             1T (GM)',(16F7.0),/,T2,'MENSES MASS OUT (GM)',(16F7.0),/,T2,'VOMIT OCDW2570
             2 MASS OUT (GM)',(16F7.0),/,T2,'CO2    MASS OUT (GM)',(16F7.0),//,TOCDW2580
             32,'ENERGY SOURCES (KCAL)',/,T3,'FOOD METABOLIZED',3X,16F7.0,/,T3,'OCDW2590
             4TISSUE METABOLIZED ',(16F7.0),/,T2,'MASS OF TISSUE  (GM)',(16F7.0)OCDW2600
             5,//,T2,'WATER BALANCE   (GM)',/,T2,'IN: FOOD METABOLISM ',(16F7.0)OCDW2610
             6,/,T4,'TISSUE METABOLISM ',(16F7.0),/,T3,'WATER+FOOD MOISTURE',(16OCDW2620
             7F7.0),/,T2,'OUT: WITH URINE',5X,(16F7.0),/,T7,'WITH FECES',5X,(16FOCDW2630
             87.0),/,T7,'WITH MENSES',4X,(16F7.0),/,T7,'WITH VOMITUS',3X,(16F7.0OCDW2640
             9),/,T4,'BY EVAPORATION',4X,(16F7.0),//,T2,'CHANGE OF WATER POOL',/OCDW2650
             A,T7,'(GRAMS)',8X,(16F7.0),/,T6,'(POUNDS.)',7X,(16F7.2),/,T5,'(PER OCDW2660
             1CENT)',7X,(16F7.2))                                               OCDW2670
 17       185 FORMAT(1H1,///,T2,'TESTSUB NO.',2I2, '.  DATA FROM ',4A4,'.  SPECIOCDW2680
             1AL NOTES: ',16A4,/,48X,21A4,//,T2,'VARIABLE NAME (UNITS) DAY 1  DAOCDW2690
             2Y 2  DAY 3  DAY 4  DAY 5  DAY 6  DAY 7  DAY 8  DAY 9 DAY 10 DAY 11OCDW2700
             3 DAY 12 DAY 13 DAY 14   MEAN   SUM',//,T2,'-----INPUT DATA-----') OCDW2710
 18       184 FORMAT(1H0,3I2,5F10.1,F10.5,F10.1,/,I3,2I2,7F10.1,/,I3,2I2,7F10.1,OCDW2720
             1/,I3,2I2,3F10.0,2F10.5,2F10.7,/,I3,2I2,2F10.7)                    OCDW2730
       C                                                                        OCDW2740
 19           REAL METAB,MPCRM,MPCNM,MSFH2C,MUROM,MUROB,MFECOB,MENSOB,MVOMTB,MFOOCDW2750
             1ODM,MFCODB,MH2OIM,MH2OIB,MFECO,MTISMM,MTISMB,MENSES,NAMWTI(6)/'KILOCDW2760
             2O','GRAM','S   ','POUN','DS  ',' '/,                        SUBXM(OCDW2770
             32)/72.576E0,72.576E0/,SBTYP(8)/'160 ','LB. ','MALE',' ','140 ','LBOCDW2780
             4. ','FEMA','LE  '/,METABM,METABB,NWM,NMFCOD,NMH2OI,NMTISM,NAVAPM  OCDW2790
 20           INTEGER ONE/1/,TWO/2/,THREE/3/,FOUR/4/,FIVE/5/                    OCDW2800
       C                                                                        OCDW2810
 21           DIMENSION WTI(20,20),WTM(20,20),WTF(20,20),VH2OI(20,20),FDUI(20,2OCDW2820
             2),CANDY(20,20),VURO(20,20),MFECO(20,20),MENSES(20,20),VOMIT(20,20)OCDW2830
             3,SBNMAG(20,4),COMENT(37),GMO2(20,20),GMCO2(20,20),RQ(20,20),AVAPM(OCDW2840
             420,20),DPOOLM(20,20),DPOOLF(20,20),EAFIM(20,20),APOOLM(20),PDWTFT(OCDW2850
             520),QMETM(20,20),WM(20,20),DWTM(20,20),PDWT(20,20),MFOODM(20,20),MOCDW2860
             6H2OIM(20,20),MUROM(20,20),MTISMM(20,20),AAFIM(20,20),AATMM(20,20),OCDW2870
             7CUMPLF(20),ETISMM(20,20),AEXLOM(20,20),AEXFOM(20,20),AEXMOM(20,20)OCDW2880
             8,AEXVOM(20,20),QMETB(20,20),DPOOLB(20,20),COMVUR(10,20),NWM(20,20)OCDW2890
             9,NMFCOD(20,20),NMH2OI(20,20),NMTISM(20,20),NAVAPM(20,20)          OCDW2900
       C                                                                        OCDW2910
:TENSION*  LIMIT OF 5 CONTINUATION CARDS EXCEEDED
 22           INTEGER SEX,WTUNIT,DIRECT                                         OCDW2920
 23           COMMON /SHIFT/ NTEST,NSUBS,NTDAYS,DIRECT,WTUNIT,SEX,FACTOR(2),B   OCDW2930
       C                                                                        OCDW2940
       C                                                                        OCDW2950
 24           READ(5,196) (SBNMAG(17,J),J=1,4),(SBNMAG(18,J),J=1,4)             OCDW2960
 25           FACTOR(1) = 1.E3                                                  OCDW2970
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26          FACTOR(2) = 453.6E0                                                 UCDW2980
      C                                                                         UCDW2990
      C     COMMUNAL URINE POOL                                                 UCDW3000
      C                                                                         UCDW3010
27          DO 100 I = 1,10                                                     UCDW3020
28          DO 100 J = 1,20                                                     UCDW3030
29      100 COMVUR(I,J) = 0.0E0                                                 UCDW3040
30          READ(5,198) (COMVUR(3,J),J = 1,6)                                   UCDW3050
      C                                                                         UCDW3060
      C                                                                         UCDW3070
      C     READ IDENTIFICATION AND CONTROL PARAMETERS                          UCDW3080
      C                                                                         UCDW3090
31        1 READ(5,199) NTEST,NSUBS,NTDAYS,B,NS1,NS2,NS3,NS4,NS5,NS6,NS7,NS8, UCDW3100
         1 NS9,NS10,NS11,NS12,NS13,NS14,NS15,NS16,EXM,TSFF,METAB,SEX,WTUNIT,UCDW3110
         2 DIRECT,NR                                                            UCDW3120
32          READ(5,198)MPCRM,CRFP,CRFF,CRFC,CRFH2O,MPCNM,CNFC,CNFH2O,CODP,COCFUCDW3130
         1,CODC,FVP,FVF,FVC                                                     UCDW3140
33          READ(5,198)AMETP,AMETF,AMETC,GMO2P,GMO2F,GMO2C,GMCO2P,GMCO2F,GMCO2UCDW3150
         1C,SPGURO,URFH2O,FEFH2O,MSFH2O,VOFH2O                                  UCDW3160
      C                                                                         UCDW3170
      C     IF THIS IS THE END OF THE DATA SETS, GO TO STOP.                    UCDW3180
      C     OTHERWISE, CONTINUE.                                                UCDW3190
      C                                                                         UCDW3200
34          IF(NTEST.EQ.99) GO TO 50                                            UCDW3210
      C                                                                         UCDW3220
      C     SET UP SUBSCRIPTS FOR SUBJECT SEX AND INPUT WEIGHT UNITS.           UCDW3230
      C                                                                         UCDW3240
35          MSX  = 4*SEX - 3                                                    UCDW3250
36          MSX1 = MSX + 1                                                      UCDW3260
37          MSX2 = MSX1 + 1                                                     UCDW3270
38          MSX3 = MSX2 + 1                                                     UCDW3280
      C                                                                         UCDW3290
39          NWT  = 3*WTUNIT - 2                                                 UCDW3300
40          NWT1 = NWT + 1                                                      UCDW3310
41          NWT2 = NWT1 + 1                                                     UCDW3320
      C                                                                         UCDW3330
      C                                                                         UCDW3340
      C     CALCULATE CONSTANT MULTIPLIER IN METABOLISM EQUATION, AND CHANGE    UCDW3350
      C     THE INPUT METABOLIC PARAMETER TO METRIC AND BRITISH ENERGY PER DAYUCDW3360
      C                                                                         UCDW3370
42          METABB = 24.E0*METAB                                                UCDW3380
43          METABM = 0.252E0*METABB                                             UCDW3390
44          FMETRM = METABM/(SUBXM(SEX)**EXM)                                   UCDW3400
      C                                                                         UCDW3410
      C                                                                         UCDW3420
      C     WRITE PARAMETERS                                                    UCDW3430
      C                                                                         UCDW3440
45          WRITE(6,189) NTEST,NSUBS,NTDAYS,B,NSUBS,NAMWTI(NWT),NAMWTI(NWT1),NUCDW3450
         1AMWTI(NWT2),SBTYP(MSX),SBTYP(MSX1),SBTYP(MSX2),SBTYP(MSX3),METAB, UCDW3460
         2METABB,METABM,EXM,MPCRM,CRFH2O,CRFP,CRFF,CRFC,MPCNM,CNFH2O            UCDW3470
46          WRITE(6,1891)                                    CNFC,TSFF,CODP,COUCDW3480
         3ODF,CODC,FVP,FVF,FVC,GMO2P,GMO2F,GMO2C,GMCO2P,GMCO2F,GMCO2C,AMETP,UCDW3490
         4AMETF,AMETC,SPGURO,URFH2O,FEFH2O,MSFH2O,VOFH2O,NR                     UCDW3500
      C                                                                         UCDW3510
      C                                                                         UCDW3520
      C     READ AND WRITE ANY COMMENTS REGARDING THIS RUN.                     UCDW3530
      C                                                                         UCDW3540
47          READ(5,196) (COMENT(J),J = 1,37)                                    UCDW3550
48          WRITE(6,195)(COMENT(J),J = 1,37)                                    UCDW3560
      C                                                                         UCDW3570
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```
49          WRITE(6,188)
      C
      C
50        2 IF(DIRECT - (((DIRECT/3)*3)+1))3,4,9
      C
      C
51        3 READ(5,197) NTEST,I,J,WTI(I,J),WTM(I,J),WTF(I,J),VH2OI(I,J),FDUI(I
         1,J),CANDY(I,J),VURO(I,J),MFECO(I,J),MENSES(I,J),VOMIT(I,J),(SBNMAG
         2(I,IS),IS=1,4)
      C
52          WRITE(6,187)NTEST,I,J,WTI(I,J),WTM(I,J),WTF(I,J),VH2OI(I,J),FDUI(I
         1,J),CANDY(I,J),VURO(I,J),MFECO(I,J),MENSES(I,J),VOMIT(I,J),(SBNMAG
         2(I,IS),IS=1,4)
53          GO TO 5
      C
      C
54        4 READ(5,197) NTEST,I,J,WTI(I,J),WTM(I,J),WTF(I,J),VH2OI(I,J),FDUI(I
         1,J),CANDY(I,J),VURO(I,J),MFECO(I,J),MENSES(I,J),VOMIT(I,J),(SBNMAG
         2(I,IS),IS=1,4)
      C
      C
      C
      C
55        5 IF((I.NE.NS1).AND.(I.NE.NS2).AND.(I.NE.NS3).AND.(I.NE.NS4).AND.(I.
         1NE.NS5).AND.(I.NE.NS6).AND.(I.NE.NS7).AND.(I.NE.NS8).AND.(I.NE.NS9
         2).AND.(I.NE.NS10).AND.(I.NE.NS11).AND.(I.NE.NS12).AND.(I.NE.NS13).
         3AND.(I.NE.NS14).AND.(I.NE.NS15).AND.(I.NE.NS16))GO TO 6
56          IF((I.EQ.NSUBS).AND.(J.EQ.NTDAYS))GO TO 7
      C
      C
57          GO TO 2
      C     THE PRECEDING IF STATEMENT AND THE FOLLOWING "ZEROERS" TAKE CARE
      C     OF THE DATA TREATMENT FOR SUBJECTS WHO DID NOT COMPLETE THE TEST.
      C
58        6 WTI(I,J)     = 0.0E0
59          WTM(I,J)     = 0.0E0
60          WTF(I,J)     = 0.0E0
61          VH2OI(I,J)   = 0.0E0
62          FDUI(I,J)    = 0.0E0
63          CANDY(I,J)   = 0.0E0
64          VURO(I,J)    = 0.0E0
65          MFECO(I,J)   = 0.0E0
66          MENSES(I,J)  = 0.0E0
67          VOMIT(I,J)   = 0.0E0
68          NWM(I,J)     = 0.0E0
69          NMFCOD(I,J)  = 0.0E0
70          NMH2OI(I,J)  = 0.0E0
71          NMTISM(I,J)  = 0.0E0
72          NAVAPM(I,J)  = 0.0E0
73          IF((I.EQ.NSUBS).AND.(J.EQ.NTDAYS))GO TO 7
74          GO TO 2
      C
      C
      C
      C     CONVERT INPUT WEIGHT DATA TO GRAMS
      C     NOTE:    IF ONLY PARAMETERS ARE CHANGED, THIS CONVERSION HAS
      C              ALREADY BEEN DONE ON THE INDIVIDUAL SUBJECT DATA AND
      C              IS THEREFORE SKIPPED.
      C
      C
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```
    7 DO 8 I=1,NSUBS                                                    OCDW4170
      DO 8 J=1,NTDAYS                                                   OCDW4180
      WTI(I,J) = WTI(I,J)*FACTOR(WTUNIT)                                OCDW4190
      WTM(I,J) = WTM(I,J)*FACTOR(WTUNIT)                                OCDW4200
    8 WTF(I,J) = WTF(I,J)*FACTOR(WTUNIT)                                OCDW4210
C                                                                       OCDW4230
C                                                                       OCDW4240
C                                                                       OCDW4250
C     GO TO MAIN PROGRAM                                                OCDW4260
C                                                                       OCDW4270
C     TURN TC NEW PAGE OF OUTPUT                                        OCDW4280
    9 WRITE(6,499)                                                      OCDW4290
C                                                                       OCDW4300
C     THE FOLLOWING LOOP CALCULATES AND STORES THE VALUE OF VARIABLES   OCDW4310
C     FOR EACH SUBJECT ("I"), FOR EACH DAY ("J").                       OCDW4320
C                                                                       OCDW4330
      DO 16 I=1,NSUBS                                                   OCDW4340
      DO 16 J=1,NTDAYS                                                  OCDW4350
C                                                                       OCDW4360
C     FIND THE AVERAGE WEIGHT OF "I" ON DAY "J".                        OCDW4370
   10 WM(I,J) = ((WTI(I,J)+WTM(I,J)+WTF(I,J))/3.E0)                     OCDW4380
C                                                                       OCDW4390
C     FIND THE WT CHANGE OF "I" DURING "J".                             OCDW4400
      DWTM(I,J) = (WTF(I,J) - WTI(I,J))                                 OCDW4410
C                                                                       OCDW4420
C                                                                       OCDW4430
C     DETERMINE THE TOTAL METABOLIC ENERGY OF "I" DURING "J".           OCDW4440
C                                                                       OCDW4450
      DLGTHC = 1.E0                                                     OCDW4460
      IF((NTEST.EQ.3).AND.(J.EQ.1))DLGTHC = (21.5E0/24.E0)              OCDW4470
      IF((NTEST.EQ.3).AND.(J.EQ.6))DLGTHC = (2.5E0/24.E0)               OCDW4480
      QMETM(I,J) = FMETRM*((WM(I,J)*1.E-3)**EXM)*DLGTHC                 OCDW4490
      QMETB(I,J) = QMETM(I,J)/6.048E0                                   OCDW4500
C                                                                       OCDW4510
C     CALCULATE WT CHANGE FOR "I" DURING "J" AS A PERCENTAGE OF "I'S"   OCDW4520
C     INITIAL WT AT THE START OF THE TEST.                              OCDW4530
C                                                                       OCDW4540
      IF(WTI(I,1).NE.0.0E0)GO TO 11                                     OCDW4550
      PDWT(I,J) = 0.0E0                                                 OCDW4560
      GO TO 12                                                          OCDW4570
   11 PDWT(I,J) = (DWTM(I,J)/WTI(I,1))*1.0E2                            OCDW4580
C                                                                       OCDW4590
C                                                                       OCDW4610
C                                                                       OCDW4620
C     TOTAL MASS INPUT OF FOOD LESS THE WATER IT CONTAINS.              OCDW4630
C                                                                       OCDW4640
   12 MFOODM(I,J) = (FDUI(I,J)-CANDY(I,J))*MPCRM*(1.0E0-CRFH2O) + CANDY(OCDW4650
     1I,J)*MPCNM*(1.0E0-CNFH2O)                                         OCDW4660
C                                                                       OCDW4670
C                                                                       OCDW4680
C     TOTAL MASS INPUT OF WATER (AS WATER AND AS MOISTURE IN FOOD).     OCDW4690
C                                                                       OCDW4700
      MH2OIM(I,J) = VH2OI(I,J) + (FDUI(I,J)-CANDY(I,J))*MPCRM*CRFH2O +  OCDW4710
     1CANDY(I,J)*MPCNM*CNFH2O                                           OCDW4720
C                                                                       OCDW4730
C                                                                       OCDW4740
C     TOTAL MASS OUTPUT OF URINE AND WATER OUT WITH IT                  OCDW4750
C                                                                       OCDW4760
      MUROM(I,J) = VURO(I,J)*SPGURC                                     OCDW4770
      AEXUOM(I,J) = MUROM(I,J)*URFH2O                                   OCDW4780
```

```
      C
      C
      C     TOTAL MASS OUTPUT OF FECES IS MFECO(I,J). FIND WATER OUT WITH IT.
      C
 98         AEXFOM(I,J) = MFECO(I,J)*FEFH20
      C
      C
      C     TOTAL MASS OUTPUT OF MENSES IS MENSES(I,J). FIND WATER OUT WITH IT
      C
 99         AEXMOM(I,J) = MENSES(I,J)*MSFH20
      C
      C
      C     TOTAL MASS OUTPUT OF VOMIT IS VOMIT(I,J). FIND WATER OUT WITH IT.
      C
100         AEXVOM(I,J) = VOMIT(I,J)*VOFH20
      C
      C
      C     CALCULATE THE ENERGY AVAILABLE FROM THE FOOD CONSUMED AND THE
      C     WATER PRODUCED BY THE METABOLISM OF THIS AMOUNT  OF FOOD.
      C
101         EAFIM(I,J) = (FDUI(I,J)-CANDY(I,J))*MPCRM*(CRFP*CODP*FVP + CRFF*COO
           1DF*FVF + CRFC*CODC*FVC)*(1.E0-CRFH20) + CANDY(I,J)*MPCNM*CNFC*CODC
           2*FVC*(1.E0-CNFH20)
      C
102         AAFIM(I,J) = (FDUI(I,J)-CANDY(I,J))*MPCRM*(CRFP*CODP*AMETP + CRFF*
           1CODF*AMETF + CRFC*CODC*AMETC)*(1.0E0-CRFH20) + CANDY(I,J)*MPCNM*CN
           2FC*CODC*AMETC*(1.0E0-CNFH20)
      C
      C
      C     DETERMINE THE AMOUNT OF ENERGY WHICH HAD TO COME FROM METABOLISM
      C     OF TISSUE TO MEET THE METABOLIC ENERGY REQUIREMENTS.
      C
103         ETISMM(I,J) = QMETM(I,J) - EAFIM(I,J)
      C
      C
      C     FIND THE MASS OF TISSUE REQUIRED TO PROVIDE THE ABOVE ENERGY AND
      C     THE WATER PRODUCED BY ITS METABOLISM.
      C
104         MTISMM(I,J) = ETISMM(I,J)/(TSFF*FVF + (1.0E0-TSFF)*FVP)
105         AATMM(I,J)  = MTISMM(I,J)*(TSFF*AMETF + (1.0E0-TSFF)*AMETP)
      C
      C
      C     CALCULATE OXYGEN CONSUMPTION DUE TO METABOLISM
      C
106         GMO2(I,J) = (FDUI(I,J)-CANDY(I,J))*MPCRM*(CRFP*CODP*GMO2P + CRFF*CO
           1DF*GMO2F + CRFC*CODC*GMO2C)*(1.E0-CRFH20) + CANDY(I,J)*MPCNM*CNFC
           2*CODC*GMO2C*(1.E0-CNFH20) + MTISMM(I,J)*(TSFF*GMO2F + (1.0E0-TSFF)
           3*GMO2P)
      C
      C
      C     CALCULATE THE CARBON DIOXIDE PRODUCTION DUE TO METABOLISM.
      C
107         GMCO2(I,J) = (FDUI(I,J)-CANDY(I,J))*MPCRM*(CRFP*CODP*GMCO2P + CRFF
           1*CODF*GMCO2F + CRFC*CODC*GMCO2C)*(1.E0-CRFH20) + CANDY(I,J)*MPCNM*
           2CNFC*CODC*GMCO2C*(1.E0-CNFH2O) + MTISMM(I,J)*(TSFF*GMCO2F + (1.0E0
           2-TSFF)*GMCO2P)
      C
      C
      C
      C
```

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C     CALCULATE THE RESPIRATORY QUCTIENT.                                OCDW5370
C                                                                        OCDW5380
      IF(GMC2(I,J).NE.0.0EC)GO TO 13                                     OCDW5390
      RC(I,J) = 0.0E0                                                    OCDW5400
      GO TO 14                                                           OCDW5410
   13 RQ(I,J) = (GMCO2(I,J)/44.011E0)/(GMO2(I,J)/32.E0)                  OCDW5420
C                                                                        OCDW5430
C                                                                        OCDW5440
C     CALCULATE THE MASS OF WATER LOST BY EVAPORATION.                   OCDW5450
C                                                                        OCDW5460
   14 AVAPM(I,J) = MH2OIM(I,J) + MFOODM(I,J) + GMO2(I,J) - GMCO2(I,J) -  OCDW5470
     1 MUROM(I,J) - MFECO(I,J) - MENSES(I,J) - VOMIT(I,J) - DWTM(I,J)    OCDW5480
C                                                                        OCDW5490
C                                                                        OCDW5500
C     CALCULATE THE CHANGE IN THE BODY WATER POOL.                       OCDW5510
C                                                                        OCDW5520
      DPOOLM(I,J) = AAFIM(I,J) + MH2CIM(I,J) + AATMM(I,J) - AEXUOM(I,J)  OCDW5530
     1- AEXFOM(I,J) - AEXMOM(I,J) - AEXVOM(I,J) - AVAPM(I,J)             OCDW5540
      DPOCLB(I,J) = DPOOLM(I,J)/FACTOR(2)                                OCDW5550
C                                                                        OCDW5560
C     CALCULATE BODY POOL CHANGE AS A PERCENT OF INITIAL SUBJECT WEIGHT.OCDW5570
C                                                                        OCDW5580
      IF(WTI(I,1).NE.0.0EO)GO TO 15                                      OCDW5590
      DPOOLF(I,J) = 0.0E0                                                OCDW5600
      GC TO 16                                                           OCDW5610
   15 DPOOLF(I,J) = (DPCOLM(I,J)/WTI(I,1))*1.0E2                         OCDW5620
C                                                                        OCDW5630
C                                                                        OCDW5640
C     TERMINATE THIS CALCULATION LCOP.                                   OCDW5650
C                                                                        OCDW5660
   16 CONTINLE                                                           OCDW5670
C                                                                        OCDW5680
C                                                                        OCDW5690
C                                                                        OCDW5700
C                                                                        OCDW5710
   17 CONTINLE                                                           OCDW5720
   18 CONTINLE                                                           OCDW5730
   19 CONTINLE                                                           OCDW5740
   20 CALL TREAT(WTI)                                                    OCDW5750
      CALL TREAT(WTM)                                                    OCDW5760
      CALL TREAT(WTF)                                                    OCDW5770
      CALL TREAT(VH2OI)                                                  OCDW5780
      CALL TREAT(FCUI)                                                   OCDW5790
      CALL TREAT(CANDY)                                                  OCDW5800
      CALL TREAT(VURO)                                                   OCDW5810
      CALL TREAT(MFECO)                                                  OCDW5820
      CALL TREAT(MENSES)                                                 OCDW5830
      CALL TREAT(VOMIT)                                                  OCDW5840
      CALL TREAT(WM)                                                     OCDW5850
      CALL TREAT(PDWT)                                                   OCDW5860
      CALL TREAT(DWTM)                                                   OCDW5870
      CALL TREAT(QMETM)                                                  OCDW5880
      CALL TREAT(QMETB)                                                  OCDW5890
      CALL TREAT(RQ)                                                     OCDW5900
      CALL TREAT(MFOODM)                                                 OCDW5910
      CALL TREAT(MH2OIM)                                                 OCDW5920
      CALL TREAT(GMO2)                                                   OCDW5930
      CALL TREAT(MUROM)                                                  OCDW5940
      CALL TREAT(GMCO2)                                                  OCDW5950
      CALL TREAT(EAFIM)                                                  OCDW5960
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      CALL TREAT(ETISMM)                                                OCDW5970
      CALL TREAT(MTISMM)                                                OCDW5980
      CALL TREAT(AAFIM)                                                 OCDW5990
      CALL TREAT(AATMM)                                                 OCDW6000
      CALL TREAT(AEXUOM)                                                OCDW6010
      CALL TREAT(AEXFOM)                                                OCDW6020
      CALL TREAT(AEXMOM)                                                OCDW6030
      CALL TREAT(AEXVOM)                                                OCDW6040
      CALL TREAT(AVAPM)                                                 OCDW6050
      CALL TREAT(DPOOLM)                                                OCDW6060
      CALL TREAT(DPOOLB)                                                OCDW6070
      CALL TREAT(DPOOLF)                                                OCDW6080
C                                                                       OCDW6090
C                                                                       OCDW6100
      IF(DIRECT.GT.8)GO TO 30                                           OCDW6110
C                                                                       OCDW6120
C     WRITE INDIVIDUAL DAILIES                                          OCDW6130
C                                                                       OCDW6140
   21 DO 22 I = 1,NSUBS                                                 OCDW6150
      WRITE(6,185) NTEST,I,(SBNMAG(I,J),J=1,4),(COMENT(J),J=1,37)       OCDW6160
      WRITE(6,1861)(WTI(I,J),J=1,15),(WTM(I,J),J=1,15),(WTF(I,J),J=1,15)OCDW6170
     1,(VH2CI(I,J),J=1,16),(FDUI(I,J),J=1,16),(CANDY(I,J),J=1,16),(VURO(OCDW6180
     2I,J),J=1,16),(MFECO(I,J),J=1,16),(MENSES(I,J),J=1,16),(VOMIT(I,J),OCDW6190
     3J=1,16),(WM(I,J),J=1,15),(PDWT(I,J),J=1,16),(DWTM(I,J),J=1,16),(QMOCDW6200
     4ETM(I,J),J=1,16),(QMETB(I,J),J=1,16),(RQ(I,J),J=1,15),(MFOODM(I,J)OCDW6210
     5,J=1,16),(MH2OIM(I,J),J=1,16),(GMO2(I,J),J=1,16)                 OCDW6220
   22 WRITE(6,1862) (MUROM(I,J),J=1,16),(MFECO(I,J),J=1,16),            OCDW6230
     1  (MENSES(I,J),J=1,16),(VOMIT(I,J),J=1,16),(GMCO2(I,J),J=1,16),(EAOCDW6240
     8FIM(I,J),J=1,16),(ETISMM(I,J),J=1,16),(MTISMM(I,J),J=1,16),(AAFIM(OCDW6250
     9I,J),J=1,16),(AATMM(I,J),J=1,16),(MH2OIM(I,J),J=1,16),(AEXUOM(I,J)OCDW6260
     A,J=1,16),(AEXFOM(I,J),J=1,16),(AEXMOM(I,J),J=1,16),(AEXVOM(I,J),J=OCDW6270
     11,16),(AVAPM(I,J),J=1,16),(DPOOLM(I,J),J=1,16),(DPOOLB(I,J),J=1,16OCDW6280
     2),(DPCCLF(I,J),J=1,16)                                            OCDW6290
C                                                                       OCDW6300
C                                                                       OCDW6310
ENSION*  LIMIT OF 5 CONTINUATION CARDS EXCEEDEC
   30 IF(NTEST.NE.3)GO TO 40                                            OCDW6320
      SAVE4 = 0.0E0                                                     OCDW6330
      DO 31 I = 1,NTDAYS                                                OCDW6340
      VURO(17,I) = VURO(17,I) + (CCMVUR(NTEST,I)/8)                     OCDW6350
      COMVUR(NTEST,I) = 0.0E0                                           OCDW6360
      SAVE1 = MUROM(17,I)                                               OCDW6370
      MUROM(17,I) = VURO(17,I)*SPGLRO                                   OCDW6380
      SAVE2 = AEXUOM(17,I)                                              OCDW6390
      AEXUOM(17,I) = MUROM(17,I)*URFH2O                                 OCDW6400
      SAVE3 = AVAPM(17,I)                                               OCDW6410
      AVAPM(17,I) = AVAPM(17,I) + SAVE1 - MUROM(17,I)                   OCDW6420
      DPOOLM(17,I) = DPOOLM(17,I) + SAVE2-AEXUOM(17,I)+SAVE3-AVAPM(17,I)OCDW6430
      DPOOLB(17,I) = DPCOLM(17,I)/FACTCR(2)                             OCDW6440
      DPOOLF(17,I) =(DPOOLM(17,I)/WTI(17,1))*1.E2                       OCDW6450
      DPOCLF(18,I) = SAVE4 + DPOOLF(17,I)                               OCDW6460
   31 SAVE4 = DPOOLF(18,I)                                              OCDW6470
      VURO(17,15) = 0.0E0                                               OCDW6480
      VURO(17,16) = 0.0E0                                               OCDW6490
      AVAPM(17,15) = 0.0E0                                              OCDW6500
      AVAPM(17,16) = C.0EC                                              OCDW6510
      DPOOLM(17,15) = 0.0E0                                             OCDW6520
      DPOCLM(17,16) = 0.0E0                                             OCDW6530
      DPOOLB(17,15) = 0.0E0                                             OCDW6540
      DPOCLF(17,15) = 0.0E0                                             OCDW6550
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186          DPOOLB(17,16) = 0.0E0                                                    OCDW6560
187          DPOOLF(17,16) = 0.0E0                                                    OCDW6570
188          DO 32  I = 1,NTDAYS                                                      OCDW6580
189          VURO  (17,16) = VURO  (17,16) + VURC  (17,I)                             OCDW6590
190          AVAPM (17,16) = AVAPM (17,16) + AVAPM (17,I)                             OCDW6600
191          DPOOLM(17,16) = DPOOLM(17,16) + DPCCLM(17,I)                             OCDW6610
192          DPOOLB(17,16) = DPOOLB(17,16) + DPCCLB(17,I)                             OCDW6620
193          DPOOLF(17,16) = DPOOLF(17,16) + DPCCLF(17,I)                             OCDW6630
194       32 CONTINUE                                                                 OCDW6640
195          VURO  (17,15) = VURO  (17,16) / 5.0E0                                    OCDW6650
196          AVAPM (17,15) = AVAPM (17,16) / 5.0E0                                    OCDW6660
197          DPCCLM(17,15) = DPCOLM(17,16) / 5.0E0                                    OCDW6670
198          DPOOLB(17,15) = DPCOLB(17,16) / 5.0E0                                    OCDW6680
199          DPOOLF(17,15) = DPCOLF(17,16) / 5.0E0                                    OCDW6690
200          DPOOLF(18,15) = DPOOLF(17,15)                                            OCDW6700
201          DPOOLF(18,16) = DPOOLF(17,16)                                            OCDW6710
202          DPOOLM(18,16) = DPOOLM(17,16)                                            OCDW6720
203          DPOOLM(18,15) = DPCOLM(17,15)                                            OCDW6730
204          VURO(18,15) = VURO(17,15)                                                OCDW6740
205          VURO(18,16) = VURO(17,16)                                                OCDW6750
206          AVAPM(18,16) = AVAPM(17,16)                                              OCDW6760
207          AVAPM(18,15) = AVAPM(17,15)                                              OCDW6770
208          WTI(17,15) = WTI(17,16)/6.E0                                             OCDW6780
209          WTM(17,15) = WTM(17,16)/6.E0                                             OCDW6790
210          WTF(17,15) = WTF(17,16)/6.E0                                             OCDW6800
211          WM(17,15) = WM(17,16)/6.E0                                               OCDW6810
212          RQ(17,15) = RQ(17,16)/6.E0                                               OCDW6820
      C                                                                               OCDW6840
      C                                                                               OCDW6850
      C      WRITE OUT AVERAGE DAILIES FOR MR., MISS., OR MRS. AVERAGE.               OCDW6860
      C                                                                               OCDW6870
213       40 I = 17                                                                   OCDW6880
214          WRITE(6,186) NTEST,  (SBNMAG(I,J),J=1,4),(COMENT(J),J=1,37)              OCDW6890
215          WRITE(6,1861)(WTI(I,J),J=1,15),(WTM(I,J),J=1,15),(WTF(I,J),J=1,15)OCDW6900
            1,(VH2CI(I,J),J=1,16),(FDUI(I,J),J=1,16),(CANDY(I,J),J=1,16),(VURO(OCDW6910
            2I,J),J=1,16),(MFECO(I,J),J=1,16),(MENSES(I,J),J=1,16),(VOMIT(I,J),OCDW6920
            3J=1,16),(WM(I,J),J=1,15),(PUWT(I,J),J=1,16),(DWTM(I,J),J=1,16),(QMOCDW6930
            4ETM(I,J),J=1,16),(QMETB(I,J),J=1,16),(RQ(I,J),J=1,15),(MFOODM(I,J)OCDW6940
            5,J=1,16),(MH2OIM(I,J),J=1,16),(GMO2(I,J),J=1,16)                       OCDW6950
216          WRITE(6,1862) (MUROM(I,J),J=1,16),(MFECO(I,J),J=1,16),                 OCDW6960
            1  (MENSES(I,J),J=1,16),(VOMIT(I,J),J=1,16),(GMCO2(I,J),J=1,16),(EAOCDW6970
            8FIM(I,J),J=1,16),(ETISMM(I,J),J=1,16),(MTISMM(I,J),J=1,16),(AAFIM(OCDW6980
            9I,J),J=1,16),(AATMM(I,J),J=1,16),(MH2OIM(I,J),J=1,16),(AEXUOM(I,J)OCDW6990
            A,J=1,16),(AEXFOM(I,J),J=1,16),(AEXMOM(I,J),J=1,16),(AEXVOM(I,J),J=OCDW7000
            11,16),(AVAPM(I,J),J=1,16),(DPOOLM(I,J),J=1,16),(DPOOLB(I,J),J=1,16OCDW7010
            2),(DPCCLF(I,J),J=1,16)                                                  OCDW7020
TENSION*  LIMIT OF 5 CONTINUATION CARDS EXCEEDED
217          I = 18                                                                   OCDW7030
218          WRITE(6,186) NTEST,  (SBNMAG(I,J),J=1,4),(COMENT(J),J=1,37)              OCDW7040
219          WRITE(6,1861)(WM(20,J),J=1,15),(WM(20,J),J=1,15),(WM(20,J),J=1,15)OCDW7050
            1,(VH2CI(I,J),J=1,16),(FDUI(I,J),J=1,16),(CANDY(I,J),J=1,16),(VURO(OCDW7060
            2I,J),J=1,16),(MFECO(I,J),J=1,16),(MENSES(I,J),J=1,16),(VOMIT(I,J),OCDW7070
            3J=1,16),(WM(20,J),J=1,15),(PCWT(I,J),J=1,16),(DWTM(I,J),J=1,16),(WOCDW7080
            4M(20,J),J=1,16),(WM(20,J),J=1,16),(WM(20,J),J=1,15),(MFOODM(I,J)   OCDW7090
            5,J=1,16),(MH2OIM(I,J),J=1,16),(GMO2(I,J),J=1,16)                       OCDW7100
220          WRITE(6,1862) (MUROM(I,J),J=1,16),(MFECO(I,J),J=1,16),                 OCDW7110
            1               (MENSES(I,J),J=1,16),(VOMIT(I,J),J=1,16),(GMCO2(I,J)OCDW7120
            1,J=1,16),(EAFIM(I,J),J=1,16),(ETISMM(I,J),J=1,16),(MTISMM(I,J),J=1OCDW7130
            2,16),(AAFIM(I,J),J=1,16),(AATMM(I,J),J=1,16),(MH2OIM(I,J),J=1,16),OCDW7140
            3(AEXUOM(I,J),J=1,16),(AEXFOM(I,J),J=1,16),(AEXMOM(I,J),J=1,16),(AEOCDW7150
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          5XVOM(I,J),J=1,16),(AVAPM(I,J),J=1,16),(DPOOLM(I,J),J=1,16),(DPOOLBOCDW7160
          6(I,J),J=1,16),(DPOOLF(I,J),J=1,16)                                OCDW7170
      C   NORMALIZE SELECTED VARIABLES                                       OCDW7180
XTENSION*  LIMIT OF 5 CONTINUATION CARDS EXCEEDED
 221        CALL NORM(WM,WTI,NWM)                                            OCDW7190
 222        CALL NORM(MFOODM,WTI,NMFOOD)                                     OCDW7200
 223        CALL NORM(MH2OIM,WTI,NMH2OI)                                     OCDW7210
 224        CALL NORM(MTISMM,WTI,NMTISM)                                     OCDW7220
 225        CALL NORM(AVAPM,WTI,NAVAPM)                                      OCDW7230
      C                                                                      OCDW7240
      C   PUNCH OUTPUT FOR USE IN STATISTICAL ANALYSIS                       OCDW7260
 226        DO 45 J = 1,NTDAYS                                               OCDW7290
 227        DO 45 I = 1,16                                                   OCDW7300
 228     45 WRITE(6,184) J,I,ONE,WTI(I,J),WTF(I,J),VH2OI(I,J),VURO(I,J),WM(I,JOCDW7310
          1),PDWT(I,J),DWTM(I,J),J,I,TWC,QMETM(I,J),MFOODM(I,J),MH2OIM(I,J), OCDW7320
          2GMO2(I,J),MUROM(I,J),GMCO2(I,J),EAFIM(I,J),J,I,THREE,ETISMM(I,J), OCDW7330
          3MTISMM(I,J),AAFIM(I,J),AATMM(I,J),AEXUUM(I,J),AEXFOM(I,J),AEXMOM( OCDW7340
          4I,J),J,I,FOUR,AEXVOM(I,J),AVAPM(I,J),DPOOLM(I,J),DPOOLF(I,J),NWM( OCDW7350
          5I,J),NMFOOD(I,J),NMH2OI(I,J),J,I,FIVE,NMTISM(I,J),NAVAPM(I,J)     OCDW7360
      C                                                                      OCDW7380
 229        GO TO 1                                                          OCDW7390
 230     50 STOP                                                             OCDW7400
 231        END                                                              OCDW7410
      C                                                                      OCDW7420
      C   AVERAGING AND ACCUMULATING SUBROUTINE                              OCDW7421
      C                                                                      OCDW7430
WARNING**  FORMAT STATEMENT    498 IS UNREFERENCED
WARNING**  FORMAT STATEMENT    497 IS UNREFERENCED
WARNING**  FORMAT STATEMENT    496 IS UNREFERENCED

 232        SUBROUTINE TREAT (A)                                             OCDW7440
 233        DIMENSION A(20,20)                                               OCDW7450
 234        COMMON /SHIFT/ ITST,ISBS,IDYS,IGD,IWTU,ISEX,FACTOR(2),B          OCDW7460
 235        ISBP1 = ISBS + 1                                                 OCDW7470
 236        ISBP2 = ISBS + 2                                                 OCDW7480
 237        ISBP3 = ISBS + 3                                                 OCDW7490
 238        ISBP4 = ISBS + 4                                                 OCDW7500
 239        IDYSP1 = IDYS + 1                                                OCDW7510
 240        IDYSP2 = IDYS + 2                                                OCDW7520
 241        IDYSP3 = IDYS+3                                                  OCDW7530
 242        IDYSP4 = IDYS + 4                                                OCDW7540
 243        TDAYS = IDYS                                                     OCDW7550
 244        IF(ITST.EQ.3)TDAYS = 5                                           OCDW7560
 245        CUM = 0.0E0                                                      OCDW7570
 246        DO 1 I = 1,16                                                    OCDW7580
 247        DO 1 J = IDYSP1,20                                               OCDW7590
 248      1 A(I,J) = 0.0E0                                                   OCDW7600
 249        DO 2 I = ISBP1,20                                                OCDW7610
 250        DO 2 J = 1,20                                                    OCDW7620
 251      2 A(I,J) = 0.0E0                                                   OCDW7630
 252        IF((IGD/3) - 3*(IGD/9) - 1)3,6,10                                OCDW7640
 253      3 DO 5 I = 1,IDYS                                                  OCDW7650
 254        DO 4 J = 1,ISBS                                                  OCDW7660
 255      4 A(17,I) = A(17,I) + A(J,I)                                       OCDW7670
 256        A(17,I) = A(17,I)/B                                              OCDW7680
 257        CUM = CUM + A(17,I)                                              OCDW7690
 258      5 A(18,I) = CUM                                                    OCDW7700
 259        A(17,15) = CUM/TDAYS                                             OCDW7710
 260        A(17,16) = CUM                                                   OCDW7720
 261        A(18,15) = A(17,15)                                              OCDW7730
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      A(18,16) = CUM                                                  OCDW7740
    6 DO 8 I = 1,ISBS                                                 OCDW7750
      DO 7 J = 1,IDYS                                                 OCDW7760
    7 A(I,16) = A(I,16) + A(I,J)                                      OCDW7770
    8 A(I,15) = A(I,16)/TDAYS                                         OCDW7780
   10 RETURN                                                          OCDW7790
      END                                                             OCDW7800
C                                                                     OCDW7801
C                                                                     OCDW7802
C     NORMALIZATION SUBROUTINE                                        OCDW7803
C                                                                     OCDW7804

      SUBROUTINE NORM(A,B,C)                                          OCDW7810
      DIMENSION A(20,20),B(20,20),C(20,20)                            OCDW7820
      DO 2 I = 1,16                                                   OCDW7830
      IF(B(I,1).EQ.0.0)GO TO 2                                        OCDW7840
      DO 1 J = 1,14                                                   OCDW7850
    1 C(I,J) = A(I,J)/B(I,1)                                          OCDW7860
    2 CONTINUE                                                        OCDW7870
    3 RETURN                                                          OCDW7880
      END                                                             OCDW7890

$ENTRY
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WATER REQUIREMENT DATA PRESENTATION --- OCD CONTRACT DAHC20-68-C-0173 --- TEST NUMBER 1. -- 16 SUBJECTS FOR 5 DAYS.

13. OF THE 16 SUBJECTS COMPLETED THIS TEST.

THE UNITS OF INPUT SUBJECT WEIGHT ARE POUNDS

THE AVERAGE SUBJECT IS ASSUMED TO BE A 160 LB. MALE , WITH AN AVERAGE METABOLIC RATE OF 372. BTU/HOUR.
THE ABOVE METABOLIC RATE MIGHT ALSO BE EXPRESSED AS 8928. BTU/DAY OR 2250. KILOCALORIES/DAY.
KLEIBERS LAW IS USED TO DETERMINE METABOLIC RATE, USING AN EXPONENT OF 0.750

FOOD DATA

SURVIVAL CRACKER: TOTAL MASS = 5.003 GRAMS. MOISTURE FRACTION = 0.0232.
DRY BASIS FRACTIONAL COMPOSITIONS HAVE BEEN FOUND TO BE: PROTEIN (0.083) FAT(0.025) CARBOHYDRATE (0.877).
SURVIVAL CANDY: TOTAL MASS = 5.300 GRAMS. MOISTURE FRACTION = 0.0028.
DRY BASIS FRACTIONAL COMPOSITIONS HAVE BEEN FOUND TO BE: CARBOHYDRATE (0.942).
IN BOTH CRACKERS AND CANDY THERE IS SOME ASH.

MOST SUBJECTS METABOLIZED TISSUE. FOR MASS DETERMINATIONS, THIS TISSUE HAS BEEN ASSUMED TO BE 0.90 FAT, THE REMAINDER PROTEIN.

SEVERAL METABOLIC PARAMETERS FOR:		PROTEIN,	FAT AND	CARBOHYDRATE
COEFFICIENT OF DIGESTION		0.92	0.95	0.98
FUEL VALUE	(KCAL/GRAM)	4.400	9.540	4.100
OXYGEN REQUIRED	(GRAM/GRAM)	1.380	2.885	1.184
CO2 PRODUCED	(GRAM/GRAM)	1.535	2.804	1.548
WATER PRODUCED	(GRAM/GRAM)	0.400	1.070	0.580

ASSUMED VALUES FOR EXCRETED MATERIALS:
SPECIFIC GRAVITY OF URINE = 1.025 AND ITS WATER MASS FRACTION IS 0.975
THE WATER MASS FRACTION OF FECES = 0.700
THE WATER MASS FRACTION OF MENSES = 0.950
THE WATER MASS FRACTION OF VOMIT = 0.950

THIS IS RUN NUMBER 1

RUN # 1, TEST # 1, METABOLIC RATE = 372 B/HR., THIS RUN USES DISCRETE URINE VOLUME DATA AND ENERGY BASED FOOD COMPOSITIONS. RUN
4 JUNE 1969

TEST NUMBER 1. DATA FROM AVERAGE SUBJECT. SPECIAL NOTES: RUN # 1, TEST # 1, METABOLIC RATE = 372 D/HR., THIS RUN USES DISCRETE URINE VOLUME DATA AND ENERGY BASED FOOD COMPOSITIONS. RUN 24 JUNE 1969

VARIABLE NAME (UNITS)	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12	DAY 13	DAY 14	MEAN	SUM
-----INPUT DATA-----																
INITIAL WEIGHT (KG)	75.29	73.83	72.54	71.61	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	72.82	
EVENING WEIGHT (KG)	74.81	73.37	72.30	71.35	70.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	72.50	
FINAL WEIGHT (KG)	73.83	72.54	71.61	70.85	70.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	71.78	
WATER CONSUMED (ML)	959.	960.	960.	960.	960.	0.	0.	0.	0.	0.	0.	0.	0.	0.	960.	4799.
FOOD UNITS EATEN (#)	57.42	32.00	21.31	16.65	8.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.16	135.81
CANDY BITS EATEN (#)	0.00	4.00	4.00	4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.20	16.00
URINE VOIDED (ML)	579.	455.	448.	497.	500.	0.	0.	0.	0.	0.	0.	0.	0.	0.	496.	2479.
FECES VOIDED (GM)	9.	19.	0.	0.	9.	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.	38.
MENSES VOIDED (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
VOMITUS VOIDED (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
-CALCULATED RESULTS-																
AVERAGE WEIGHT (KG)	74.64	73.25	72.15	71.27	70.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	72.37	
WEIGHT CHANGE (%)	-1.91	-1.70	-1.23	-1.01	-1.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.38	-6.91
WEIGHT CHANGE (GM)	-1455.	-1292.	-931.	-761.	-800.	0.	0.	0.	0.	0.	0.	0.	0.	0.	-1048.	-5240.
METABOLISM(KCAL/DAY)	2297.	2264.	2239.	2218.	2201.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2244.	11219.
METABOLISM(BTU/HOUR)	380.	374.	370.	367.	364.	0.	0.	0.	0.	0.	0.	0.	0.	0.	371.	1855.
RESPIRATORY QUOTIENT	0.82	0.77	0.75	0.74	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	
OVERALL MASS BALANCE																
FOOD MASS IN (GM)	281.	158.	106.	83.	43.	0.	0.	0.	0.	0.	0.	0.	0.	0.	134.	670.
WATER MASS IN (GM)	966.	963.	962.	962.	961.	0.	0.	0.	0.	0.	0.	0.	0.	0.	963.	4814.
OXYGEN MASS IN (GM)	683.	679.	673.	668.	665.	0.	0.	0.	0.	0.	0.	0.	0.	0.	673.	3367.
URINE MASS OUT (GM)	593.	467.	459.	510.	512.	0.	0.	0.	0.	0.	0.	0.	0.	0.	508.	2541.
FECES MASS OUT (GM)	9.	19.	0.	0.	9.	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.	36.
MENSES MASS OUT (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
VOMIT MASS OUT (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CO2 MASS OUT (GM)	766.	719.	696.	683.	666.	0.	0.	0.	0.	0.	0.	0.	0.	0.	706.	3531.
ENERGY SOURCES (KCAL)																
FOOD METABOLIZED	1149.	640.	426.	333.	168.	0.	0.	0.	0.	0.	0.	0.	0.	0.	543.	2717.
TISSUE METABOLIZED	1148.	1624.	1813.	1885.	2033.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1701.	8503.
MASS OF TISSUE (GM)	127.	180.	201.	209.	225.	0.	0.	0.	0.	0.	0.	0.	0.	0.	168.	942.
WATER BALANCE (GM)																
IN: FOOD METABOLISM	156.	87.	58.	46.	23.	0.	0.	0.	0.	0.	0.	0.	0.	0.	74.	370.
TISSUE METABOLISM	128.	180.	201.	209.	226.	0.	0.	0.	0.	0.	0.	0.	0.	0.	189.	945.
WATER+FOOD MOISTURE	966.	963.	962.	962.	961.	0.	0.	0.	0.	0.	0.	0.	0.	0.	963.	4814.
OUT: WITH URINE	578.	455.	449.	497.	499.	0.	0.	0.	0.	0.	0.	0.	0.	0.	496.	2478.
WITH FECES	6.	13.	0.	0.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	27.
WITH MENSES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
WITH VOMITUS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BY EVAPORATION	2017.	1887.	1516.	1281.	1280.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1596.	7981.
CHANGE OF WATER POOL																
(GRAMS)	-1352.	-1124.	-742.	-561.	-577.	0.	0.	0.	0.	0.	0.	0.	0.	0.	-871.	-4356.
(POUNDS.)	-2.98	-2.48	-1.64	-1.24	-1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.92	-9.60
(PER CENT)	-1.77	-1.48	-0.98	-0.74	-0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.15	-5.73

TEST NUMBER 1. DATA FROM CUM AVG SUBJECT. SPECIAL NOTES: RUN # 1, TEST # 1, METABOLIC RATE = 372 B/HR., THIS RUN USES DISCRETE URINE VOLUME DATA AND ENERGY BASED FOOD COMPOSITIONS. RUN 24 JUNE 1969

VARIABLE NAME (UNITS)	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12	DAY 13	DAY 14	MEAN	SUM
-----INPUT DATA-----																
INITIAL WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
EVENING WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
FINAL WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
WATER CONSUMED (ML)	959.	1919.	2879.	3839.	4799.	0.	0.	0.	0.	0.	0.	0.	0.	0.	960.	4799.
FOOD UNITS EATEN (#)	57.42	89.42	110.73	127.38	135.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.16	135.81
CANDY BITS EATEN (#)	0.00	4.00	8.00	12.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.20	16.00
URINE VOIDED (ML)	579.	1034.	1482.	1980.	2479.	0.	0.	0.	0.	0.	0.	0.	0.	0.	496.	2479.
FECES VOIDED (GM)	9.	28.	29.	29.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.	38.
MENSES VOIDED (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
VOMITUS VOIDED (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
-CALCULATED RESULTS-																
AVERAGE WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
WEIGHT CHANGE (%)	-1.91	-3.61	-4.84	-5.85	-6.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.38	-6.91
WEIGHT CHANGE (GM)	-1455.	-2748.	-3679.	-4440.	-5240.	0.	0.	0.	0.	0.	0.	0.	0.	0.	-1048.	-5240.
METABOLISM(KCAL/DAY)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
METABOLISM(BTU/HOUR)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RESPIRATORY QUOTIENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OVERALL MASS BALANCE																
FOOD MASS IN (GM)	281.	439.	544.	627.	670.	0.	0.	0.	0.	0.	0.	0.	0.	0.	134.	670.
WATER MASS IN (GM)	966.	1929.	2891.	3853.	4814.	0.	0.	0.	0.	0.	0.	0.	0.	0.	963.	4814.
OXYGEN MASS IN (GM)	683.	1361.	2034.	2702.	3367.	0.	0.	0.	0.	0.	0.	0.	0.	0.	673.	3367.
URINE MASS OUT (GM)	593.	1060.	1519.	2029.	2541.	0.	0.	0.	0.	0.	0.	0.	0.	0.	508.	2541.
FECES MASS OUT (GM)	9.	28.	29.	29.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.	38.
MENSES MASS OUT (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
VOMIT MASS OUT (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CO2 MASS OUT (GM)	766.	1485.	2182.	2865.	3531.	0.	0.	0.	0.	0.	0.	0.	0.	0.	706.	3531.
ENERGY SOURCES (KCAL)																
FOOD METABOLIZED	1149.	1789.	2215.	2548.	2717.	0.	0.	0.	0.	0.	0.	0.	0.	0.	543.	2717.
TISSUE METABOLIZED	1148.	2772.	4585.	6470.	8503.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1701.	8503.
MASS OF TISSUE (GM)	127.	307.	508.	717.	942.	0.	0.	0.	0.	0.	0.	0.	0.	0.	188.	942.
WATER BALANCE (GM)																
IN: FOOD METABOLISM	156.	243.	301.	347.	370.	0.	0.	0.	0.	0.	0.	0.	0.	0.	74.	370.
TISSUE METABOLISM	128.	308.	509.	719.	945.	0.	0.	0.	0.	0.	0.	0.	0.	0.	189.	945.
WATER+FOOD MOISTURE	966.	1929.	2891.	3853.	4814.	0.	0.	0.	0.	0.	0.	0.	0.	0.	963.	4814.
OUT: WITH URINE	578.	1034.	1481.	1978.	2478.	0.	0.	0.	0.	0.	0.	0.	0.	0.	496.	2478.
WITH FECES	6.	20.	20.	20.	27.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	27.
WITH MENSES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
WITH VOMITUS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BY EVAPORATION	2017.	3903.	5419.	6700.	7981.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1596.	7981.
CHANGE OF WATER POOL																
(GRAMS)	-1352.	-2476.	-3218.	-3780.	-4356.	0.	0.	0.	0.	0.	0.	0.	0.	0.	-671.	-4356.
(POUNDS.)	-2.98	-5.46	-7.10	-8.33	-9.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.92	-9.60
(PER CENT)	-1.77	-3.25	-4.23	-4.97	-5.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.15	-5.73

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WATER REQUIREMENT DATA PRESENTATION --- OCD CONTRACT DAHC20-68-C-0173 --- TEST NUMBER 6. -- 16 SUBJECTS FOR 10 DAYS.

13. OF THE 16 SUBJECTS COMPLETED THIS TEST.

THE UNITS OF INPUT SUBJECT WEIGHT ARE POUNDS

THE AVERAGE SUBJECT IS ASSUMED TO BE A 160 LB. MALE    , WITH AN AVERAGE METABOLIC RATE OF 372. BTU/HOUR.
THE ABOVE METABOLIC RATE MIGHT ALSO BE EXPRESSED AS  8928. BTU/DAY OR 2250. KILOCALORIES/DAY.
KLEIBERS LAW IS USED TO DETERMINE METABOLIC RATE, USING AN EXPONENT OF 0.750

FOOD DATA
          SURVIVAL CRACKER: TOTAL MASS =     5. GRAMS.  MOISTURE FRACTION = 0.0393.
                    DRY BASIS FRACTIONAL COMPOSITIONS HAVE BEEN FOUND TO BE:  PROTEIN (0.094)   FAT(0.081)   CARBOHYDRATE (0.814).
          SURVIVAL CANDY: TOTAL MASS = 5.300 GRAMS.  MOISTURE FRACTION = 0.0028.
                    DRY BASIS FRACTIONAL COMPOSITIONS HAVE BEEN FOUND TO BE:  CARBOHYDRATE (0.942).
          IN BOTH CRACKERS AND CANDY THERE IS SOME ASH.

MOST SUBJECTS METABOLIZED TISSUE.  FOR MASS DETERMINATIONS, THIS TISSUE HAS BEEN ASSUMED TO BE 0.90 FAT, THE REMAINDER PROTEIN.

SEVERAL METABOLIC PARAMETERS FOR:  PROTEIN, FAT AND CARBOHYDRATE
   COEFFICIENT OF DIGESTION          0.92      0.95         0.98
   FUEL VALUE        (KCAL/GRAM)     4.400     9.540        4.100
   OXYGEN REQUIRED   (GRAM/GRAM)     1.380     2.885        1.184
   CO2 PRODUCED      (GRAM/GRAM)     1.535     2.804        1.548
   WATER PRODUCED    (GRAM/GRAM)     0.400     1.070        0.580

ASSUMED VALUES FOR EXCRETED MATERIALS:
   SPECIFIC GRAVITY OF URINE = 1.025 AND ITS WATER MASS FRACTION IS 0.975
   THE WATER MASS FRACTION OF FECES = 0.700
   THE WATER MASS FRACTION OF MENSES = 0.950
   THE WATER MASS FRACTION OF VOMIT = 0.950

THIS IS RUN NUMBER  6

OCD WATER  -  1.25 QUARTS  -  MEN  -  TEN DAYS   (JPR)
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TEST NUMBER 6. DATA FROM AVERAGE SUBJECT. SPECIAL NOTES: OCD WATER - 1.25 QUARTS - MEN - TEN DAYS (JMR)

VARIABLE NAME (UNITS)	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12	DAY 13	DAY 14	MEAN	SUM
-----INPUT DATA-----																
INITIAL WEIGHT (KG)	76.88	75.63	74.75	74.00	73.43	72.94	72.39	72.04	71.76	71.57	0.00	0.00	0.00	0.00	73.54	
EVENING WEIGHT (KG)	76.58	75.55	74.58	74.01	73.38	73.00	72.56	72.13	71.86	71.67	0.00	0.00	0.00	0.00	73.53	
FINAL WEIGHT (KG)	75.63	74.75	74.00	73.43	72.94	72.39	72.04	71.76	71.57	71.24	0.00	0.00	0.00	0.00	72.97	
WATER CONSUMED (ML)	1200.	1200.	1200.	1200.	1200.	1200.	1200.	1200.	1200.	1200.	0.	0.	0.	0.	1200.	12000.
FOOD UNITS EATEN (#)	44.00	44.00	44.00	44.00	41.02	40.46	40.15	39.23	38.73	38.00	0.00	0.00	0.00	0.00	41.36	413.60
CANDY BITS EATEN (#)	16.00	16.00	16.00	16.00	15.23	14.62	14.69	14.46	14.23	15.31	0.00	0.00	0.00	0.00	15.25	152.54
URINE VOIDED (ML)	625.	403.	427.	370.	454.	454.	501.	471.	400.	449.	0.	0.	0.	0.	455.	4552.
FECES VOIDED (GM)	0.	3.	13.	14.	18.	42.	21.	32.	5.	54.	0.	0.	0.	0.	20.	201.
MENSES VOIDED (GM)	10.	0.	0.	10.	0.	0.	10.	0.	0.	0.	0.	0.	0.	0.	3.	30.
VOMITUS VOIDED (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
-CALCULATED RESULTS-																
AVERAGE WEIGHT (KG)	76.36	75.31	74.45	73.81	73.25	72.78	72.33	71.97	71.73	71.49	0.00	0.00	0.00	0.00	73.35	
WEIGHT CHANGE (%)	-1.63	-1.14	-0.98	-0.73	-0.63	-0.70	-0.46	-0.37	-0.23	-0.43	0.00	0.00	0.00	0.00	-0.73	-7.30
WEIGHT CHANGE (GM)	-1257.	-874.	-748.	-578.	-486.	-549.	-356.	-278.	-188.	-331.	0.	0.	0.	0.	-564.	-5645.
METABOLISM (KCAL/DAY)	2333.	2309.	2289.	2274.	2261.	2250.	2240.	2232.	2226.	2220.	0.	0.	0.	0.	2263.	22633.
METABOLISM (BTU/HOUR)	386.	382.	378.	376.	374.	372.	370.	369.	368.	367.	0.	0.	0.	0.	374.	3742.
RESPIRATORY QUOTIENT	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.00	0.00	0.00	0.00	0.79	
OVERALL MASS BALANCE																
FOOD MASS IN (GM)	222.	222.	222.	222.	207.	204.	202.	198.	195.	192.	0.	0.	0.	0.	209.	2085.
WATER MASS IN (GM)	1206.	1206.	1206.	1206.	1205.	1205.	1205.	1205.	1205.	1205.	0.	0.	0.	0.	1205.	12055.
OXYGEN MASS IN (GM)	696.	689.	683.	679.	675.	672.	669.	667.	665.	664.	0.	0.	0.	0.	676.	6759.
URINE MASS OUT (GM)	641.	413.	438.	379.	465.	465.	513.	482.	410.	461.	0.	0.	0.	0.	467.	4666.
FECES MASS OUT (GM)	0.	3.	13.	14.	18.	42.	21.	32.	5.	54.	0.	0.	0.	0.	20.	201.
MENSES MASS OUT (GM)	10.	0.	0.	10.	0.	0.	10.	0.	0.	0.	0.	0.	0.	0.	3.	30.
VOMIT MASS OUT (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CO2 MASS OUT (GM)	757.	749.	744.	739.	731.	727.	723.	720.	717.	715.	0.	0.	0.	0.	732.	7322.
ENERGY SOURCES (KCAL)																
FOOD METABOLIZED	921.	921.	921.	921.	858.	847.	841.	821.	811.	793.	0.	0.	0.	0.	866.	8656.
TISSUE METABOLIZED	1412.	1387.	1367.	1353.	1403.	1403.	1399.	1410.	1415.	1427.	0.	0.	0.	0.	1398.	13977.
MASS OF TISSUE (GM)	156.	154.	152.	150.	155.	155.	155.	156.	157.	158.	0.	0.	0.	0.	155.	1549.
WATER BALANCE (GM)																
IN: FOOD METABOLISM	125.	125.	125.	125.	116.	115.	114.	111.	110.	108.	0.	0.	0.	0.	117.	1173.
TISSUE METABOLISM	157.	154.	152.	150.	156.	156.	155.	157.	157.	159.	0.	0.	0.	0.	155.	1553.
WATER+FOOD MOISTURE	1206.	1206.	1206.	1206.	1205.	1205.	1205.	1205.	1205.	1205.	0.	0.	0.	0.	1205.	12055.
OUT: WITH URINE	625.	403.	427.	369.	453.	453.	500.	470.	399.	449.	0.	0.	0.	0.	455.	4549.
WITH FECES	0.	2.	9.	9.	13.	29.	15.	23.	3.	38.	0.	0.	0.	0.	14.	141.
WITH MENSES	9.	0.	0.	9.	0.	0.	9.	0.	0.	0.	0.	0.	0.	0.	3.	28.
WITH VOMITUS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BY EVAPORATION	1973.	1825.	1664.	1543.	1359.	1397.	1166.	1114.	1122.	1162.	0.	0.	0.	0.	1432.	14325.
CHANGE OF WATER POOL																
(GRAMS)	-1120.	-745.	-617.	-450.	-348.	-403.	-215.	-133.	-53.	-178.	0.	0.	0.	0.	-426.	-4263.
(POUNDS)	-2.47	-1.64	-1.36	-0.99	-0.77	-0.89	-0.47	-0.29	-0.12	-0.39	0.00	0.00	0.00	0.00	-0.94	-9 40
(PER CENT)	-1.45	-0.98	-0.81	-0.57	-0.45	-0.52	-0.28	-0.18	-0.06	-0.23	0.00	0.00	0.00	0.00	-0.55	-5.53

TEST NUMBER 6. DATA FROM CUM AVG SUBJECT. SPECIAL NOTES: OCD WATER - 1.25 QUARTS - MEN - TEN DAYS (JMR)

VARIABLE NAME (UNITS)	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12	DAY 13	DAY 14	MEAN	SUM
-----INPUT DATA-----																
INITIAL WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
EVENING WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
FINAL WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
WATER CONSUMED (ML)	1200.	2400.	3600.	4800.	6000.	7200.	8400.	9600.	10800.	12000.	0.	0.	0.	0.	1200.	12000.
FOOD UNITS EATEN (#)	44.00	88.00	132.00	176.00	217.02	257.48	297.63	336.87	375.60	413.60	0.00	0.00	0.00	0.00	41.36	413.60
CANDY BITS EATEN (#)	16.00	32.00	48.00	64.00	79.23	93.85	108.54	123.00	137.23	152.54	0.00	0.00	0.00	0.00	15.25	152.54
URINE VOIDED (ML)	625.	1028.	1455.	1825.	2278.	2732.	3233.	3703.	4103.	4552.	0.	0.	0.	0.	455.	4552.
FECES VOIDED (GM)	0.	3.	16.	30.	48.	89.	110.	143.	148.	201.	0.	0.	0.	0.	20.	201.
MENSES VOIDED (GM)	10.	10.	10.	20.	20.	20.	30.	30.	30.	30.	0.	0.	0.	0.	3.	30.
VOMITUS VOIDED (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
-CALCULATED RESULTS-																
AVERAGE WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
WEIGHT CHANGE (%)	-1.63	-2.77	-3.75	-4.48	-5.11	-5.81	-6.28	-6.64	-6.87	-7.30	0.00	0.00	0.00	0.00	-0.73	-7.30
WEIGHT CHANGE (GM)	-1257.	-2131.	-2879.	-3457.	-3942.	-4491.	-4848.	-5126.	-5314.	-5645.	0.	0.	0.	0.	-564.	-5645.
METABOLISM(KCAL/DAY)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
METABOLISM(BTU/HOUR)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RESPIRATORY QUOTIENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OVERALL MASS BALANCE																
FOOD MASS IN (GM)	222.	444.	665.	887.	1094.	1298.	1500.	1698.	1893.	2085.	0.	0.	0.	0.	209.	2085.
WATER MASS IN (GM)	1206.	2412.	3618.	4823.	6029.	7234.	8439.	9645.	10850.	12055.	0.	0.	0.	0.	1205.	12055.
OXYGEN MASS IN (GM)	696.	1385.	2068.	2747.	3422.	4094.	4763.	5430.	6095.	6759.	0.	0.	0.	0.	676.	6759.
URINE MASS OUT (GM)	641.	1054.	1492.	1870.	2335.	2800.	3313.	3796.	4205.	4666.	0.	0.	0.	0.	467.	4666.
FECES MASS OUT (GM)	0.	3.	16.	30.	48.	89.	110.	143.	148.	201.	0.	0.	0.	0.	20.	201.
MENSES MASS OUT (GM)	10.	10.	10.	20.	20.	20.	30.	30.	30.	30.	0.	0.	0.	0.	3.	30.
VOMIT MASS OUT (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CO2 MASS OUT (GM)	757.	1506.	2250.	2989.	3720.	4447.	5170.	5890.	6607.	7322.	0.	0.	0.	0.	732.	7322.
ENERGY SOURCES (KCAL)																
FOOD METABOLIZED	921.	1842.	2764.	3685.	4543.	5390.	6231.	7052.	7863.	8656.	0.	0.	0.	0.	866.	8656.
TISSUE METABOLIZED	1412.	2799.	4166.	5519.	6922.	8325.	9724.	11135.	12550.	13977.	0.	0.	0.	0.	1398.	13977.
MASS OF TISSUE (GM)	156.	310.	462.	612.	767.	922.	1077.	1234.	1390.	1549.	0.	0.	0.	0.	155.	1549.
WATER BALANCE (GM)																
IN: FOOD METABOLISM	125.	249.	374.	499.	615.	730.	844.	955.	1065.	1173.	0.	0.	0.	0.	117.	1173.
TISSUE METABOLISM	157.	311.	463.	613.	769.	925.	1081.	1237.	1395.	1553.	0.	0.	0.	0.	155.	1553.
WATER+FOOD MOISTURE	1206.	2412.	3618.	4823.	6029.	7234.	8439.	9645.	10850.	12055.	0.	0.	0.	0.	1205.	12055.
OUT: WITH URINE	625.	1028.	1454.	1824.	2277.	2730.	3231.	3701.	4100.	4549.	0.	0.	0.	0.	455.	4549.
WITH FECES	0.	2.	11.	21.	33.	63.	77.	100.	103.	141.	0.	0.	0.	0.	14.	141.
WITH MENSES	9.	9.	9.	19.	19.	19.	28.	28.	28.	28.	0.	0.	0.	0.	3.	28.
WITH VOMITUS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BY EVAPORATION	1973.	3798.	5462.	7005.	8365.	9761.	10927.	12041.	13163.	14325.	0.	0.	0.	0.	1432.	14325.
CHANGE OF WATER POOL																
(GRAMS)	-1120.	-1865.	-2483.	-2933.	-3281.	-3684.	-3899.	-4033.	-4085.	-4263.	0.	0.	0.	0.	-426.	-4263.
(POUNDS.)	-2.47	-4.11	-5.47	-6.47	-7.23	-8.12	-8.60	-8.89	-9.01	-9.40	0.00	0.00	0.00	0.00	-0.94	-9.40
(PER CENT)	-1.45	-2.43	-3.24	-3.81	-4.26	-4.77	-5.06	-5.24	-5.30	-5.53	0.00	0.00	0.00	0.00	-0.55	-5.53

WATER REQUIREMENT DATA PRESENTATION --- CCD CONTRACT DAHC20-68-C-0173 --- TEST NUMBER 5. -- 16 SUBJECTS FOR 9 DAYS.

13. OF THE 16 SUBJECTS COMPLETED THIS TEST.

THE UNITS OF INPUT SUBJECT WEIGHT ARE POUNDS

THE AVERAGE SUBJECT IS ASSUMED TO BE A 160 LB. MALE , WITH AN AVERAGE METABOLIC RATE OF 372. BTU/HOUR.
THE ABOVE METABOLIC RATE MIGHT ALSO BE EXPRESSED AS 8928. BTU/DAY OR 2250. KILOCALORIES/DAY.
KLEIBERS LAW IS USED TO DETERMINE METABOLIC RATE, USING AN EXPONENT OF 0.750

FOOD DATA
SURVIVAL CRACKER: TOTAL MASS = 5. GRAMS. MOISTURE FRACTION = 0.0232.
DRY BASIS FRACTIONAL COMPOSITIONS HAVE BEEN FOUND TO BE: PROTEIN (0.083) FAT(0.025) CARBOHYDRATE (0.877).
SURVIVAL CANDY: TOTAL MASS = 5.300 GRAMS. MOISTURE FRACTION = 0.0028.
DRY BASIS FRACTIONAL COMPOSITIONS HAVE BEEN FOUND TO BE: CARBOHYDRATE (0.942).
IN BOTH CRACKERS AND CANDY THERE IS SOME ASH.

MOST SUBJECTS METABOLIZED TISSUE. FOR MASS DETERMINATIONS, THIS TISSUE HAS BEEN ASSUMED TO BE 0.90 FAT, THE REMAINDER PROTEIN.

SEVERAL METABOLIC PARAMETERS FOR:	PROTEIN,	FAT AND	CARBOHYDRATE
COEFFICIENT OF DIGESTION	0.92	0.95	0.98
FUEL VALUE (KCAL/GRAM)	4.400	9.540	4.100
OXYGEN REQUIRED (GRAM/GRAM)	1.380	2.865	1.184
CO2 PRODUCED (GRAM/GRAM)	1.535	2.804	1.548
WATER PRODUCED (GRAM/GRAM)	0.400	1.070	0.580

ASSUMED VALUES FOR EXCRETED MATERIALS:
SPECIFIC GRAVITY OF URINE = 1.025 AND ITS WATER MASS FRACTION IS 0.975
THE WATER MASS FRACTION OF FECES = 0.700
THE WATER MASS FRACTION OF MENSES = 0.950
THE WATER MASS FRACTION OF VOMIT = 0.950

THIS IS RUN NUMBER 5

NINE DAY TEST (MEN) - 11/15/69 THROUGH 11/24/69 - RUN 11/26/69 BY JON M. RUECK

TEST NUMBER 5. DATA FROM AVERAGE SUBJECT. SPECIAL NOTES: NINE DAY TEST (MEN) - 11/15/69 THROUGH 11/24/69 - RUN 11/26/69
BY JON M. RLECK

VARIABLE NAME (UNITS)	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12	DAY 13	DAY 14	MEAN	SUM
-----INPUT DATA-----																
INITIAL WEIGHT (KG)	75.90	74.54	73.88	73.47	73.07	72.81	72.53	72.39	72.16	0.00	0.00	0.00	0.00	0.00	73.42	
EVENING WEIGHT (KG)	75.43	74.54	74.00	73.66	73.33	73.02	72.86	72.59	72.46	0.00	0.00	0.00	0.00	0.00	73.54	
FINAL WEIGHT (KG)	74.54	73.88	73.47	73.07	72.81	72.53	72.39	72.16	71.97	0.00	0.00	0.00	0.00	0.00	72.98	
WATER CONSUMED (ML)	1440.	1440.	1440.	1440.	1440.	1440.	1440.	1440.	1440.	0.	0.	0.	0.	0.	1440.	12960.
FOOD UNITS EATEN (#)	48.00	48.00	48.00	47.38	39.54	39.92	40.88	40.46	40.54	0.00	0.00	0.00	0.00	0.00	43.64	392.73
CANDY BITS EATEN (#)	16.00	16.00	15.00	16.00	14.00	14.69	14.42	14.38	15.38	0.00	0.00	0.00	0.00	0.00	15.21	136.88
URINE VOIDED (ML)	831.	426.	390.	394.	412.	407.	403.	455.	447.	0.	0.	0.	0.	0.	463.	4164.
FECES VOIDED (GM)	[illegible]	6.	4.	60.	28.	31.	38.	45.	35.	0.	0.	0.	0.	0.	27.	246.
MENSES VOIDED (GM)	10.	0.	0.	10.	0.	0.	10.	0.	0.	0.	0.	0.	0.	0.	3.	30.
VOMITUS VOIDED (GM)	[illegible]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
-CALCULATED RESULTS-																
AVERAGE WEIGHT (KG)	75.29	74.32	73.78	73.40	73.07	72.79	72.59	72.38	72.20	0.00	0.00	0.00	0.00	0.00	73.31	
WEIGHT CHANGE (%)	-1.79	-0.86	-0.53	-0.52	-0.34	-0.34	-0.16	-0.30	-0.24	0.00	0.00	0.00	0.00	0.00	-0.56	-5.07
WEIGHT CHANGE (GM)	-1353.	-664.	-411.	-399.	-261.	-280.	-136.	-231.	-191.	0.	0.	0.	0.	0.	-436.	-3927.
METABOLISM (KCAL/DAY)	2309.	2287.	2274.	2265.	2258.	2251.	2247.	2242.	2238.	0.	0.	0.	0.	0.	2263.	20371.
METABOLISM (BTU/HOUR)	382.	378.	376.	375.	373.	372.	372.	371.	370.	0.	0.	0.	0.	0.	374.	3368.
RESPIRATORY QUOTIENT	0.80	0.80	0.80	0.80	0.79	0.79	0.79	0.79	0.79	0.00	0.00	0.00	0.00	0.00	0.80	
OVERALL MASS BALANCE																
FOOD MASS IN (GM)	241.	241.	241.	238.	199.	201.	206.	203.	204.	0.	0.	0.	0.	0.	219.	1974.
WATER MASS IN (GM)	1444.	1444.	1444.	1444.	1443.	1443.	1443.	1443.	1443.	0.	0.	0.	0.	0.	1444.	12992.
OXYGEN MASS IN (GM)	688.	691.	677.	675.	674.	672.	671.	669.	668.	0.	0.	0.	0.	0.	675.	6075.
URINE MASS OUT (GM)	852.	436.	400.	404.	422.	417.	413.	466.	458.	0.	0.	0.	0.	0.	474.	4269.
FECES MASS OUT (GM)	[illegible]	6.	4.	60.	28.	31.	38.	45.	35.	0.	0.	0.	0.	0.	27.	246.
MENSES MASS OUT (GM)	10.	0.	0.	10.	0.	0.	10.	0.	0.	0.	0.	0.	0.	0.	3.	30.
VOMIT MASS OUT (GM)	[illegible]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CO2 MASS OUT (GM)	758.	751.	748.	744.	730.	729.	729.	727.	726.	0.	0.	0.	0.	0.	738.	6642.
ENERGY SOURCES (KCAL)																
FOOD METABOLIZED	959.	959.	959.	947.	790.	798.	817.	808.	810.	0.	0.	0.	0.	0.	872.	7847.
TISSUE METABOLIZED	1350.	1328.	1315.	1318.	1468.	1454.	1430.	1434.	1428.	0.	0.	0.	0.	0.	1392.	12524.
MASS OF TISSUE (GM)	150.	147.	146.	146.	163.	161.	158.	159.	158.	0.	0.	0.	0.	0.	154.	1388.
WATER BALANCE (GM)																
IN: FOOD METABOLISM	132.	132.	132.	130.	109.	110.	113.	111.	112.	0.	0.	0.	0.	0.	120.	1081.
TISSUE METABOLISM	150.	148.	146.	147.	163.	162.	159.	159.	159.	0.	0.	0.	0.	0.	155.	1392.
WATER+FOOD MOISTURE	1444.	1444.	1444.	1444.	1443.	1443.	1443.	1443.	1443.	0.	0.	0.	0.	0.	1444.	12992.
OUT: WITH URINE	831.	425.	390.	394.	412.	407.	403.	454.	447.	0.	0.	0.	0.	0.	462.	4162.
WITH FECES	[illegible]	4.	3.	42.	19.	22.	27.	32.	25.	0.	0.	0.	0.	0.	19.	173.
WITH MENSES	9.	0.	0.	9.	0.	0.	9.	0.	0.	0.	0.	0.	0.	0.	3.	28.
WITH VOMITUS	[illegible]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BY EVAPORATION	2105.	1837.	1623.	1537.	1398.	1420.	1265.	1309.	1287.	0.	0.	0.	0.	0.	1531.	13780.
CHANGE OF WATER POOL																
(GRAMS)	-1227.	-542.	-293.	-262.	-114.	-133.	10.	-81.	-45.	0.	0.	0.	0.	0.	-298.	-2679.
(POUNDS)	-2.69	-1.20	-0.65	-0.58	-0.25	-0.29	0.02	-0.18	-0.10	0.00	0.00	0.00	0.00	0.00	-0.66	-5.91
(PER CENT)	-1.61	-0.70	-0.38	-0.34	-0.15	-0.15	0.03	-0.10	-0.05	0.00	0.00	0.00	0.00	0.00	-0.38	-3.45

TEST NUMBER 9. DATA FROM CUM AVG SUBJECT. SPECIAL NOTES: NINE DAY TEST (MEN) - 11/15/69 THROUGH 11/24/69 - RUN 11/26/69
BY JON M. RUECK

VARIABLE NAME (UNITS)	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12	DAY 13	DAY 14	MEAN	SUM
-----INPUT DATA-----																
INITIAL WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
EVENING WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
FINAL WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
WATER CONSUMED (ML)	1440.	2880.	4320.	5760.	7200.	8640.	10080.	11520.	12960.	0.	0.	0.	0.	0.	1440.	12960.
FOOD UNITS EATEN (#)	48.00	96.00	144.00	191.38	230.92	270.85	311.73	352.19	392.73	0.00	0.00	0.00	0.00	0.00	43.64	392.73
CANDY BITS EATEN (#)	16.00	32.00	48.00	64.00	78.00	92.69	107.12	121.50	136.88	0.00	0.00	0.00	0.00	0.00	15.21	136.88
URINE VOIDED (ML)	831.	1257.	1647.	2041.	2453.	2860.	3263.	3718.	4164.	0.	0.	0.	0.	0.	463.	4164.
FECES VOIDED (GM)	0.	6.	9.	69.	97.	128.	166.	211.	246.	0.	0.	0.	0.	0.	27.	246.
MENSES VOIDED (GM)	10.	10.	10.	20.	20.	20.	30.	30.	30.	0.	0.	0.	0.	0.	3.	30.
VOMITUS VOIDED (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
-CALCULATED RESULTS-																
AVERAGE WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
WEIGHT CHANGE (%)	-1.79	-2.65	-3.18	-3.70	-4.04	-4.38	-4.54	-4.83	-5.07	0.00	0.00	0.00	0.00	0.00	-0.56	-5.07
WEIGHT CHANGE (GM)	-1353.	-2317.	-2428.	-2827.	-3088.	-3369.	-3505.	-3736.	-3927.	0.	0.	0.	0.	0.	-436.	-3927.
METABOLISM(KCAL/DAY)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
METABOLISM(BTU/HOUR)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RESPIRATORY QUOTIENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OVERALL MASS BALANCE																
FOOD MASS IN (GM)	241.	482.	723.	961.	1160.	1361.	1566.	1770.	1974.	0.	0.	0.	0.	0.	219.	1974.
WATER MASS IN (GM)	1444.	2888.	4332.	5776.	7219.	8662.	10105.	11549.	12992.	0.	0.	0.	0.	0.	1444.	12992.
OXYGEN MASS IN (GM)	688.	1369.	2046.	2721.	3395.	4067.	4738.	5407.	6075.	0.	0.	0.	0.	0.	675.	6075.
URINE MASS OUT (GM)	852.	1288.	1688.	2092.	2514.	2931.	3345.	3810.	4269.	0.	0.	0.	0.	0.	474.	4269.
FECES MASS OUT (GM)	0.	6.	9.	69.	97.	128.	166.	211.	246.	0.	0.	0.	0.	0.	27.	246.
MENSES MASS OUT (GM)	10.	10.	10.	20.	20.	20.	30.	30.	30.	0.	0.	0.	0.	0.	3.	30.
VOMIT MASS OUT (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CO2 MASS OUT (GM)	758.	1509.	2257.	3001.	3731.	4460.	5189.	5916.	6642.	0.	0.	0.	0.	0.	738.	6642.
ENERGY SOURCES (KCAL)																
FOOD METABOLIZED	959.	1915.	2877.	3824.	4614.	5412.	6229.	7037.	7847.	0.	0.	0.	0.	0.	872.	7847.
TISSUE METABOLIZED	1357.	2677.	3993.	5311.	6779.	8233.	9663.	11096.	12524.	0.	0.	0.	0.	0.	1392.	12524.
MASS OF TISSUE (GM)	150.	297.	442.	588.	751.	912.	1071.	1229.	1388.	0.	0.	0.	0.	0.	154.	1388.
WATER BALANCE (GM)																
IN: FOOD METABOLISM	132.	264.	396.	526.	635.	745.	858.	969.	1081.	0.	0.	0.	0.	0.	120.	1081.
TISSUE METABOLISM	150.	298.	444.	590.	753.	915.	1074.	1233.	1392.	0.	0.	0.	0.	0.	155.	1392.
WATER+FOOD MOISTURE	1444.	2888.	4332.	5776.	7219.	8662.	10105.	11549.	12992.	0.	0.	0.	0.	0.	1444.	12992.
OUT: WITH URINE	831.	1256.	1646.	2040.	2451.	2858.	3261.	3715.	4162.	0.	0.	0.	0.	0.	462.	4162.
WITH FECES	0.	4.	7.	49.	68.	90.	116.	148.	173.	0.	0.	0.	0.	0.	19.	173.
WITH MENSES	9.	9.	9.	19.	19.	19.	28.	28.	28.	0.	0.	0.	0.	0.	3.	28.
WITH VOMITUS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BY EVAPORATION	2105.	3942.	5564.	7101.	8499.	9919.	11184.	12493.	13780.	0.	0.	0.	0.	0.	1531.	13780.
CHANGE OF WATER POOL																
(GRAMS)	[illegible]	-1762	-2055.	-2316.	-2430.	-2563.	-2553.	-2634.	-2679.	0.	0.	0.	0.	0.	-298.	-2679.
(POUNDS)	[illegible]	[illegible]	-4.53	-5.11	-5.36	-5.65	-5.63	-5.81	-5.91	0.00	0.00	0.00	0.00	0.00	-0.66	-5.91
(PER CENT)	-1.61	-2.21	-2.69	-3.03	-3.18	-3.33	-3.30	-3.40	-3.45	0.00	0.00	0.00	0.00	0.00	-0.38	-3.45

WATER REQUIREMENT DATA PRESENTATION --- OCD CONTRACT DAHC20-68-C-0173 --- TEST NUMBER 2. -- 16 SUBJECTS FOR 5 DAYS.

16. OF THE 16 SUBJECTS COMPLETED THIS TEST.

THE UNITS OF INPUT SUBJECT WEIGHT ARE KILOGRAMS

THE AVERAGE SUBJECT IS ASSUMED TO BE A 160 LB. MALE , WITH AN AVERAGE METABOLIC RATE OF 372. BTU/HOUR.
THE ABOVE METABOLIC RATE MIGHT ALSO BE EXPRESSED AS 8928. BTU/DAY OR 2250. KILOCALORIES/DAY.
KLEIBERS LAW IS USED TO DETERMINE METABOLIC RATE, USING AN EXPONENT OF 0.750

FOOD DATA

SURVIVAL CRACKER: TOTAL MASS = 5.003 GRAMS. MOISTURE FRACTION = 0.0232.
DRY BASIS FRACTIONAL COMPOSITIONS HAVE BEEN FOUND TO BE: PROTEIN (0.083) FAT(0.025) CARBOHYDRATE (0.877).
SURVIVAL CANDY: TOTAL MASS = 5.300 GRAMS. MOISTURE FRACTION = 0.0028.
DRY BASIS FRACTIONAL COMPOSITIONS HAVE BEEN FOUND TO BE: CARBOHYDRATE (0.942).
IN BOTH CRACKERS AND CANDY THERE IS SOME ASH.

MOST SUBJECTS METABOLIZED TISSUE. FOR MASS DETERMINATIONS, THIS TISSUE HAS BEEN ASSUMED TO BE 0.90 FAT, THE REMAINDER PROTEIN.

SEVERAL METABOLIC PARAMETERS FOR:		PROTEIN,	FAT AND	CARBOHYDRATE
COEFFICIENT OF DIGESTION		0.92	0.95	0.98
FUEL VALUE	(KCAL/GRAM)	4.400	9.540	4.100
OXYGEN REQUIRED	(GRAM/GRAM)	1.360	2.885	1.184
CO2 PRODUCED	(GRAM/GRAM)	1.535	2.804	1.548
WATER PRODUCED	(GRAM/GRAM)	0.400	1.070	0.580

ASSUMED VALUES FOR EXCRETED MATERIALS:
SPECIFIC GRAVITY OF URINE = 1.025 AND ITS WATER MASS FRACTION IS 0.975
THE WATER MASS FRACTION OF FECES = 0.700
THE WATER MASS FRACTION OF MENSES = 0.950
THE WATER MASS FRACTION OF VOMIT = 0.950

THIS IS RUN NUMBER 2

UN # 2, TEST # 2, METABOLIC RATE = 372 B/HR. THIS RUN USES DISCRETE URINE VOLUME DATA AND ENERGY BASED FOOD COMPOSITIONS. RUN
7 JUNE 1969

TEST NUMBER 2. DATA FROM AVERAGE SUBJECT. SPECIAL NOTES: RUN # 2, TEST # 2, METABOLIC RATE = 372 B/HR. THIS RUN USES DISCRETE URINE VOLUME DATA AND ENERGY BASED FOOD COMPOSITIONS. RUN 27 JUNE 1969

VARIABLE NAME (UNITS)	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12	DAY 13	DAY 14	MEAN	SUM
-----INPUT DATA-----																
INITIAL WEIGHT (KG)	74.81	73.92	73.32	73.08	72.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.57	
EVENING WEIGHT (KG)	74.45	73.86	73.61	73.25	72.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.62	
FINAL WEIGHT (KG)	73.92	73.32	73.08	72.71	72.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.08	
WATER CONSUMED (ML)	1755.	1840.	1833.	1788.	1738.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1791.	8954.
FOOD UNITS EATEN (#)	50.79	50.41	47.25	43.53	38.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.12	230.61
CANDY BITS EATEN (#)	3.88	3.88	3.88	3.88	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.90	19.50
URINE VOIDED (ML)	883.	623.	558.	498.	621.	0.	0.	0.	0.	0.	0.	0.	0.	0.	637.	3184.
FECES VOIDED (GM)	0.	0.	0.	23.	15.	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.	39.
MENSES VOIDED (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
VOMITUS VOIDED (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
-CALCULATED RESULTS-																
AVERAGE WEIGHT (KG)	74.39	73.70	73.34	73.01	72.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.42	
WEIGHT CHANGE (%)	-1.16	-0.77	-0.31	-0.48	-0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.63	-3.15
WEIGHT CHANGE (GM)	-896.	-593.	-243.	-371.	-339.	0.	0.	0.	0.	0.	0.	0.	0.	0.	-489.	-2443.
METABOLISM(KCAL/DAY)	2289.	2273.	2265.	2257.	2249.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2267.	11333.
METABOLISM(BTU/HOUR)	378.	376.	374.	373.	372.	0.	0.	0.	0.	0.	0.	0.	0.	0.	375.	1874.
RESPIRATORY QUOTIENT	0.80	0.81	0.80	0.79	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	
OVERALL MASS BALANCE																
FOOD MASS IN (GM)	250.	248.	232.	214.	190.	0.	0.	0.	0.	0.	0.	0.	0.	0.	227.	1135.
WATER MASS IN (GM)	1760.	1846.	1838.	1792.	1742.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1796.	8979.
OXYGEN MASS IN (GM)	682.	677.	675.	674.	672.	0.	0.	0.	0.	0.	0.	0.	0.	0.	676.	3380.
URINE MASS OUT (GM)	905.	639.	572.	511.	637.	0.	0.	0.	0.	0.	0.	0.	0.	0.	653.	3263.
FECES MASS OUT (GM)	0.	0.	0.	23.	15.	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.	39.
MENSES MASS OUT (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
VOMIT MASS OUT (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CO2 MASS OUT (GM)	755.	749.	742.	734.	725.	0.	0.	0.	0.	0.	0.	0.	0.	0.	741.	3705.
ENERGY SOURCES (KCAL)																
FOOD METABOLIZED	1016.	1004.	945.	871.	773.	0.	0.	0.	0.	0.	0.	0.	0.	0.	923.	4613.
TISSUE METABOLIZED	1273.	1265.	1320.	1386.	1477.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1344.	6720.
MASS OF TISSUE (GM)	141.	140.	146.	154.	164.	0.	0.	0.	0.	0.	0.	0.	0.	0.	149.	745.
WATER BALANCE (GM)																
IN: FOOD METABOLISM	138.	137.	129.	119.	105.	0.	0.	0.	0.	0.	0.	0.	0.	0.	126.	628.
TISSUE METABOLISM	141.	141.	147.	154.	164.	0.	0.	0.	0.	0.	0.	0.	0.	0.	149.	747.
WATER+FOOD MOISTURE	1760.	1846.	1836.	1792.	1742.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1796.	8979.
OUT: WITH URINE	882.	623.	558.	498.	621.	0.	0.	0.	0.	0.	0.	0.	0.	0.	636.	3182.
WITH FECES	0.	0.	0.	16.	11.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	27.
WITH MENSES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
WITH VOMITUS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BY EVAPORATION	1929.	1976.	1675.	1783.	1567.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1786.	8930.
CHANGE OF WATER POOL																
(GRAMS)	-770.	-475.	-113.	-233.	-187.	0.	0.	0.	0.	0.	0.	0.	0.	0.	-357.	-1785.
(POUNDS.)	-1.70	-1.05	-0.26	-0.51	-0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.79	-3.93
(PER CENT)	-0.99	-0.62	-0.15	-0.30	-0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.46	-2.28

TEST NUMBER 2. DATA FROM CUM AVG SUBJECT. SPECIAL NOTES: RUN # 2, TEST # 2, METABOLIC RATE = 372 B/HR. THIS RUN USES DIS CRETE URINE VOLUME DATA AND ENERGY BASED FOOD COMPOSITIONS. RUN 27 JUNE 1969

VARIABLE NAME (UNITS)	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12	DAY 13	DAY 14	MEAN	SUM
-----INPUT DATA-----																
INITIAL WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
EVENING WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
FINAL WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
WATER CONSUMED (ML)	1755.	3595.	5428.	7216.	8954.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1791.	8954.
FOOD UNITS EATEN (#)	50.90	101.21	148.46	191.39	230.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.12	230.61
CANDY BITS EATEN (#)	3.88	7.75	11.63	15.50	19.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.90	19.50
URINE VOIDED (ML)	883.	1506.	2064.	2562.	3184.	0.	0.	0.	0.	0.	0.	0.	0.	0.	637.	3184.
FECES VOIDED (GM)	0.	0.	0.	23.	39.	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.	39.
MENSES VOIDED (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
VOMITUS VOIDED (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
-CALCULATED RESULTS-																
AVERAGE WEIGHT (KG)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
WEIGHT CHANGE (%)	-1.16	-1.93	-2.24	-2.73	-3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.63	-3.15
WEIGHT CHANGE (GM)	-896.	-1489.	-1733.	-2104.	-2443.	0.	0.	0.	0.	0.	0.	0.	0.	0.	-489.	-2443.
METABOLISM(KCAL/DAY)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
METABOLISM(BTU/HOUR)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RESPIRATORY QUOTIENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
OVERALL MASS BALANCE																
FOOD MASS IN (GM)	250.	498.	730.	944.	1135.	0.	0.	0.	0.	0.	0.	0.	0.	0.	227.	1135.
WATER MASS IN (GM)	1760.	3606.	5444.	7237.	8979.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1796.	8979.
OXYGEN MASS IN (GM)	682.	1359.	2034.	2708.	3380.	0.	0.	0.	0.	0.	0.	0.	0.	0.	676.	3380.
URINE MASS OUT (GM)	905.	1544.	2116.	2626.	3263.	0.	0.	0.	0.	0.	0.	0.	0.	0.	653.	3263.
FECES MASS OUT (GM)	0.	0.	0.	23.	39.	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.	39.
MENSES MASS OUT (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
VOMIT MASS OUT (GM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CO2 MASS OUT (GM)	755.	1504.	2246.	2980.	3705.	0.	0.	0.	0.	0.	0.	0.	0.	0.	741.	3705.
ENERGY SOURCES (KCAL)																
FOOD METABOLIZED	1016.	2024.	2970.	3840.	4613.	0.	0.	0.	0.	0.	0.	0.	0.	0.	923.	4613.
TISSUE METABOLIZED	1273.	2539.	3857.	5244.	6720.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1344.	6720.
MASS OF TISSUE (GM)	141.	281.	427.	581.	745.	0.	0.	0.	0.	0.	0.	0.	0.	0.	149.	745.
WATER BALANCE (GM)																
IN: FOOD METABOLISM	138.	276.	404.	523.	628.	0.	0.	0.	0.	0.	0.	0.	0.	0.	126.	628.
TISSUE METABOLISM	141.	282.	429.	583.	747.	0.	0.	0.	0.	0.	0.	0.	0.	0.	149.	747.
WATER+FOOD MOISTURE	1760.	3606.	5444.	7237.	8979.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1796.	8979.
OUT: WITH URINE	882.	1505.	2063.	2561.	3182.	0.	0.	0.	0.	0.	0.	0.	0.	0.	636.	3182.
WITH FECES	0.	0.	0.	16.	27.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	27.
WITH MENSES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
WITH VOMITUS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BY EVAPORATION	1928.	3904.	5579.	7362.	8930.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1786.	8930.
CHANGE OF WATER POOL																
(GRAMS)	-770.	-1246.	-1365.	-1598.	-1785.	0.	0.	0.	0.	0.	0.	0.	0.	0.	-357.	-1785.
(POUNDS)	-1.70	-2.75	-3.01	-3.52	-3.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.79	-3.93
(PER CENT)	-0.99	-1.60	-1.75	-2.05	-2.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.46	-2.28

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VITAE

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WATER REQUIREMENTS

FOR

PROLONGED SHELTER OCCUPANCY

by

JON MICHAEL RUECK

B. S., Kansas State University, 1964

AN ABSTRACT OF A MASTER'S THESIS

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ABSTRACT

Water requirements for prolonged shelter occupancy is the topic of this study by an inter-disciplinary research team of engineers, nutritionists, physiologists, and psychologists. This thesis presents an engineer's point-of-view on the topic, including the development of a model of the water pool which exists in a human subject. This model describes the same water pool described in the physiological literature. The project involved testing 96 subjects in 6 tests.

Evaporation as a heat exchange mechanism is studied and is a major part of the model. Metabolic rate is treated rather lightly and is accounted for by assuming a fit of the law of Kleiber, which relates this parameter to the weight of an individual raised to the 3/4 power. Nitrogen balance is considered to be negative, in the sense that due to the semi-starvation nutritional conditions of the tests, some tissue was catabolized. This deficit in nitrogen was not considered sufficient to rule out an assumption of no net respiratory nitrogen exchange.

The purposes of this study were to evaluate a water ration of 1 quart per person per day for a 14 day occupancy, to determine if this amount was sufficient for "survival" and if not, to find the length of time $3\frac{1}{2}$ gallons per person would be sufficient, and find an adequate ration for 14 days. For a survival definition taken as 7% water pool loss as a per cent of body weight, a ration of 1 quart per day was found (statistically) to be sufficient for 8 days. The 14 day allotment of $3\frac{1}{2}$ gallons of water would last about 11 days if consumed at the recommended rate of $1\frac{1}{4}$ quarts per day with 960 kcal of OCD Survival Ration. The most observable effect shown by the subjects who failed to complete the tests was stumbling behaviour. The recommendation of this study is, for a 14 day shelter stay, $1\frac{1}{4}$ quarts of water per person per day with 960 kcal of OCD ration per person per day. The author feels that such a plan would provide sufficient water and food to meet the metabolic requirements for survival for 14 days at 82° F. ET in a well managed shelter.