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THE MEAL, READY-TO-EAT CONSUMED IN A COLD ENVIRONMENT

U S ARMY RESEARCH INSTITUTE
OF
ENVIRONMENTAL MEDICINE
Natick, Massachusetts

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The Meal Ready-to-Eat (MRE) was adopted into service in 1985 as a replacement for the Meal Combat Individual. It provides individual meals in field feeding environments when centralized feeding is either impractical or not possible. To determine the suitability of using the MRE in a cold environment, the validity of a supplemental pack as a cold weather energy supplement and the effectiveness of a chemical Ration Heater Pad (RHP), a 10 day field study was held in Alaska in March 1989. Approximately half of the soldiers in one Company were fed 4 MRE VIs and the other half 3 or 4 MREs Vllls daily. In the other Company, half of the soldiers were fed 3 MRE VIs plus a supplemental pack and the other half, 3 MRE Vllls plus a supplemental pack daily. Each soldier was given a RHP to heat his meals.				
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ABSTRACT (Continued)

Initial and final body weights, heights, blood and urine samples were taken on all subjects and, on a smaller sample, activity monitors were attached. Daily urine samples were collected and Dietary Logs completed on the amount of food and water consumed and the acceptability of individual food items. A final questionnaire was also administered at the end of the study.

The mean daily energy intake confirms the success of the supplemental pack and, while total energy intake in the group consuming MRE VIII and supplemental pack is an improvement over earlier studies, it still only represents between 42% and 78% of the Military Recommended Dietary Allowances (MRDA) of 4500 kcal. Further improvement in the overall intake of the MRE, in particular energy, is needed.

Despite the additional MRE VIII issued to one group, the frequency of consumption and intake of energy, protein, fat and carbohydrate were not significantly increased. The supplemental pack therefore provides a viable alternative to issuing a fourth MRE VIII.

The results show that by day three, two groups (one company) were hypohydrated. This was due almost exclusively to the low water intake which was less than two liters per man per day. Only after direct intervention did water intake, and consequently hydration status, improve. Further efforts to improve water intake need to be investigated. Water and food intakes were found to be strongly correlated, although it is not clear whether food induced water consumption or water induced food consumption.

Subjects subjectively evaluated the color, lightness/darkness, frequency and amount of their urine. Although the correlations were not strong, these easily measured attributes do provide a broad indication of hydration status and remain a valid yardstick for commanders in the field.

The number of empty wrappers and unused food items were quantified and compared with entries in the 24-hour Dietary Logs. With the exception of 'other foods' (e.g. soup and gravy base, catsup and salt) in one group, no significant differences were found between the two methods.

Activity levels during the study indicate that the 4 groups had similar sleep-wake patterns. The amount of sleep, in this study, was not a major influencing factor in the quantity of food and water consumed.

While some damage was reported to pouches as a result of freezing, 94% of the soldiers reported that the brown outer MRE bag was never torn or damaged, while 84% said the individual food packets were never torn or damaged. Almost all of the soldiers indicated that the packaging for the supplemental pack items was undamaged which, in view of the nature of the products, is to be expected. However, in most cases, damage only becomes apparent when unconsumed rations are returned and thaw out at the end of the exercise. Here a failure rate as high as 20% has been reported. Under harsh environmental conditions where rations are subjected to freezing and rough handling, wet pack items may not be the ideal ration and consideration should be given to replacing the MRE with a dehydrated ration.

Although soldiers were issued one RHP with each of their meals, in many cases they chose not to take or use them. This was not necessarily due to short-comings in the RHP since other heat sources were available and more suited to this type of environment. The low use of the RHP under these conditions precludes any definitive conclusion from being drawn. Further work is required to assess the suitability of the RHP and whether it is a feasible method of increasing the consumption of the entree.

HUMAN RESEARCH AND DISCLAIMER STATEMENTS

Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on the Use of Volunteers in Research.

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THE MEAL, READY-TO-EAT CONSUMED
IN A COLD ENVIRONMENT

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FOREWORD

The initial rationale leading to this study was to develop a supplemental pack that could be used to enhance the acceptability and nutritional intake obtained from the older versions of the Meals, Ready-to-Eat (MRE V to VII). However, for the results of this study to be utilized in the development and procurement process, a report was required in a timely manner. This was achieved and an initial report (1) was provided addressing the issues of nutritional intake and acceptability.

The first report focused principally upon nutrient intakes and food acceptability and included only those objectives, methodology, results and discussion pertinent to a procurement decision. This second report now addresses other aspect of the study which, because of time, were not considered before.

ACKNOWLEDGEMENTS

In addition to those personnel acknowledged in the first report, the authors would like to acknowledge the assistance provided by Daniel Williams, Dean Harris and Carlo Radovsky for their work on the data analysis, April Armstrong for her work on the graphics presentation and to Dr. Don Poe for his advice and guidance in the manipulation and interpretation of the data.

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ABSTRACT

The Meal Ready-to-Eat (MRE) was adopted into service in 1985 as a replacement for the Meal Combat Individual. It provides individual meals in field feeding environments when centralized feeding is either impractical or not possible.

To determine the suitability of using the MRE in a cold environment, the validity of a supplemental pack as a cold weather energy supplement and the effectiveness of a chemical Ration Heater Pad (RHP), a 10 day field study was held in Alaska in March 1989. Approximately half of the soldiers in one Company were fed 4 MRE VIs and the other half 3 or 4 MREs VIIIs daily. In the other Company, half of the soldiers were fed 3 MRE VIs plus a supplemental pack and the other half, 3 MRE VIIIs plus a supplemental pack daily. Each soldier was given a RHP to heat his meals.

Initial and final body weights, heights, blood and urine samples were taken on all subjects and, on a smaller sample, activity monitors were attached. Daily urine samples were collected and Dietary Logs completed on the amount of food and water consumed and the acceptability of individual food items. A final questionnaire was also administered at the end of the study.

The mean daily energy intake confirms the success of the supplemental pack and, while total energy intake in the group consuming MRE VIII and supplemental pack is an improvement over earlier studies: it still only represents between 42% and 78% of the Military Recommended Dietary Allowances (MRDA) of 4500 kcal. Further improvement in the overall intake of the MRE, in particular energy, is needed.

Despite the additional MRE VIII issued to one group, the frequency of consumption and intake of energy, protein, fat and carbohydrate were not significantly increased. The supplemental pack therefore provides a viable alternative to issuing a fourth MRE VIII.

The results show that by day three, two groups (one company) were hypohydrated. This was due almost exclusively to the low water intake which was less than two liters per man per day. Only after direct intervention did water intake, and consequently hydration status, improve. Further efforts to improve water intake need to be investigated. Water and food intakes were found to be strongly correlated, although it is not clear whether food induced water consumption or water induced food consumption.

Subjects subjectively evaluated the color, lightness/darkness, frequency and amount of their urine. Although the correlations were not strong, these easily measured attributes do provide a broad indication of hydration status and remain a valid yardstick for commanders in the field.

The number of empty wrappers and unused food items were quantified and compared with entries in the 24-hour Dietary Logs. With the exception of 'other foods' (e.g. soup and gravy base, catsup and salt) in one group, no significant differences were found between the two methods.

Activity levels during the study indicate that the 4 groups had similar sleep-wake patterns. The amount of sleep, in this study, was not a major influencing factor in the quantity of food and water consumed.

While some damage was reported to pouches as a results of freezing, 94% of the soldiers reported that the brown outer MRE bag was never torn or damaged, while 84% said the individual food packets were never torn or damaged. Almost all of the soldiers indicated that the packaging for the supplemental pack items was undamaged which, in view of the nature of the products, is to be expected. However, in most cases, damage only becomes apparent when unconsumed rations are returned and thaw out at the end of the exercise. Here a failure rate as high as 20% has been reported. Under harsh environmental conditions where rations are subjected to freezing and rough handling, wet pack items may not be the ideal ration and consideration should be given to replacing the MRE with a dehydrated ration.

Although soldiers were issued one RHP with each of their meals, in many cases they chose not to take or use them. This was not necessarily due to short-comings in the RHP since other heat sources were available and more suited to this type of environment. The low use of the RHP under these conditions precludes any definitive conclusion from being drawn. Further work is required to assess the suitability of the RHP and whether it is a feasible method of increasing the consumption of the entree.

INTRODUCTION

Type classified in 1975, the Meal, Ready-to-Eat (MRE) was adopted into service in 1985 as a replacement for the Meal Combat Individual. It now forms part of the Army Field Feeding System (AFFS) where it provides individual meals when centralized feeding is either impractical or not possible.

Since its original type classification, a number of changes and improvements have been made. These have been evaluated in various field studies (2,3,4,5) and in 1986 MRE IV, MRE VII and MRE VIII were compared so as to provide the basis for a decision on future procurement (6).

Although it has been used in a cold environment, questions have arisen on whether the retort pouch can withstand the rigors of a cold environment and how well soldiers cope with the ration once it becomes frozen. In addition DoD Task Force 2000 (7) has established an urgent need for a supplemental pack to enhance the satisfaction of consumers using the older versions of the MRE (MRE IV to VII).

In order to address these issues, a supplemental pack containing items most often requested by the soldier, but not found in the MRE, was developed by the Food Engineering Directorate, Natick Research, Development and Engineering Center, and tested in Alaska in 1989 with soldiers from the 6th Infantry Division (Light) (6th ID(L)). Details of the supplemental pack are given in Appendix A.

An initial USARIEM Technical Report (1) was produced so that an early decision could be made on whether the supplemental pack should be purchased to enhance the older versions of the MRE. The issues addressed were:

1. Whether soldiers fed the MRE VI or VIII, with or without supplements, consumed sufficient calories to maintain their body weight within acceptable limits.
2. Whether soldiers fed the MRE VI or VIII, with or without supplements, consumed sufficient quantities of menu items to meet the Office of the Surgeon General's Military Recommended Dietary Allowances (MRDA) for protein, vitamins and minerals.
3. Whether the acceptability ratings of the MRE VI and VIII are improved when consumed with and without supplements in a cold environment.

The results demonstrate the success of the supplemental pack in improving energy and nutritional intakes. In the supplemented groups energy intake was approximately 41 percent higher in the groups consuming MRE VI and approximately 27 percent higher in the groups consuming MRE VIII. When the effects of the supplemental pack are removed, energy intake was still 11 percent higher in the MRE VI and 4 percent higher in the MRE VIII group. The supplemental pack was consumed not instead of, but in addition to, the MRE and also increased the intake of the MRE. There was no instance of a reduced vitamin or mineral intake attributable to the consumption of a supplemental pack along with the MRE. Caloric intake from the MRE ranged from 45 percent in the MRE VI to 79 percent in the MRE VIII supplemented group and failed to meet the test criteria. It accounted, in part, for body weight losses which varied from 4.8 lb to 3.0 lb. Even so, no losses exceeded the 3 percent criteria. Consumption of the remaining nutrients followed broadly similar patterns.

Adding the supplemental pack to the MRE ration enhanced the acceptability of the MRE VIII but not the MRE VI. The supplemental pack items themselves were rated very favorably by the subjects in both the MRE VI and the MRE VIII groups and met the test criteria. However, subjects in all groups indicated that they did not have enough to eat, despite the fact that they failed to consume all of the ration. Subjects in the supplemented groups recommended increasing the portion size of the items included in the supplemental pack.

In so far as the nutritional and acceptability factors are concerned, the supplemental pack was a success and a recommendation made that it be considered for purchase.

AIMS

The aims of this Technical Report are to address those issues which could not be considered in the first report or which now merit further and additional consideration, namely:

1. The acceptability and suitability of the supplemental pack for use as a cold weather calorie supplement.
2. Whether water consumption is adequate to maintain hydration status or is affected by the consumption of the MRE and supplemental pack.
3. Whether the retort pouch is compromised in a cold environment.

4. What difficulties soldiers encounter eating MREs in a cold environment and how well they cope with them.
5. The effectiveness and suitability of a chemical ration heater pad (Zestotherm^R) for use in an extreme cold environment.

TEST CRITERIA

The following criteria, pertinent to this report, were established for the study:

Nutritional Adequacy

The mean daily intake of energy, protein, fat, vitamins and minerals for each test group should meet or exceed the Military Recommended Dietary Allowances (8), Table 1.

Body Weight

The mean body weight loss or gain for each test group should not exceed 3% of the initial body weight at any time during the test.

Hydration Status

The mean urine specific gravity for each test group should not exceed 1.030 at any time during the test.

Environmental Suitability

Rations should not be presented in a frozen state more than 10% of the time. No more than 10% of any pouches should sustain damage as a result of freezing or other environmental reason.

Supplemental Pack Acceptance

Soldiers receiving the supplemental pack should not consume quantities of nutrients significantly less than that recorded for the unsupplemented group.

TABLE 1. Military Recommended Dietary Allowances (Male Personnel).

Nutrient	Unit	Dietary Allowance	
		Temperate Climate	Cold Climate
Energy	kcal	3200 (2800-3600)	4500
Protein	gm	100	100
Vitamin A	mcg RE	1000	1000
Vitamin D	mcg	10	10
Vitamin E	mg TE	10	10
Ascorbic Acid	mg	60	60
Thiamin	mg	1.6	1.6 *
Riboflavin	mg	1.9	1.9 *
Niacin	mg NE	21	21 *
Vitamin B6	mg	2.2	2.2
Folacin	mcg	400	400
Vitamin B12	mcg	3	3
Calcium	mg	800-1200	800-1200
Phosphorus	mg	800-1200	800-1200
Magnesium	mg	350-400	350-400
Iron	mg	10-18	10-18
Zinc	mg	15	15
Iodine	mcg	150	150
Sodium	mg	5500	5500**

Source: Reference 8

Notes:

* For extended periods of high energy expenditure additional B Vitamins may be required.

Thiamin 2.3 mg - calculated as 0.5 mg/1000 kcal (Reference 9).
 Riboflavin 2.7 mg - calculated as 0.6 mg/1000 kcal (Reference 9).
 Niacin 30.0 mg NE - calculated as 6.6 mg/1000 kcal (Reference 9).

** Upper Target

METHODOLOGY

Full details of the methodology were contained in the first report (1), although for ease of reference, the salient points and additional methodology are set out below.

Test Subjects

Test subjects were recruited from A Company, 1st Battalion (A/1/17) and A Company, 2nd Battalion (A/2/17), 17th Infantry, both part of the 1st Brigade, 6th Infantry Division (Light) stationed at Fort Richardson, Alaska, and assigned to one of four test groups in order to provide approximately 35 subjects in each group.

Prior to the start of the study, soldiers were given a comprehensive briefing on topics which included the background, aims and objectives of the study, data collection procedures, the risks involved and a subject's right not to take part in the study or to withdraw at any time. They were also warned that additional or privately purchased food ("pogey bait") would not be permitted at any stage during the study and that personal effects and all resupply vehicles entering the training area would be searched. All subjects volunteered to take part in the study and signed the Volunteer Agreement Affidavit (Appendix B). Before leaving the briefing, subjects were given a urine collection container and instructed to return it the following morning with their first morning void.

Pre- and Post-Test Measurements

Pre-test measurements were taken on the morning following the briefing prior to breakfast. Similar post-test measurements were taken at the end of the study where two final questionnaires were also administered. On both occasions soldiers were instructed not to eat before these measurements were taken.

Blood

Fasting blood samples (30 cc) were drawn by venipuncture, without stasis, by a trained phlebotomist. Subjects were seated and samples were taken from the antecubital vein and drawn into serum vacutainers. Two (10 cc each) Serum Separator tubes (SST) were used for serum samples and one (10 cc) Ethylenediaminetetraacetic Acid (EDTA) tube was used for determination of hemoglobin and hematocrit. After the blood in the SST tubes had clotted, the tubes were centrifuged and the serum poured into 4.5 ml cryo tubes for storage (-40°F) and shipment to a clinical laboratory (MedPath, Boston, MA) for analysis. Two samples were prepared with one stored as a backup. The remaining unfrozen serum was used to measure serum osmolality (Wescor vapor pressure method). The EDTA tubes were well mixed, the hematocrit was determined by centrifugation and the hemoglobin was determined by the cyanomethemoglobin method. All tests were performed in duplicate.

Serum samples were analyzed to determine changes in hydration and nutritional status from the beginning to the end of the field test. A standard panel of clinical tests were performed by MedPath which included:

Albumin
Alkaline Phosphatase
Bilirubin, Total
Calcium
Carbon Dioxide
Chloride
Cholesterol
Creatinine
Glucose
Iron
Lactic Dehydrogenase (LDH)
Phosphorus, Inorganic

Potassium
SGOT (AST)
SGPT (ALT)
Sodium
Protein, Total
Triglycerides
Urea Nitrogen (BUN)
Uric Acid
A/G Ratio
BUN/Creatinine Ratio
Electrolyte Balance
Globulin
HDL Cholesterol

Urine

A first void, mid stream urine sample, was collected on the morning of the pre-test measurements and on each day of the study. Samples were collected in 50 cc screw top tubes. Each sample was analyzed for:

Urinary Ketone
Urinary Protein
Leucocytes
pH
Specific Gravity
Sodium
Potassium

Body Weight and Height

Body weights were measured using the Seca digital electronic battery operated scales accurate to ± 0.1 lb. Scales were calibrated, subjects asked to strip and weighed in their "boxer shorts" and socks. Heights were taken as part of the pre-test measurements to ± 0.1 cm.

Activity Levels

Activity levels were sampled to determine sleep/wake patterns in each group and to permit comparisons between the 4 test groups. Prior to being attached, ambulatory activity monitors were initialized to record motor activity in 3 minute epochs for a 10-day period. They were then strapped to subjects' wrists, five subjects from three groups and 10 from the fourth group. They were checked regularly to ensure their presence and proper operation. At the end of the study the monitors were recovered and the information down-loaded via an interface onto a lap-top computer. The data were analyzed using a sleep/wake scoring algorithm for wrist activity.

Ration Heater Pad (Zestotherm^R)

The ration heater pad (RHP) has been proposed as an additional field ration heating method because it: is lightweight; can be packaged individually with the MRE; can be used on the move; does not require fuel, matches or other additional equipment; and requires only two ounces of water. Heat is produced through an exothermic chemical reaction which is activated by pouring a small amount of water on the pad. To heat an MRE, the RHP is placed into the MRE meal bag, 1/4 cup of water added and the MRE entree placed into the bag on top of the pad. Heating reaction takes approximately 15 minutes.

Soldiers were issued one ration heater pad with each of their meals. This study was not designed to rigorously test the RHP; however it was the first Army cold weather field test in which the RHP was utilized, hence soldiers acceptability data was collected.

Daily Measurements

Units taking part in the study underwent their own training and evaluation exercise. The total duration of the study was 10 days for one Company (2 groups) and 11 days for the other. The units continued with their military evaluation exercise after the study was concluded. The 4 test groups were assigned a daily eating regimen as follows:

- Group 1. 4 x MRE VI.
- Group 2. 3.5 x MRE VIII (7 per 2 days).
- Group 3. 3 x MRE VI plus 1 x supplemental pack.
- Group 4. 3 x MRE VIII plus 1 x supplemental pack.

Whenever possible urine samples and completed Dietary Logs were collected daily from the test subjects. Ration resupply was also completed at this stage as part of the test schedule.

Food and Water Intake, Food Acceptability

All subjects recorded their daily food and water intake using a 24-hour Dietary Log (Appendix C). Subjects selected from the itemized list of foods those which had been consumed during the 24-hour period and either circled their estimated portion size (1/4, 1/2, 3/4, 1, 2) or wrote in the amounts, where these were larger.

Food acceptability was assessed daily using a 9-point hedonic scale (1 = 'dislike extremely', 5 = 'neither like nor dislike' and 9 = 'like extremely') on the 24-hour Dietary Logs. When foods were not consumed or finished, the reason for doing so was recorded on the Dietary Log. The reason was recorded by reference to a code number which appeared at the top of the sheet.

Water consumption was ascertained using self reporting procedures on the reverse of the 24-hour Dietary Log. Subjects recorded the number of canteens of water: drunk as plain water; used and consumed as a beverage, for example coffee; or mixed with food during 3 time frames (morning, afternoon and evening). They were also asked to state, by checking one item, the primary source or origin of that water.

In addition to water consumption, subjects were also asked to rate a number of attributes of their urine by circling the number that most closely corresponded with their subjective evaluation. The lightness or darkness of their urine was rated using a 7 point scale where 1 = 'extremely light' and 7 = 'extremely dark'. Color was rated on a 4 point scale 1 = 'light yellow' to 4 = 'brown'. Frequency of urination was rated on a 7 point scale 1 = 'extremely less' to 7 = 'extremely more' while volume was rated again on a 7 point scale 1 = 'extremely less' to 7 = 'extremely more'.

Trained dietary data collectors interviewed subjects daily when collecting the previous day's Dietary Log. Obvious omissions, ambiguities and queries were resolved immediately and the next 24-hour Dietary Log and day's supply of food were issued. In addition, each soldier collected, in a plastic Ziploc^R trash bag, his empty wrappers, unwanted food and food waste. This bag was retrieved from the subjects at the same time as the Dietary Logs were collected although care was taken to ensure that soldiers did not complete their Logs on the basis of the empty wrappers that they turned in.

On return to the laboratory, data collectors sorted through the empty and partially empty wrappers and recorded the quantities consumed. Two groups used a regular form requiring manual processing for this purpose and the opportunity was also taken to test the suitability of an optically mark read sheet. Examples of these forms are given in Appendix D.

Final Questionnaires

Two final questionnaires were administered on the last day of the study. One requested information about demographics and soldiers's opinions on general aspects of the ration and supplemental pack; the other related to the chemical ration heating pad (Zestotherm^R). The opportunity was also taken at this stage to canvass the opinion of soldiers who, while engaged in similar activities and ate the same rations, were not test subjects. Samples of these questionnaires are given at Appendix E.

Meteorological Data

Meteorological data were collected daily by the Atmospheric Science Laboratory, Alaska Meteorological Team, located at Fort Greely, as part of their routine weather forecasting operation. Hourly readings were taken of actual, minimum and maximum temperatures; wind speed and direction; wind chill; solar radiation; and precipitation from 4 remote weather stations located in the training area and further measurements from the main weather station at Fort Greely. Times of sunrise and sunset were also recorded.

Data Analysis

Data has been analyzed using both the statistical analysis package Statistical Package for the Social Sciences (SPSS^X), and specially developed software. Frequencies, means and standard deviations have been calculated for the macro nutrients obtained from the MREs and supplemental packs and also for fluid consumption. Results were compared using a one-way ANOVA together with Tukey HSD. Similar calculations have been made for the information obtained from the empty wrappers and Dietary Logs and the results compared using a Chi-square test. Pearsons products moment correlation was used to compare urine specific gravity with the self reported questions relating to urine, and with calories consumed; and for water compared with calories consumed. A Student-Newman-Keuls post hoc test has been used to determine differences between groups when comparing the attributes associated with ease of preparation. Results are not considered to have occurred through chance when the p value is less than 0.05.

Data analysis, covering the full 10/11 days of the study was presented in the previous Technical Report (1). Due to the exercise scenario, the start of the exercise and therefore the study was staggered with one company (2 groups) deploying at midday on day one and the other company (2 groups) deploying late in the evening the following day. The end of the study was also staggered partly to comply with the exercise scenario and partly for logistical reasons.

The opportunity has been taken in the present Technical Report to realign the data by calendar days and exclude the days of deployment and the last days of the study. Previous experience has shown that the turbulence and the uncertainty of the situation on these days is reflected in the data recording and collection. Unless otherwise stated data analysis centers on a 7-day consecutive period in the middle of the exercise as outlined in Table 2.

TABLE 2. Data Collection Periods

Date	Group 1 MRE VI	Group 2 MRE VIII	Group 3 MRE VI + Supplement	Group 4 MRE VIII + Supplement
1 March	Day 1	Day 1		
2 March	Day 2	Day 2		
3 March	Day 3	Day 3	Day 1	Day 1

4 March*	Day 4	Day 4	Day 2	Day 2
5 March*	Day 5	Day 5	Day 3	Day 3
6 March*	Day 6	Day 6	Day 4	Day 4
7 March*	Day 7	Day 7	Day 5	Day 5
8 March*	Day 8	Day 8	Day 6	Day 6
9 March*	Day 9	Day 9	Day 7	Day 7
10 March*	Day 10	Day 10	Day 8	Day 8

11 March	Day 11	Day 11	Day 9	Day 9
12 March			Day 10	Day 10

* Data utilized for calculation of mean daily nutrient intakes.

RESULTS AND DISCUSSION

Study Sample

Volunteers for this study were provided by A Companies, 1st and 2nd Battalion 17th Infantry, 1st Brigade, 6th Infantry Division (Light) stationed at Fort Richardson, Alaska. The study protocol required that a minimum of 35 personnel be assigned to each test group. Details of subjects recruited and completing the study are summarized in Table 3.

TABLE 3. Details of the Study Sample

Company/ Group	Subjects Recruited	Failed to Deploy	Failed to Complete	Completed Study
A/1/17				
Group 1	36	2	1	33
Group 2	39	2	5	32
A/2/17				
Group 3	36	1	5	30
Group 4	38	1	2	35

Demographic information was collected on the last day of the field exercise as part of a self-reported final questionnaire completed by 139 male subjects. The majority of subjects (97%) were enlisted soldiers whose ranks ranged from E-1 to E-7. They were similar in terms of the type of climate they had lived in the longest: hot or mixed climate being most prevalent with only 18% having lived most of their lives in a cold climate. The majority (75.5%) had been in the Armed Services for five years or less.

The subjects' overall mean pre-body weight was 173.7 lb and ranged from 119.7 lb to 239.4 lb. There were no significant differences between the 4 groups. The overall mean post-weight was 170.1 lb and ranged from 115.3 lb to 234.6 lb. Again there were no significant differences between the groups. However significant differences did exist for all groups between the pre and post-weights. In total, 26 of the 127 for whom both pre- and post-weights were taken gained weight; 3 from group 1; 7 from group 2; 8 from group 3; and 8 from group 4. There was no change for 1 subject, the remainder lost weight. The overall mean weight loss was

3.6 lb with the highest, 4.8 lb, in group 1 (MRE VI only) and the lowest, 3.0 lb, in group 4 (MRE VIII plus supplement). Mean percentage weight losses ranged from 2.8% in group 1 to 1.7% in group 4. These weight losses are within the limits of the established criteria of no more than 3%.

The majority of soldiers were not trying to either gain or lose weight during the field exercise. However, slightly more of the subjects (20%) in the MRE VI group were trying to lose weight than in the other groups but correspondingly, slightly more of the subjects (21%) in the unsupplemented groups were trying to gain weight. Overall these effects are not thought to have unduly influence the total food consumption.

The overall mean height was 176.8 cm and ranged from 158.6 cm to 195.1 cm. There were no significant differences between the 4 groups.

The overall mean age was 24.6 years and ranged from 18 years to 39 years. There were no significant differences between the 4 groups.

Activity Levels

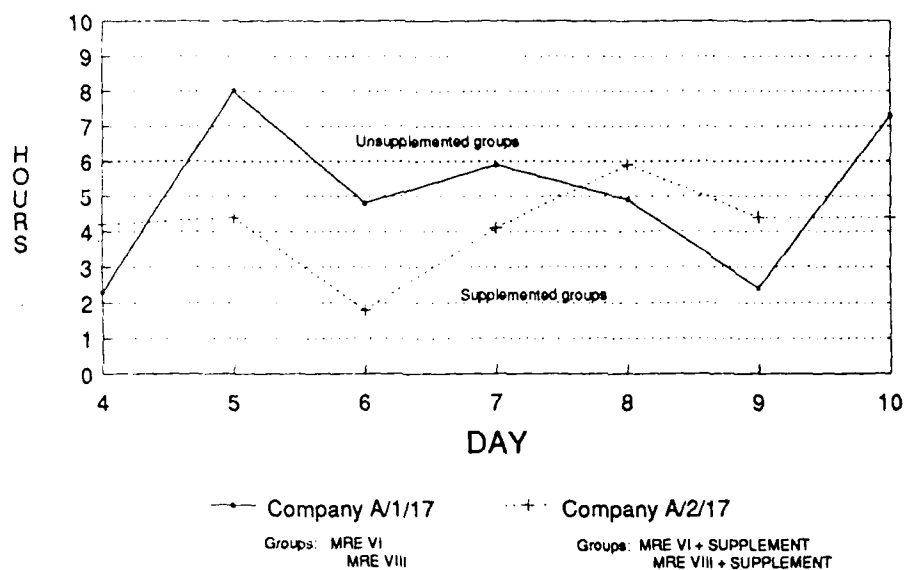
Twenty-five subjects were initially set up to wear the activity monitors but only 14 complete records were available for the 7 day period (4 - 10 March). This was mainly due to the higher than anticipated drop-out rate [9] and partly the inability to down-load two data sets. Activity data have therefore been consolidated and are reported by Company.

The mean daily number of hours of sleep for each Company is presented in Figure 1. During the seven-day period, the mean number of hours of sleep for the unsupplemented groups was 5.09 (SD 2.20) hours and ranged from 2.3 hours to 8 hours. The mean number of hours sleep for the supplemented groups was 4.17 (SD 1.21) hours. These figures were similar to the ten-day period where 5.0 and 4.7 hours of sleep were recorded for the respective Companies.

No particular patterns emerge when comparing food intake, expressed as kilocalories, with the total number of hours of sleep; for example, the groups consuming MRE VI, caloric intake on 6 March with 4.8 hours of sleep was 1358 kcal whereas on 8 March with 4.9 hours of sleep they consumed 2603 kcal. Similarly, when comparing the mean daily water intake from all sources, no clear patterns emerge relating the total volume of water consumed to the number of hours of sleep. It would seem therefore that the amount of sleep in this study was not a major influencing factor in the quantity of food and water consumed.

Figure 1

Number of Hours of Sleep

Nutrient Intake

Nutrient intakes were calculated from the 24-hour Dietary Logs. Details of the usable number of Dietary Logs are given in Table 4. These figures include Dietary Logs for subjects who, for a number of reasons, did not complete the full study but did complete daily logs for the time period preceding their departure.

TABLE 4. Total Number of Usable Dietary Logs.

Day	Group 1 MRE VI	Group 2 MRE VIII	Group 3 MRE VI + Supplement	Group 4 MRE VIII + Supplement
4 March	32	23	32	35
5 March	20	11	29	33
6 March	23	17	29	34
7 March	27	25	28	34
8 March	27	20	29	35
9 March	29	27	31	34
10 March	27	28	31	35
Total	185	151	209	240
Mean	26.4	21.6	29.9	34.3

The mean daily energy intake and intake of macronutrients (protein, fat and carbohydrate) are presented in Figures 2 To 5. Significant differences between groups in the daily levels of consumption of kilocalories, protein, fat and carbohydrate were established with a one way analysis of variance. The results are given in Table 5.

TABLE 5. Groups Where the Daily Consumption of Calories, Protein, Fat and Carbohydrate were Significantly Different at 0.05 Level.

	GROUP/DAY											
	MRE VI				MRE VIII				MRE VI: + Supplement			
MRE VIII												
kcal	4	6	7	9								
Protein			7	9								
Fat			6	7	9							
Carbohydrate	4	6	7	9								
MRE VI + Supplement												
kcal		6	7	9	10							
Protein		6	7	9	10		10					
Fat		6	7	9	10							
Carbohydrate		6	7	9	10							
MRE VIII + Supplement												
kcal	4	5	6	7	8	9	10	6	9	10	4	5 9
Protein	4		6	7	9	10		6	9	10		5
Fat	4		6	7	9	10			9	10	4	
Carbohydrate	4	5	6	7	8	9	10	6	9	10	4	5 6 7 9 10

Note: Numbers in the Table correspond with dates where there was a significant difference ($p < 0.05$) between groups.

Figure 2
Total Daily Energy Consumption (kcal)

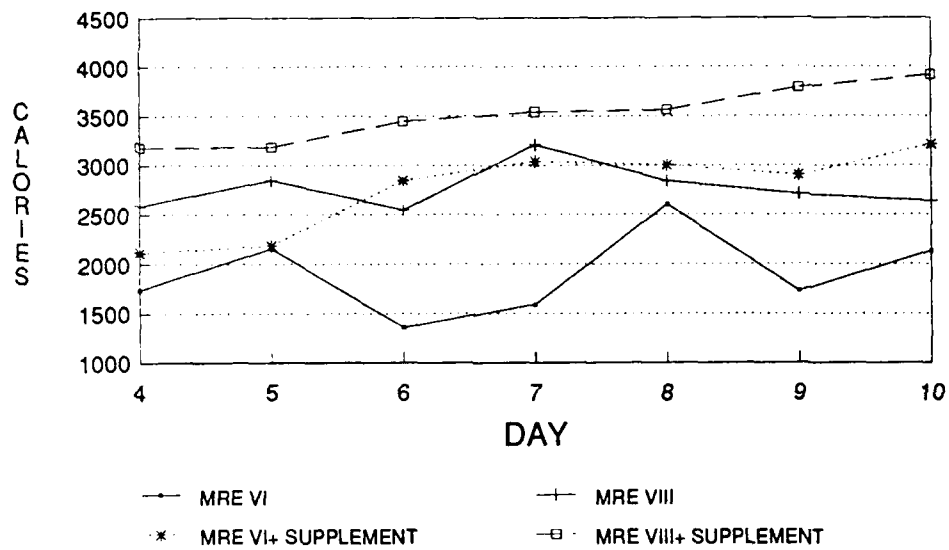


Figure 3
Total Daily CHO Consumption (g)

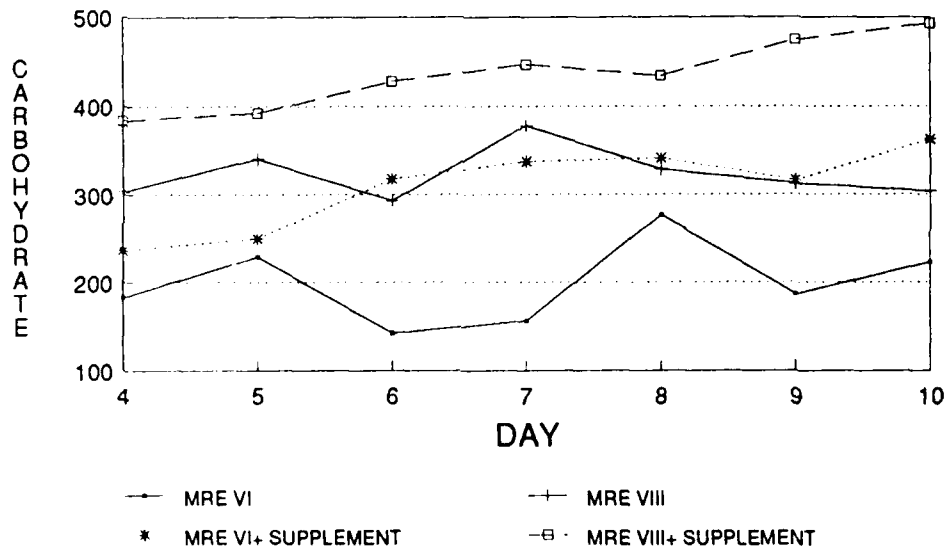


Figure 4
Total Daily Protein Consumption (g)

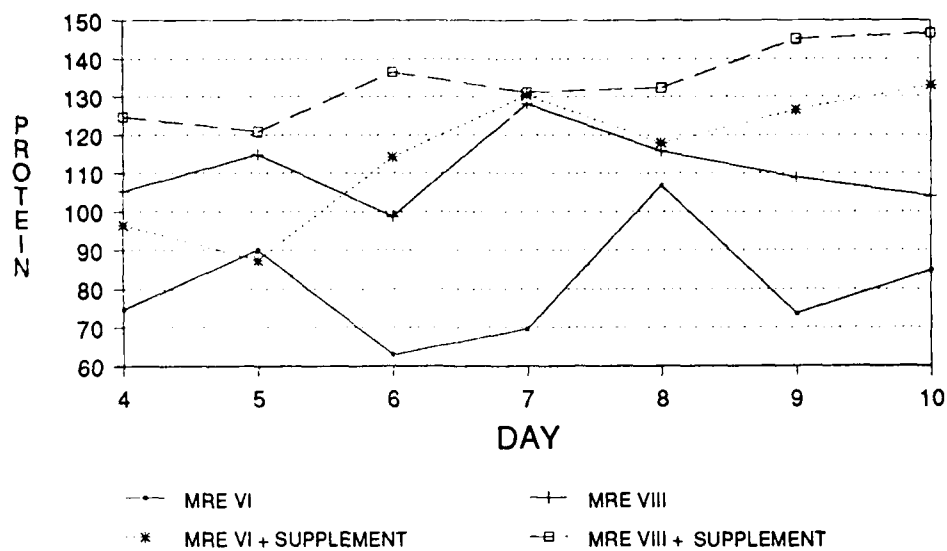
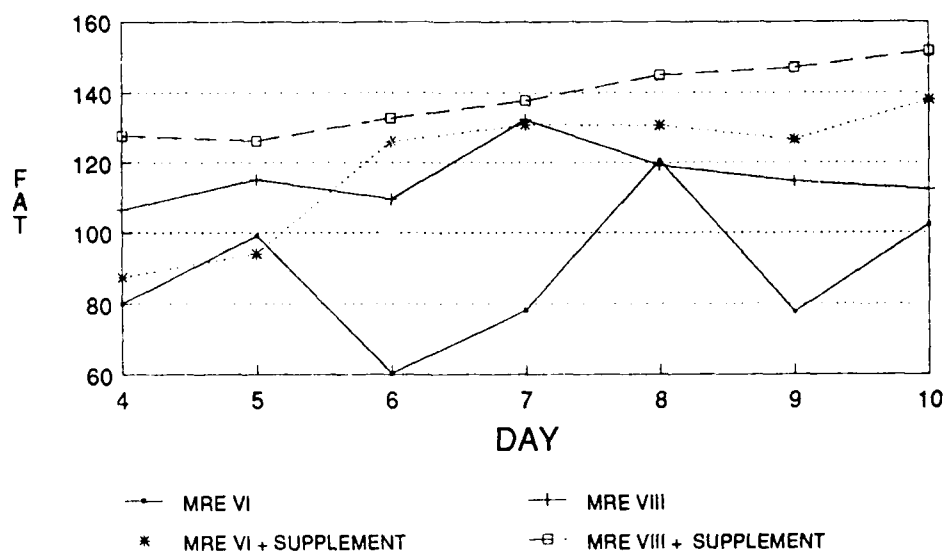


Figure 5
Total Daily Fat Consumption (g)



The first and last days of the study have been excluded, thereby eliminating any error which may have been introduced by the start or finish of the exercise. However, it should be borne in mind when making inter-group comparisons, that the daily activity levels of each group were different, (see page 11) and that the time frame which the data represents may be slightly different; data collection took place at times convenient to the exercise scenario and as such varied from group to group. Consumption periods may therefore vary between groups and may not necessarily reflect a 24-hour period because they are either slightly longer or slightly shorter. The mean energy intakes for the seven-day analysis period were 1898 kcal for the group consuming MRE VI; 2769 kcal for MRE VIII; 2752 for MRE VI with the supplemental pack and 3518 kcal for MRE VIII with the supplemental pack. These figures were slightly less (6%, 1%, 3% and 1% respectively) than the mean amounts consumed over the total study period and still represent between 42%, at worst, and 78%, at best, of the recommended energy intake of 4500 kcal. All groups, with the exception of MRE VI plus supplemental pack and MRE VIII, were significantly different ($p < 0.05$).

Consuming adequate quantities of nutrients, especially kilocalories, has always been a problem with MREs in both cold and temperate environments. Over an extended period (34 days), in a temperate climate (10), the mean daily energy intake was 2189 kcal or 60% of the available energy. This compares with the nutritional standard for operational rations of 3600 kcal. In a later study (11), the mean daily consumption of MREs for the male subjects during the first three days of the study when all groups were consuming MREs was 2445 kcal or 68% of the nutritional standard of 3600 kcal. In a study involving Special Operations Soldiers consuming either the MRE or Ration, Lightweight on a 30 day field training exercise (12), energy consumption was 2782 kcal (77% of the nutritional standards) for the MRE and 1946 kcal for the Ration, Lightweight. In an evaluation of the improved MRE (MRE VIII), MRE VII and MRE IV (6) mean caloric intake from both the MRE IV and MRE VII was 2517 kcal, and 2842 kcal for the MRE VIII. This shows a considerable improvement, for the MRE VIII, but still only represents 72% of available calories or 79% of the nutritional standard of 3600 kcal.

In a cold environment, energy intakes were not increased despite the higher energy requirement and a recommended intake of 4500 kcal (8). During a cold weather field training study in which the MRE was compared with the Ration, Cold Weather (2), the mean daily energy consumption was 2733 kcal for the MRE and 2751 kcal for the Ration, Cold Weather. This

represents, in the case of the MRE, 56% of the available energy or 61 % of the MRDA of 4500 kcal. In a cold weather study comparing the MRE, Ration, Cold Weather and the Ration, Lightweight at moderate altitude (13), mean energy intake for the MRE group was 3217 kcal or 71% of the MRDA of 4500 kcal. Full details of these studies are given in Appendix F.

Although the groups consuming the supplemental pack ate more, it is germane to the aims of the study and has already been established (1) that this enhanced food consumption was not at the expense of, but in addition to, the MRE. This is also the case for the 7-day period where increased energy intake in the MRE VI groups was 262 kcal (14%) and 113 kcal (4%) in the MRE VIII Groups.

The mean amounts (%) of individual components consumed in the supplemental pack are given in Table 6. There were no significant differences between groups.

TABLE 6. Mean Amounts (%) of the Supplemental Pack Consumed.

	Group 3 MRE VI + Supplement %	Group 4 MRE VIII + Supplement %
Pouched Bread	100	100
Cold Beverage Base	100	97
Hot Pepper Sauce	63	65
Charms	91	94
Beef Jerky	95	91
Raisin Nut Mix	97	96

The mean daily nutritional intake of energy, protein, fat and carbohydrate obtained from the supplemental pack are shown in Figures 6 to 10 and summarized for the 7-day period in Table 7. As can be seen, intakes for both groups are similar and in terms of the caloric intake, represent 85% and 89% of the energy available from the supplemental pack for groups 3 and 4. However, daily intake fluctuates from 549 kcal to 727 kcal in the group consuming MRE VI and 600 kcal to 732 kcal in the group consuming MRE VIII. Furthermore, the daily intake of the supplemental pack does not appear to be directly related to the intake of the MRE varying from 23% to 40% of food consumed for the MRE VI and between 8% and 28% of the food of the MRE VIII. For the total period this represents an average 29% and 23% of total energy intake for the MRE VI and MRE VIII, respectively.

Figure 6

Total Daily Energy (kcal)
Obtained from the Supplemental Pack

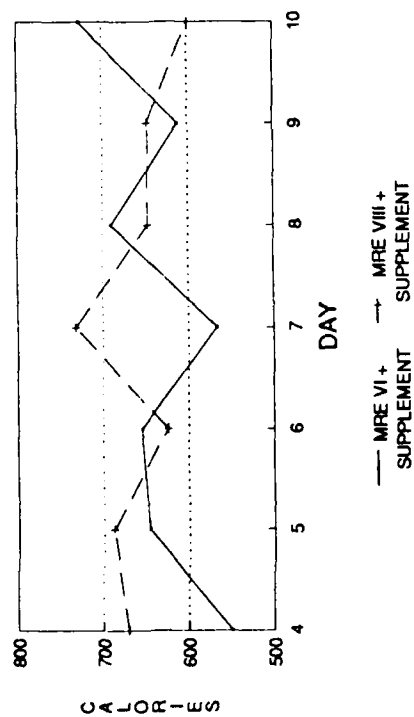


Figure 7

Total Daily Carbohydrate (g)
Obtained from the Supplemental Pack

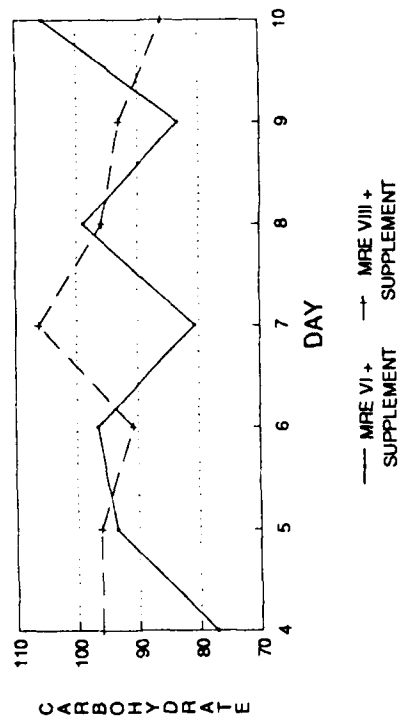


Figure 8

Total Daily Protein (g)
Obtained from the Supplemental Pack

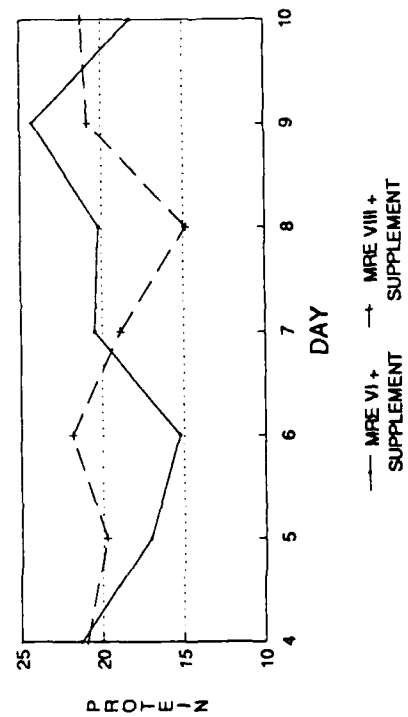


Figure 9

Total Daily Fat (g)
Obtained from the Supplemental Pack

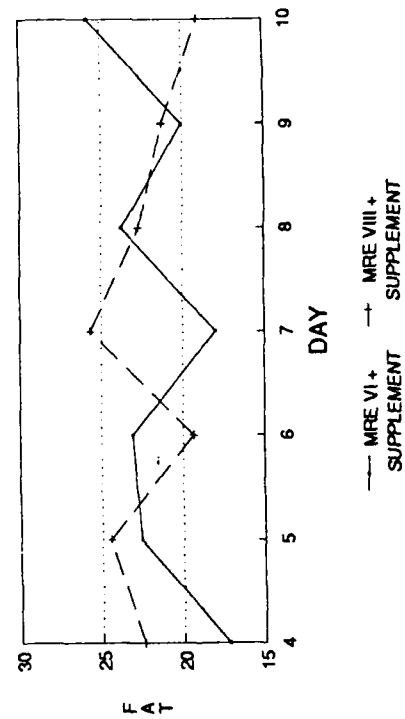


TABLE 7. Mean Nutritional Intake Derived from the Supplemental Pack over Seven Days.

	Unit	Group 3		Group 4	
		MRE VI	% kcal	MRE VIII	% kcal
Energy	kcal	632		658	
Protein	g	19.7	12.5%	19.7	12.0%
Fat	g	21.4	30.5%	22.2	30.4%
Carbohydrate	g	90.3	57.0%	94.8	57.6%

It is clear from these results that not only does food consumption increase in the supplemented groups but that this consumption can in part be attributed to the supplemental pack and in part to consumption of more of the MRE. The concern, therefore, that provision of the supplemental pack would cause soldiers to eat less of the MRE is not supported.

Nutritional Status as Determined by Blood Chemistries

Fasting blood samples were drawn by venipuncture prior to deployment and on the last day in the field. Blood chemistries are presented in Tables 8 and 9. The values shown are means $\pm$ SD and each Table includes a normal range for each variable. This group of subjects was young and healthy and abnormal values were not expected. All values were within the normal range, but there were significant changes in some variables over the course of the study indicating changes in either nutritional status or hydration status. Since the source of variation depends on intake and/or changes in clearance, examination of these changes could pinpoint possible long term problems with either the rations or in using the rations.

TABLE 8. A Comparison of Pre- and Post- Blood Values (Groups 1 and 2).

	Group 1 MRE VI		Group 2 MRE VIII		NORMAL
	PRE	POST	PRE	POST	
Glucose, mg/DL	90.30 $\pm$ 12.4	86.70 $\pm$ 8.1	93.00 $\pm$ 8.5	86.90 $\pm$ 16.3	65-130
Sodium, mmol/L	139.50 $\pm$ 3.2	139.70 $\pm$ 2.1	140.10 $\pm$ 1.1	139.60 $\pm$ 2.5	134-143
Potassium, mmol/L	4.28 $\pm$ 0.35	4.47 $\pm$ 0.42*	4.35 $\pm$ 0.37	4.29 $\pm$ 0.3	3.5-5.3
Chloride, mmol/L	98.50 $\pm$ 2.4	98.50 $\pm$ 1.4	98.80 $\pm$ 1.8	98.70 $\pm$ 1.7	96-107
BUN, mg/DL	14.30 $\pm$ 4.3	14.90 $\pm$ 3.3	16.10 $\pm$ 3.6	13.90 $\pm$ 2.6	6-23
Creatinine, mg/DL	0.90 $\pm$ 0.1	0.96 $\pm$ 0.2	0.96 $\pm$ 0.11	0.94 $\pm$ 0.18	6-1.3
BUN/Creatinine	14.70 $\pm$ 3.4	15.90 $\pm$ 4.1	17.10 $\pm$ 4.3	15.60 $\pm$ 5.1	
Uric Acid, mg/DL	5.96 $\pm$ 0.96	5.45 $\pm$ 1.09*	5.59 $\pm$ 0.9	4.99 $\pm$ 0.8	2.2-8.3
Phosphate, mg/DL	4.04 $\pm$ 0.69	3.43 $\pm$ 0.44*	4.05 $\pm$ 0.63	3.42 $\pm$ 0.56	2.2-4.6
Calcium, mg/DL	9.73 $\pm$ 0.35	9.75 $\pm$ 0.27	9.80 $\pm$ 0.29	9.76 $\pm$ 0.27	8.8-10
Magnesium, meq/L	1.96 $\pm$ 0.09	1.93 $\pm$ 0.07	1.97 $\pm$ 0.13	1.93 $\pm$ 0.15	1.5-2.1
Cholesterol, mg/DL	195.00 $\pm$ 35.0	179.00 $\pm$ 31.0*	187.00 $\pm$ 31.0	176.00 $\pm$ 22.0*	120-240
Triglycerides, mg/DL	148.00 $\pm$ 56.0	78.00 $\pm$ 32.0*	141.00 $\pm$ 77.0	87.00 $\pm$ 42.0*	50-200
Total Protein, gm/DL	7.29 $\pm$ 0.42	7.31 $\pm$ 0.34	7.41 $\pm$ 0.34	7.39 $\pm$ 0.38	6.4-8.1
Albumin, gm/DL	4.37 $\pm$ 0.22	4.47 $\pm$ 0.20*	4.42 $\pm$ 0.21	4.43 $\pm$ 0.24	3.7-5.0
Globulin, gm/DL	2.93 $\pm$ 0.31	2.84 $\pm$ 0.28	3.00 $\pm$ 0.31	2.95 $\pm$ 0.34	2.1-3.6
Albumin/Globulin	1.51 $\pm$ 0.16	1.59 $\pm$ 0.18*	1.49 $\pm$ 0.19	1.52 $\pm$ 0.18	1.1-2.3
Bilirubin, T, mg/DL	0.63 $\pm$ 0.21	0.63 $\pm$ 0.25	0.60 $\pm$ 0.26	0.62 $\pm$ 0.22	0.2-1.6
Akl Phosphatase, IU/L	29.70 $\pm$ 7.7	28.90 $\pm$ 8.2	28.70 $\pm$ 7.2	28.80 $\pm$ 8.6	10-50
Glu Transp, IU/L	15.10 $\pm$ 12.6	11.80 $\pm$ 6.1*	10.50 $\pm$ 6.9	9.60 $\pm$ 2.5	1-60
Transaminase, IU/L	25.70 $\pm$ 11.5	30.50 $\pm$ 10.1	23.70 $\pm$ 7.2	28.20 $\pm$ 6.5*	1-50
LDH, IU/L	143.00 $\pm$ 22.0	196.00 $\pm$ 32.0*	150.00 $\pm$ 22.0	193.00 $\pm$ 35.0*	110-250
Iron, mcg/DL	101.00 $\pm$ 23.0	100.00 $\pm$ 37.0	99.00 $\pm$ 32.0	91.00 $\pm$ 34.0	40-180
HDL Cholest, mg/DL	50.00 $\pm$ 11.0	57.00 $\pm$ 11.0*	51.00 $\pm$ 14.0	56.00 $\pm$ 9.0*	39-90
Cholesterol/HDL	4.10 $\pm$ 1.0	3.20 $\pm$ 0.9*	3.90 $\pm$ 1.1	3.20 $\pm$ 0.6*	

* p < 0.05 $\pm$ SD

TABLE 9. A Comparison of Pre- and Post- Blood Values (Groups 3 and 4).

	Group 3 MRE VI + Supplement		Group 4 MRE VIII + Supplement		NORMAL
	PRE	POST	PRE	POST	
Glucose, mg/DL	89.70 $\pm$ 12.4	81.20 $\pm$ 13.8*	87.00 $\pm$ 8.5	84.9 $\pm$ 14.7	65-130
Sodium, mmol/L	139.90 $\pm$ 12.4	140.50 $\pm$ 2.3	139.90 $\pm$ 2.0	137.6 $\pm$ 3.7	134-143
Potassium, mmol/L	4.00 $\pm$ 0.4	4.49 $\pm$ 0.44*	4.20 $\pm$ 0.34	4.51 $\pm$ 0.3*	3.5-5.3
Chloride, mmol/L	99.00 $\pm$ 1.8	98.70 $\pm$ 2.1	98.80 $\pm$ 2.2	97.4 $\pm$ 2.6*	96-107
BUN, mg/DL	14.10 $\pm$ 3.5	17.90 $\pm$ 3.3*	15.60 $\pm$ 4.6	17.1 $\pm$ 2.9*	6-23
Creatinine, mg/DL	0.98 $\pm$ 0.13	0.97 $\pm$ 0.17	1.00 $\pm$ 0.15	1.0 $\pm$ 0.11	0.6-1.3
BUN/Creatinine	14.50 $\pm$ 3.3	18.70 $\pm$ 3.5*	15.60 $\pm$ 4.2	17.1 $\pm$ 2.7	
Uric Acid, mg/DL	6.05 $\pm$ 0.95	5.13 $\pm$ 0.75*	6.46 $\pm$ 1.19	5.1 $\pm$ 0.96	2.2-8.3
Phosphate, mg/DL	3.57 $\pm$ 0.55	3.73 $\pm$ 0.42	3.38 $\pm$ 0.68	3.56 $\pm$ 0.48	2.2-4.6
Calcium, mg/DL	9.61 $\pm$ 0.34	9.67 $\pm$ 0.26	9.78 $\pm$ 0.27	9.66 $\pm$ 0.36*	8.8-10
Magnesium, meq/L	1.92 $\pm$ 0.13	1.99 $\pm$ 0.13*	1.89 $\pm$ 0.13	1.99 $\pm$ 0.13*	1.5-2.1
Cholesterol, mg/DL	190.00 $\pm$ 33.0	169.00 $\pm$ 25.0*	194.00 $\pm$ 38.0	165.0 $\pm$ 26.0*	120-240
Triglycerides, mg/DL	111.00 $\pm$ 55.0	117.00 $\pm$ 60.0	110.00 $\pm$ 53.0	120.0 $\pm$ 48.0	50-200
Total Protein, gm/DL	7.22 $\pm$ 0.36	7.28 $\pm$ 0.29	7.30 $\pm$ 0.32	7.27 $\pm$ 0.38	6.4-8.1
Albumin, gm/DL	4.32 $\pm$ 0.15	4.33 $\pm$ 0.17	4.47 $\pm$ 0.19	4.37 $\pm$ 0.22*	3.7-5.0
Globulin, gm/DL	2.91 $\pm$ 0.34	2.95 $\pm$ 0.29	2.83 $\pm$ 0.3	2.89 $\pm$ 0.31	2.1-3.6
Albumin/Globulin	1.50 $\pm$ 0.18	1.48 $\pm$ 0.17	1.59 $\pm$ 0.19	1.53 $\pm$ 0.18*	1.1-2.3
Bilirubin, T, mg/DL	0.64 $\pm$ 0.36	0.63 $\pm$ 0.26	0.59 $\pm$ 0.17	0.55 $\pm$ 0.15	0.2-1.6
Alk Phosphatase, IU/L	26.40 $\pm$ 9.6	28.70 $\pm$ 9.9*	22.90 $\pm$ 8.0	24.7 $\pm$ 7.2*	10-50
Glu Transp, IU/L	11.80 $\pm$ 5.9	9.80 $\pm$ 3.6*	11.40 $\pm$ 5.1	9.6 $\pm$ 3.5*	1-60
Transaminase, IU/L	25.10 $\pm$ 11.1	27.60 $\pm$ 8.0	30.60 $\pm$ 5.2	28.4 $\pm$ 7.2	1-50
LDH, IU/L	152.00 $\pm$ 19.0	197.00 $\pm$ 28.0*	164.00 $\pm$ 31.0	195.0 $\pm$ 29.0*	110-250
Iron, mcg/DL	107.00 $\pm$ 31.0	93.00 $\pm$ 43.0	110.00 $\pm$ 25.0	89.0 $\pm$ 23.0*	40-180
HDL Cholest, mg/DL	45.00 $\pm$ 8.0	49.00 $\pm$ 10.0	48.00 $\pm$ 10.0	53.0 $\pm$ 10.0*	39-90
Cholesterol/HDL	4.20 $\pm$ 1.0	4.40 $\pm$ 5.3	4.10 $\pm$ 0.9	3.2 $\pm$ 0.6*	

* p < 0.05

$\pm$ SD

Serum electrolytes are carefully controlled by the body to maintain the osmotic balance which controls water distribution in the body spaces. Sodium is the most controlled of the positive ions and its control is linked to the control of potassium. When sodium intake is reduced (as in the unsupplemented groups, 1 and 2), then potassium is excreted by the kidney in lieu of sodium. In the supplemented groups (3 and 4), sodium intake was at or above the MRDA and displayed a higher degree of clearance with only a slight increase in serum potassium.

Serum chloride is the major negative ion and has its chief function in controlling the water distribution in the extracellular space and control of the cation-anion balance. There was a minor decrease in the chloride level in group 4, but not in the other groups.

Phosphate levels decreased in the groups that did not consume supplements. Decreases in phosphates have been reported in most field trials of rations and has been attributed to the reduced intake of phosphates i.e., in soft drinks. Since the only difference in diet was the presence of the supplement packs, then the higher levels of phosphates must be from them.

Changes in total proteins, albumin, and globulin can be used as indicators of body protein status. The only significant changes occurred in group 1 with an increase in albumin and in group 4 with a decrease in globulin. Protein consumption was above the MRDA level for all groups except for group 1, with group 4 having the highest consumption.

Cholesterol was high for this age group in the pre-test which was possibly due to the pre-field study loading of 'favorite foods'. The usual pattern is found to be a decrease over the duration of the field study and all groups followed this pattern. Triglycerides are usually higher in the pre-FTX study sample and usually show dramatic reductions over the study since the total fat intake is reduced. The unsupplemented MRE groups (1 and 2) showed this reduction, but the supplemented groups (3 and 4) did not. While the percentages of energy obtained from fat (Table 20) was less for the supplemented groups than for the unsupplemented, the total fat consumption for the former groups (Figure 5) was greater. HDL cholesterol was increased in groups 1, 2 and 4 and just missed being significantly ($p < 0.05$) increased in group 3. These increased levels were possibly the result of the elevated work levels being performed during the evaluation exercise. It has been shown (14,15,16) that an increased level of exercise can produce positive changes in HDL cholesterol. Other factors that have been implicated in increasing the HDL fraction are cold exposure (14) and weight loss by dieting (16). In this group, the level of work was greater than normal and they were exposed to cold stress. All groups lost

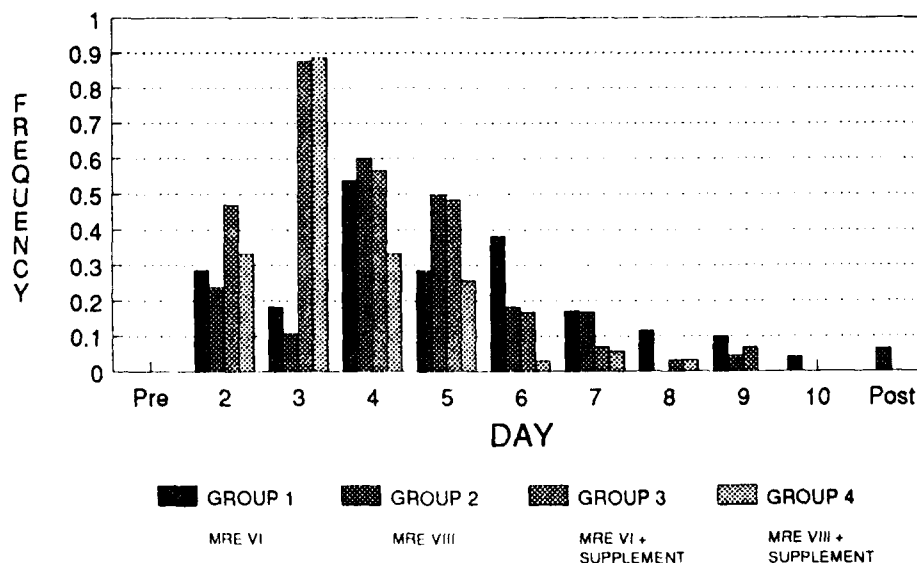
some weight because of the lowered caloric intake. The increased HDL fraction and reduction in cholesterol combined to produce significant decreases in their ratio which is indicative of lower cardiovascular risk.

The blood chemistries displayed no group differences in the pre-study measurement, but differences were shown pre- to post-evaluation exercise which reflect the influence of the ration supplement.

Ketones

The presence of acetoacetone in urine is indicative of a caloric deficit which requires mobilization and oxidation of body fat. The frequency of occurrence (number of positive responses/total number of responses) of ketone bodies in the urine is shown in Figure 10. The values are greatest in groups 3 and 4 during the early stages of the study and coincide with the time of hypohydration as indicated by elevated urinary specific gravities (Figure 11). This also coincided with a decreased caloric intake by these groups during this time. In all groups, the incidence of urinary ketone bodies decreased when water and caloric intakes were increased toward the end of the exercise.

Figure 10
The Frequency of Occurrence of
Ketone Bodies in the Urine



Optimum Number of MREs

The nutritional standards for operational rations provide for 3600 kcal in a temperate climate and 4500 kcal in a cold environment (8). This is normally achieved by issuing 3 and 4 MREs which in the case of MRE VI would provide 3612 kcal and 4815 kcal respectively. However in the case of MRE VIII these would provide 3918 kcal and 5224 kcal. The recommended intakes and nutritional standards for operational rations have always been expressed as net values hence the over provision of nutrients has been essential in order to take into account wastage and the established fact that soldiers do not consume the entire contents of operational rations. Even so, the expense and logistical effort expended to provide food that it is unlikely to be consumed is a matter that needs to be addressed.

The mean frequency of MRE consumption is given in Table 10. Significant differences between these groups were calculated and the results are presented in Table 11. A number of differences are significant but it is important to note that no significant differences ($p < 0.05$) were observed in the mean amounts consumed in the groups consuming MRE VIII with and without the supplemental pack. This indicates that while the group consuming MRE VIII was issued, on average, 3.4 MREs and the other group 3 MREs, the frequency of consumption was similar. As would be expected, more differences were found between the MRE VI and MRE VIII groups but this to a great extent can be attributed to modifications to the MREs themselves.

TABLE 10. Number of MREs Issued and Consumed.

		4	5	6	7	Day 8	9	10	Mean Total	
Group 1 MRE VI		(Mean * MREs Issued Daily = 4)								
Entrees	* Consumed	1.9	2.3	1.8	2.0	2.5	1.8	2.2	2.1	(1.1)*
Starches	* Consumed	1.9	2.3	1.6	1.9	2.6	1.9	2.0	2.0	(1.2)
Spreads	* Consumed	1.8	2.1	1.6	1.7	2.3	1.9	2.1	1.9	(1.3)
Fruit	* Consumed	1.5	1.4	1.1	1.1	1.8	1.6	1.6	1.5	(1.1)
Dessert	* Consumed	1.9	2.7	1.9	1.9	2.3	1.3	2.2	2.0	(1.5)
Beverages	* Consumed	1.9	1.3	1.3	1.4	1.9	1.5	1.9	1.7	(0.9)
Group 2 MRE VIII		(Mean * MREs Issued Daily = 3.4**)								
Entrees	* Consumed	2.4	2.7	2.4	2.9	2.7	2.5	2.4	2.6	(1.1)
Starches	* Consumed	2.5	2.3	2.1	2.8	2.5	2.4	2.2	2.4	(1.3)
Spreads	* Consumed	2.1	2.4	2.5	2.2	1.7	2.0	2.0	2.1	(1.2)
Fruit	* Consumed	1.6	2.2	2.1	1.9	1.9	1.9	2.0	1.9	(1.1)
Dessert	* Consumed	2.2	1.7	2.2	2.2	2.3	2.3	2.0	2.1	(1.1)
Beverages	* Consumed	4.8	5.3	3.3	5.8	3.3	4.2	4.2	4.4	(4.7)
Group 3 MRE VI + Supplement		(Mean * MREs Issued Daily = 3)								
Entrees	* Consumed	1.8	1.7	2.7	2.6	2.3	2.4	2.8	2.3	(1.0)
Starches	* Consumed	2.0	1.9	2.2	2.8	3.1	2.6	3.2	2.5	(1.5)
Spreads	* Consumed	1.5	2.0	2.0	2.4	2.4	2.4	2.7	2.2	(1.1)
Fruit	* Consumed	0.7	1.1	1.4	1.7	1.7	1.6	1.9	1.5	(1.0)
Dessert	* Consumed	1.2	1.6	1.9	2.0	1.9	1.7	2.0	1.7	(1.0)
Beverages	* Consumed	0.4	0.9	1.9	1.7	2.5	2.1	2.0	1.6	(1.3)
Group 4 MRE VIII + Supplement		(Mean * MREs Issued Daily = 3)								
Entrees	* Consumed	2.5	2.4	2.7	2.7	2.7	2.8	2.8	2.7	(0.8)
Starches	* Consumed	2.3	2.2	2.3	2.5	2.4	2.6	2.7	2.4	(1.2)
Spreads	* Consumed	2.1	2.1	2.3	2.2	2.4	2.4	2.8	2.3	(1.1)
Fruit	* Consumed	1.6	1.7	1.3	1.6	1.4	2.0	2.0	1.7	(1.1)
Dessert	* Consumed	2.0	1.6	1.9	1.9	1.9	2.1	2.2	2.0	(1.0)
Beverages	* Consumed	3.9	3.2	5.4	4.9	5.2	6.4	6.7	5.2	(4.2)

* Numbers in parentheses indicate Standard Deviations

** Calculated as 3 days issue of 4 MREs and 4 days issue of 3 MREs.

TABLE 11. Groups Where Frequency of Consumption of MRE Components was Significantly Different at the 0.05 Level.

	MRE VI	MRE VIII	MRE VI + Supplement
MRE VIII	Entrees Fruit Beverages		
MRE VI + Supplement	Starches	Fruit Desserts Beverages	
MRE VIII + Supplement	Entrees Starches Spreads Beverages		Entrees Beverages

The intakes of energy, protein, fat and carbohydrate from the individual food groups are shown in Table 12. Significant differences are shown in Tables 13 to 17. Again what is important to note, in so far as the groups consuming MRE VIII, is that no significant differences were recorded between the with and without supplemental pack groups even though one group was issued 3.4 and the other 3 rations.

TABLE 12. Number of MREs Issued and the Mean Amounts of Energy, Protein, Fat and Carbohydrate Consumed by Food Groups for the Seven Days.

			Energy kcal	Protein g	Fat g	Carbohydrate g
Group 1 MRE VI			(Mean * MREs Issued Daily = 4)			
Entrees	Amount Consumed		480	50.4	24.9	15.2
Starches	Amount Consumed		410	12.9	11.7	63.1
Spreads	Amount Consumed		322	10.8	24.5	14.6
Fruit	Amount Consumed		108	1.0	1.1	23.6
Dessert	Amount Consumed		595	9.0	32.2	67.2
Group 2 MRE VIII			(Mean * MREs Issued Daily = 3.4)			
Entrees	Amount Consumed		691	67.7	28.6	40.5
Starches	Amount Consumed		453	11.6	16.5	64.6
Spreads	Amount Consumed		362	12.5	26.6	18.1
Fruit	Amount Consumed		138	1.2	1.3	30.2
Dessert	Amount Consumed		633	11.6	32.9	72.7
Group 3 MRE VI + Supplement			(Mean * MREs Issued Daily = 3)			
Entrees	Amount Consumed		547	61.0	26.0	18.8
Starches	Amount Consumed		507	15.1	15.1	77.5
Spreads	Amount Consumed		358	11.7	27.4	16.2
Fruit	Amount Consumed		102	0.9	0.8	22.7
Dessert	Amount Consumed		539	8.3	28.4	62.6
Group 4 MRE VIII + Supplement			(Mean * MREs Issued Daily = 3)			
Entrees	Amount Consumed		727	70.5	29.8	43.9
Starches	Amount Consumed		471	12.0	16.7	68.1
Spreads	Amount Consumed		382	12.8	27.0	22.2
Fruit	Amount Consumed		121	1.0	1.2	26.4
Dessert	Amount Consumed		577	10.3	30.0	66.5

TABLE 13. Groups Where the Intake of Energy, Protein, Fat and Carbohydrate Obtained from Entrees was Significantly Different at the 0.05 Level.

	MRE VI	MRE VIII	MRE VI + Supplement
MRE VIII	kcal Protein Carbohydrate		
MRE VI + Supplement	Protein	kcal Carbohydrate	
MRE VIII + Supplement	kcal Protein Fat Carbohydrate		kcal Protein Fat Carbohydrate

TABLE 14. Groups Where the Intake of Energy, Protein, Fat and Carbohydrate Obtained from Starches was Significantly Different at the 0.05 Level.

	MRE VI	MRE VIII	MRE VI + Supplement
MRE VIII	Fat		
MRE VI + Supplement	kcal Fat Protein Carbohydrate	Protein Carbohydrate	
MRE VIII + Supplement	Fat		Protein

TABLE 15. Groups Where the Intake of Energy, Protein, Fat and Carbohydrate Obtained from Spreads was Significantly Different at the 0.05 Level.

	MRE VI	MRE VIII	MRE VI + Supplement
MRE VIII + Supplement	kcal Carbohydrate		Carbohydrate

TABLE 16. Groups Where the Intake of Energy, Protein, Fat and Carbohydrate Obtained from Fruits was Significantly Different at the 0.05 Level.

	MRE VI	MRE VIII	MRE VI + Supplement
MRE VIII	kcal Carbohydrate		
MRE VI + Supplement		kcal Protein Fat Carbohydrate	
MRE VIII + Supplement			Fat

TABLE 17. Groups Where the Intake of Energy, Protein, Fat and Carbohydrate Obtained from Desserts was Significantly Different at the 0.05 Level.

	MRE VI	MRE VIII	MRE VI + Supplement
MRE VIII	Protein		
MRE VI + Supplement		Protein	
MRE VIII + Supplement			Protein

Bread vs Crackers

In view of the acceptability and consumption of the bread, it may be advantageous to replace all or some of the crackers with bread but it is important to know whether this seriously affects the nutrient intake. The mean amounts of crackers consumed by study groups is presented in Table 18 indicating that bread is consumed in addition to, not instead of, crackers.

TABLE 18. Mean Amounts of Bread and Crackers Consumed.

Group	Mean Amount Consumed	
	Crackers	Bread
MRE VI	1.7	---
MRE VIII	1.9	---
MRE VI + Supplement	2.2	1.0
MRE VIII + Supplement	2.1	1.0

Environmental Temperatures and Food Intake

The lowest daily temperature recorded was -43°F and went below -20°F for 7 consecutive days (4 - 10 March). The maximum recorded temperature during the 10-day period was $+28^{\circ}\text{F}$ although during the period 4 to 10 March the temperature never exceeded $+10^{\circ}\text{F}$.

Total hours of daylight at D-2 were 9 hours 59 minutes and rose daily by approximately 7 minutes. Precipitation, as snow, occurred on 4 days. However, this snow was particularly dry and when recorded each day as water, was either a trace or 0.01 inches. Solar radiation ranged from 59 Langley¹ on the day of deployment to 226 Langleys on D+7.

¹ An electromagnetic radiation incident upon a surface:
a value of energy per unit area equal to one calorie per square centimeter.

Swain et al. (17), reviewing earlier work and reporting results of their own studies, concluded that the colder the climate, the more North American troops wanted to eat. This apparent increase in appetite is supported by other work (18,19). On the other hand, in a study investigating calorie intake and energy expenditure in a sub-arctic environment (20), appetite increased slightly during the last 6 days but this was not true of the first 6 days. There was no correlation between environmental temperature and food intake that could be attributed to appetite.

Calorie intake and minimum environmental temperatures are presented in Table 19. No discernible correlation can be observed between environmental temperature and caloric intake possibly because the temperatures were uniformly low and the time span of the study was only 7 days.

TABLE 19. Effects of Minimum Environmental Temperatures on Caloric Intake.

Date	Group 1 MRE VI	Group 2 MRE VIII	Group 3 MRE VI + Supplement	Group 4 MRE VIII + Supplement	Group Mean	Minimum Temperature
4	1740	2588	2113	3176	2404	-35
5	2157	2848	2188	3185	2595	-40
6	1358	2546	2847	3445	2549	-36
7	1592	3207	3037	3541	2844	-30
8	2604	2840	3003	3562	3002	-40
9	1731	2711	2901	3789	2783	-43
10	2133	2635	3211	3916	2974	-22

Percentages of Energy from Fat, Protein and Carbohydrate

The percentages of energy obtained from fat, protein and carbohydrate are presented in Table 20.

TABLE 20. Percent Distribution of Energy Obtained from Fat, Protein and Carbohydrate.

	Group 1 MRE VI	Group 2 MRE VIII	Group 3 MRE VI + Supplement	Group 4 MRE VIII + Supplement
Protein	16.9	16.0	16.7	15.2
Fat	41.8	37.7	38.9	35.4
Carbohydrate	41.9	46.5	44.8	49.6

As can be seen, the percentage of energy obtained from protein remains fairly constant but is slightly lower for the MRE VIII + supplement group. The higher percentage of energy obtained from carbohydrate at the expense of fat observed in the MRE VIII group can mainly be attributed to the inherent changes in the MRE. MRE VI provides 40.4% of its energy from fat and 42.8% from carbohydrate while MRE VIII provides 35.8% and 49.4%, respectively. Differences between the supplemented and unsupplemented groups can be attributed to the supplemental pack which provides on average 27.6% of it's energy from fat and 60.0% from carbohydrate.

In situations where water supply may be limited, the consumption of larger amounts of protein may be something to be avoided, partly because of the reduced volume of water liberated during metabolism (metabolic water) and partly the increased water requirements needed for excretion (obligatory water).

Metabolic water, that is water formed by the oxidation of fat, protein and carbohydrate, is liberated as follows (21,22):

1 g carbohydrate	=	0.55 g - 0.60 g water
1 g protein	=	0.40 g - 0.41 g water
1 g fat	=	1.07 g water

The amount of metabolized water provided by MRE VIII and MRE VIII plus the supplemental pack are given in Table 21. As there is likely to be an increase in the amount of liberated water in the supplemented group because of the increased amount of food, the effects of excluding the pack on the results are also included in Table 21.

TABLE 21. Amount of Metabolized Water Liberated by Complete Oxidation of the Food.

	Group 2 MRE VIII	Group 4 MRE VIII + Supplement	
		With Supplement	Without Supplement
Protein	45.4 g	54.9 g	47.1 g
Fat	124.1 g	148.1 g	125.2 g
Carbohydrate	193.3 g	261.8 g	206.8 g
Total	362.8 g	464.8 g	379.1 g

Although the amount of water liberated appears to be small, it may be important where the water supply is limited. For each 1000 kcal metabolized when the source is carbohydrate, between 130 and 150 cc of water are produced; if the source is fat then only 120 cc of water are produced (21,22).

Perhaps of more importance is the obligatory water, that is water necessary to excrete the waste products of metabolism. Protein consumed in excess of nitrogen requirements, is oxidized and the nitrogen, in the form of urea, must be excreted. In man, because the urine is hypertonic, each g of nitrogen is normally contained in 130 cc of water with a minimum of 40 to 60 cc (23). The protein content of food is generally calculated by multiplying the nitrogen (g) by 6.25 although this figure can vary being approximately 5.7 for cereals and 6.4 for milk (21). Using the multiplier of 6.25 to convert protein to nitrogen and 130 cc for each g of nitrogen, the additional amounts of obligatory water required to excrete the protein, on the assumption that it is in excess of requirements, are 482.6 cc for the MRE VIII supplemented group and for the same group, 85.3 cc when the supplemental pack is excluded.

A major disadvantage of a high fat diet is that more oxygen is required for metabolization hence a greater respiratory loss of water may occur in a dry Arctic atmosphere (22). Respiratory losses in a cold environment with hard work could amount to 1.5 l/day compared with a more conservative loss of 350 ml/day for men working in a moderately dry climate (22).

Salt and Water Requirements

A further concern, when consuming the Meal, Ready-to-Eat and supplemental pack in a cold environment where the water supply may be limited is the amount of salt contained in the ration. It has been calculated (24) that in a temperate climate, a sedentary man requires, in addition to an insensible water loss of 1.9 l, 127 ml of water for each gram of salt (sodium chloride) consumed. When consuming a diet composed of approximately 4500 kcal and 23 g of salt in a temperature between -20 and -29°C, fluid intakes of between 3.0 l and 3.5 l are required to prevent salt accumulation in the body (25). Larger quantities of water, in excess of 3.5 l, would be required if these ratios were consumed for periods in excess of one to two weeks (26).

The amount of salt, expressed both as sodium and sodium chloride equivalent, consumed by the MRE VIII groups is given in Table 22. Using the calculations of Baker et al. (24) water requirements have been estimated and are also presented in Table 22.

TABLE 22. Consumption of Sodium and Salt (Sodium Chloride) and Water Required to Prevent Salt Accumulation.

			Group 2 MRE VIII	Group 4 MRE VIII + Supplement	
				With Supplement	Without Supplement
Sodium	mg	5113		6084	5290
Sodium chloride equivalent	g	12.99		15.45	13.44
Water Required	l	3.55		3.86	3.61

Note: Calculated as 1 g sodium equals 2.54 g sodium chloride

Based on these calculations and the assumption that the protein is in excess of requirements, it should be noted that the supplemental pack containing beef jerky would require 634 ml of water whereas the pack containing Trail Mix would require 236 ml of water, Table 23.

TABLE 23. A Comparison of the Water Requirements Between Beef Jerky and Trail Mix.

	Beef Jerky g	Water Required ml	Trail Mix g	Water Required ml
Protein	18.70	388.9	7.50	156.0
Sodium Chloride Equivalent	1.93	245.1	0.63	80.0
Total		634.0		236.0

Food and Water Consumption

It has been reported both in animal (27,28,29) and laboratory human studies (30) that eating and drinking are closely related events. If this assumption can be extended into a field environment, then the amount of food consumed could well influence the amounts of water consumed and vice versa. Using the procedure 'correlation', significance and correlation coefficients were calculated for: calories consumed vs total water consumed and for calories consumed vs hydration status (as measured by urine specific gravity). The results are presented in Tables 24 and 25.

The relationship between calories consumed and water consumption shows a very strong, significant ($p < 0.01$) correlation. What is not clear is whether food induced water consumption, water induced food consumption, or food and water were consumed on an equivalent opportunity basis. Engell (30) found that 68% of drinking occurred when food was available at mealtimes when drinking was ad libitum. When fluid was limited, subjects voluntarily reduced their food intake. From these studies it could be concluded that if water is made readily available, caloric intake could be increased. Similarly, if ample opportunity is given to consume food, and water is readily available, then the consumption of water could be increased so as to prevent dehydration.

The correlation between calorie consumption and hydration status, as measured by urine specific gravity, is much weaker but statistically significant in 12 cases (Table 25). The apparent variation between reported water intake and hydration status is considered later in this report (page 40-43).

TABLE 24. A Comparison Between Calories and Total Water Consumed.

Day	Group 1 MRE VI	Group 2 MRE VIII	Group 3 MRE VI + Supplement	Group 4 MRE VIII + Supplement	Total Groups
Correlation Coefficient					
1	.5735	.7250	.6481	.5646	.6979
2	.6457	.8621	.7732	.8674	.8172
3	.7965	.7962	.6901	.8221	.7860
4	.7413	.8139	.6254	.6841	.7688
5	.7776	.6971	.7057	.7288	.7518
6	.8931	.8912	.6783	.6362	.7972
7	.7337	.8350	.4638	.6948	.7914
8	.5805	.7686	.6069	.5445	.6329
9	.5650	.8006	.5775	.6891	.7376
10	.6603	.7712	.7588	.8000	.7634
Total	.7233	.8069	.6768	.7311	.7592

Note: All Correlation Coefficients are statistically significant $p < 0.01$

TABLE 25. A Comparison Between Calories Consumed and Hydration Status (Urine Specific Gravity).

Day	Group 1 MRE VI	Group 2 MRE VIII	Group 3 MRE VI + Supplement	Group 4 MRE VIII + Supplement	Total Groups
Correlation Coefficient					
1	-.1101	.0444	.2439	-.1221	-.0073
2	-.1338	-.0211	-.0999	-.0330	-.0337
3	.0707	.0455	-.0521	.1902	.0904
4	-.0325	-.1573	-.1728	.0868	-.1072
5	-.3006	.3009	-.3357*	.1493	-.0732
6	.1312	.0916	-.1249	-.1184	-.1729*
7	.0060	-.3134	-.2106	-.1079	-.2552*
8	-.1908	-.2759	-.4191*	-.4231*	-.2999*
9	.0704	.2331	-.1164	-.0004	-.0153
10	.3280*	-.3378*	.0041	-.4646*	-.1403
Total	-.0235	-.0405	-.1751*	-.0873*	-.1085*

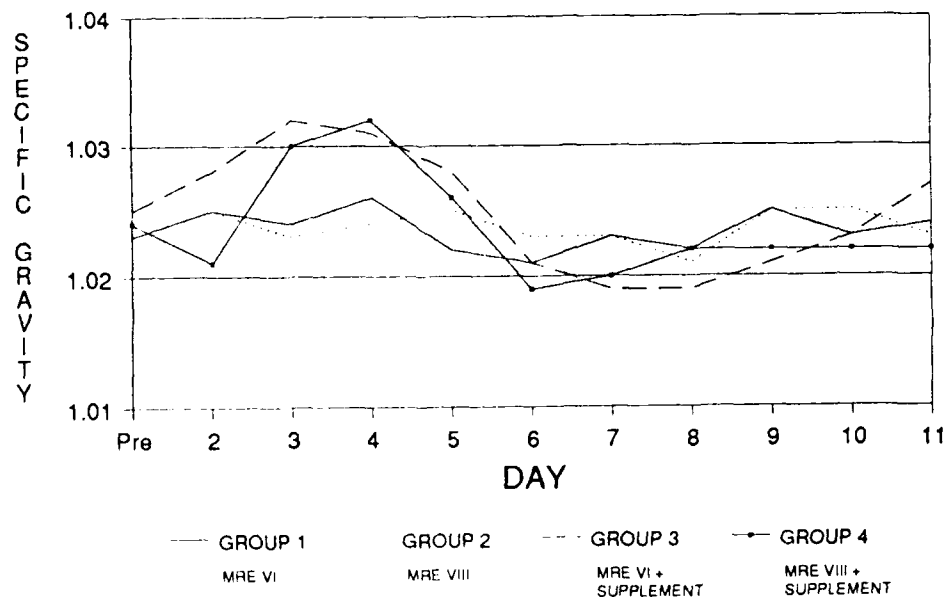
* Statistically significant $p < 0.05$, calories consumed and hydration status.

Hydration Status

The state of hydration was estimated on a daily basis by measurement of urinary specific gravity (SG) on a first void urine sample. The data are presented in Figure 11. A normal range for urinary specific gravity for an overnight urine for a well hydrated individual is 1.015 to 1.022. SG values of 1.030 or greater are indicative of hypohydration (31).

All groups were instructed on the importance of drinking during their pre-test briefing and in their usual training. The standard procedure for the 6th ID (L) is to furnish water to the troops in 5 gallon plastic or metal 'Jerry' cans. The data in Figure 11 indicate that one company (groups 3 and 4) was hypohydrated by the morning of the third day. This fact was reported to the Division Surgeon and a positive intervention (forced drinking) was instituted. Water intake data indicated that during this time, the average intake was about 1.5 canteens/day. After the intervention, water intake increased to 4 canteens/day by day 5 and remained at or above that level for the remainder of the exercise. The urinary SG values were reduced by the fifth day and hydration levels were well maintained for the duration of the exercise.

Figure 11
Mean Daily Specific Gravity



Hypohydration causes drowsiness, impatience, discomfort, weariness, irritability, reduced work efficiency, reduced cognitive ability, reduced resistance to cold exposure, and reduced caloric intake. This group of symptoms can have serious effects on the combat efficiency of a unit, and if not corrected, could lead to a reduction in unit efficiency. The reasons for the low consumption rate involves: the supply of water in a cold environment; problems with water freezing; and inadequate time to thaw the frozen water supply and insufficient time to consume the water.

Results of the pre- and post-measurements of hematocrit, hemoglobin, and serum osmolality are shown in Table 26. Changes in these variables reflect changes in circulating fluid volume while changes in urinary specific gravity reflect changes in clearance. Since all groups were well hydrated by the end of the study, there were no significant changes in these measurements across the entire operation.

TABLE 26. A Comparison of the Pre- and Post-Hemoglobin, Hematocrit, and Serum Osmolality Values.

HEMOGLOBIN					
PRE				POST	
Group	(n)	Mean	SD	Mean	SD
1	29	15.62	0.96	15.41	0.81
2	29	15.74	0.84	15.36	0.74
3	29	15.56	0.87	15.19	0.67
4	33	15.60	0.88	14.93	0.77

HEMATOCRIT					
PRE				POST	
Group	(n)	Mean	SD	Mean	SD
1	29	46.1	2.1	45.8	1.8
2	30	45.8	2.4	45.7	2.2
3	30	44.8	2.1	44.1	1.9
4	33	44.5	2.2	44.1	1.8

SERUM OSMOLALITY					
PRE				POST	
Group	(n)	Mean	SD	Mean	SD
1	28	283	3.7	284	4.1
2	32	286	5.8	289	2.9
3	30	286	5.4	288	5.0
4	34	285	6.1	284	4.8

Obtaining Water

During the study, most soldiers (92%) reported obtaining water from either 5 gallon cans or a water buffalo. Only in 8% of the 1107 occasions did they resort to melting snow to obtain water. This is at variance with the final questionnaire but can be accounted for by the differences between groups: 3%, 2%, 5% and 20% from the respective groups reported obtaining water by melting snow. The most frequently used source (by those who used more than one) was 5 gallon cans.

When asked, in the final questionnaire, how easy or difficult it was to obtain water during the exercise, there were some differences among the four groups. The MRE VIII group and the MRE VI plus supplemental pack group found it 'somewhat difficult'; the MRE VIII plus supplemental pack group found it 'moderately difficult'. The MRE VI group did not report a problem in obtaining water.

Qualitative Urine Measurements

Urine specific gravity (SG) was measured daily and these results, Figure 11, have been taken in this study as the 'Gold Standard'. Subjects were also asked to record on the reverse of the *Dietary Log Sheets*, the amount of water mixed with food, consumed as beverages or consumed as plain water. These results are presented in Figures 12 to 15.

In addition to these measurements, subjects were asked to make a value judgement in respect of that day's urine. This was done by circling a number that most closely corresponded with their judgement on color, lightness/darkness, frequency and amount of urine. Results obtained from the seven days are presented in Figures 16 to 19.

Although these subjective judgements could be considered a duplication of effort and arguably unnecessary for this particular study, a pale urine in a normal person follows high fluid intake and darker urine may be seen when fluids are withheld. Thus color roughly indicates the degree of concentration (32). As such, it is a technique that has been used on previous studies and, in the field, provides Commanders with a broad yardstick on whether their troops are dehydrated. However, there have been few, if any, attempts from these studies to relate judgements with the actual urine SG. The opportunity was therefore taken to correct this situation.

Figure 12
Mean Daily Water Consumption Mixed
With Food

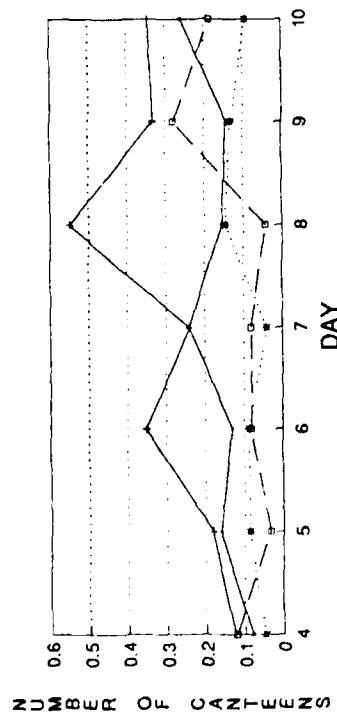


Figure 13
Mean Daily Water Intake Consumed
as Beverages

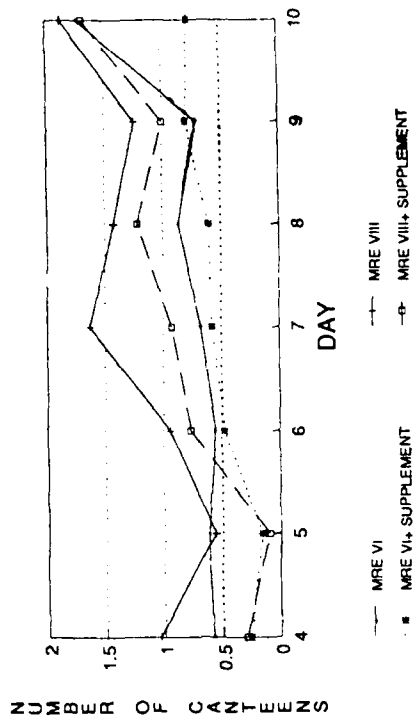


Figure 14
Mean Daily Water Intake Consumed as
Plain Water

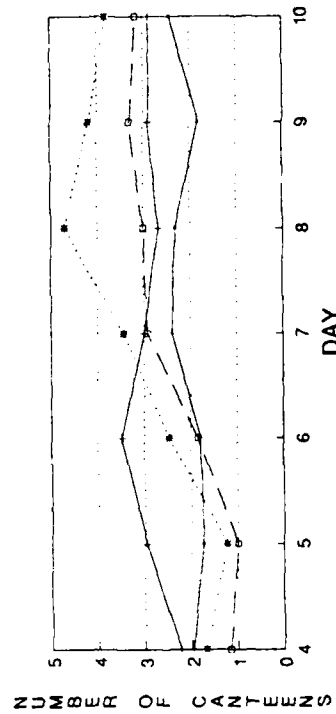


Figure 15
Mean Daily Water Consumption From
All Sources

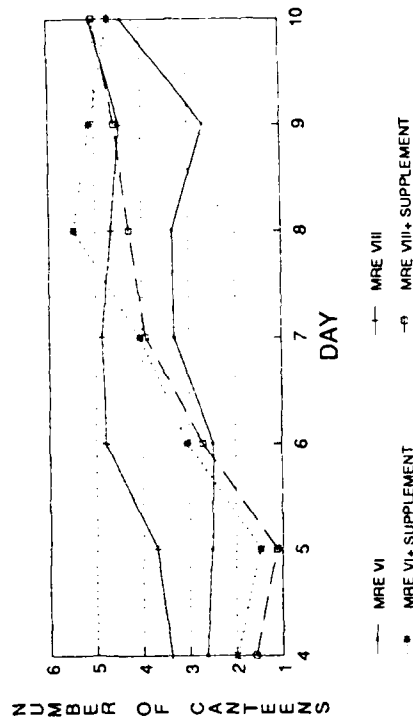


Figure 16
Mean Daily Rating of How Light
or Dark Urine Was

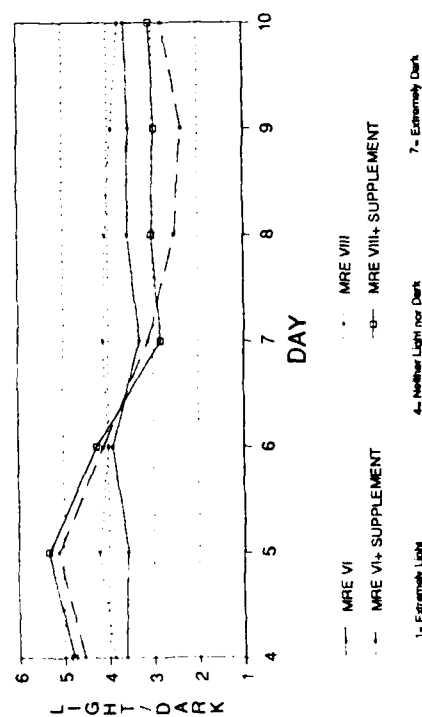


Figure 17
Mean Daily Rating of Color of Urine

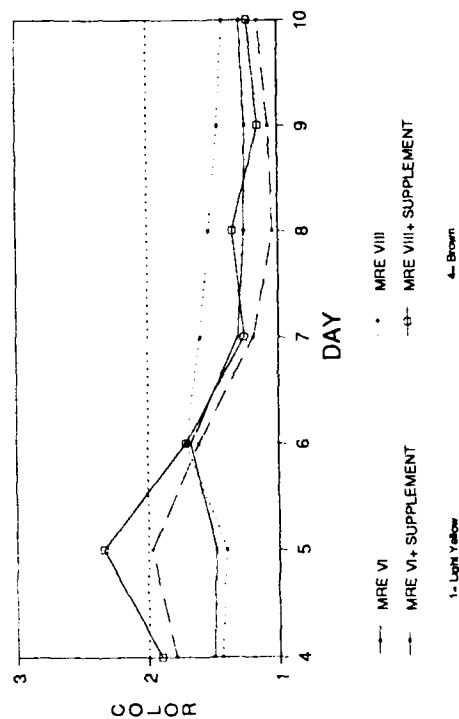


Figure 18
Mean Daily Frequency of Urination

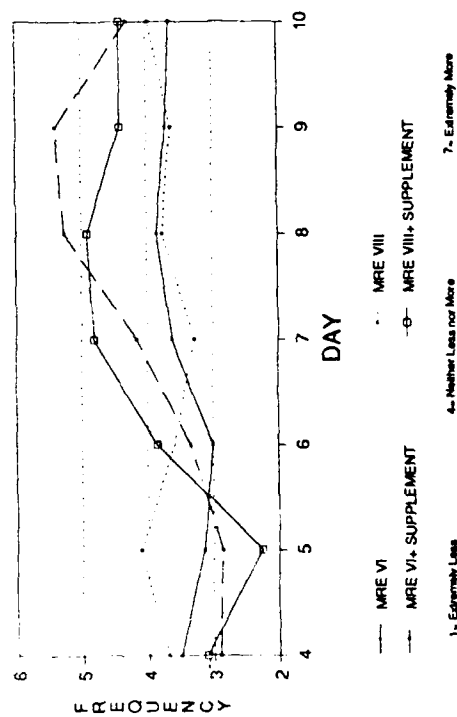
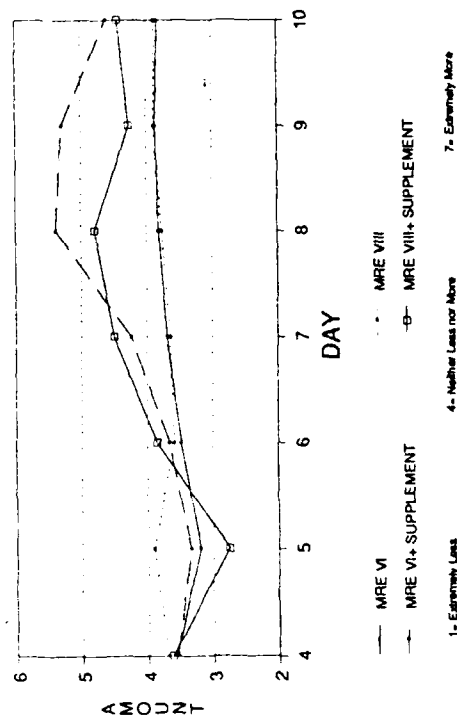


Figure 19
Mean Daily Amounts of Urination



An evaluation of the daily numeric means from these results indicates a general trend between the four measures and total water consumption. As water consumption decreases, urine is reported as being darker, browner in color and the frequency and amounts of urine are reported as decreasing. Conversely, the opposite is reported as water consumption increases.

As should be expected, there is a negative correlation between the total water consumed, lightness/darkness and color of the urine. Although significant ($p < 0.05$), the correlation coefficients are low indicating only a very weak likelihood of predicting total water consumption from the lightness and color of the urine. Similarly, there is a significant positive correlation ($p < 0.05$) between total water, frequency and amount of urination. Although the correlation coefficients are higher indicating a better predictability, they are not as high as would be expected. No significant variations in these patterns were found between groups and between days. Therefore, the data were aggregated and the results for the total period, comparing total water consumption and the relevant questions, are presented in Table 27.

TABLE 27. A Comparison Between the Total Water Consumed and Subjective Ratings of Urine Color, Frequency and Amount.

	Total Water Correlation Coefficient r
Light/Dark	- 0.093
Color	- 0.075
Frequency of Urination	0.419
Amount Urinated	0.362

What has also been observed when comparing these data is a strong, significant ($p < 0.05$) positive correlation between the questions relating to lightness/darkness and color ($r = 0.584$); and frequency and amount urinated ($r = 0.861$). These questions are answered in a similar manner indicating that one of these could be excluded from future questionnaires.

Difficulties Encountered with the MRE

The difficulties encountered by soldiers using MREs were ascertained from comments made on the Dietary Logs, the questionnaires administered at the end of the study (Appendix E) and from unstructured interviews conducted at the daily meetings.

Damage Sustained to the Pouches as a Result of Freezing

During previous cold weather exercises, there have been a number of anecdotal and documented reports of the retort pouch being compromised due to its freezing, rupturing and subsequent thawing. The pouch not only leaked but there was also contamination rendering the contents of the pouch unfit for consumption. In the After Action Report (Medical) from Brimfrost 1987 (33) there were reports of 'numerous packages of rations (MREs) that were identified as leakers, bloaters or otherwise not fit for consumption.' Two of the meals were found to be putrefied while 4 packages of beans and 2 of applesauce contained gas bubbles. In addition 'several lots of MREs were identified with a higher than acceptable rate of unsealed packages...although there did not appear to be consistency in the type of meal or manufacturing company...'. The problems associated with freezing are well recognized and were reaffirmed by soldiers, cooks and commanders in a recent study (34); but this problem may be aggravated in the future by the higher proportion of wet pack items being included in the MRE VIII.

One of the test criterion for the present study required that rations should not be presented in a frozen state more than 10% of the time and that no more than 10% of any pouch should sustain damage as a result of freezing or other environmental reason.

Ration resupply was undertaken as part of the study protocol partly to be absolutely certain that the correct rations reached the right soldier and partly to increase the likelihood of the test criteria being met. The option existed of transporting rations either on top of or inside the rear of the resupply vehicle, the latter being at the expense of other equipment. The rear of the vehicle was unheated, uninsulated and therefore, notwithstanding windchill factors, at ambient temperatures. As a result, rations were transported on top of the vehicle and, following a journey that lasted between one to 3 1/2 hours, invariably arrived frozen. In addition, where rations were issued to tent groups, the customary practice was to leave the rations outside the tent until shortly before required or until a convenient opportunity arose to move them. It was confirmed by later unstructured interviews that, with the exception of the first

day, all rations were delivered and received in a frozen state.

In order to assess the extent of any damage to the pouches or other packaging resulting from freezing, subjects were asked to record on the Dietary Log Sheets details of any damage. Results are presented in Table 28.

TABLE 28. Incidence of Damage to Retort Pouches Attributable to Freezing

Product	Date
MRE VI	
Beef Diced with Gravy	4 March
Chicken ala King	4 March
Ham Slices	4 March
Beef Stew (2 pouches)	5 March
Frankfurters	8 March
Beef Ground with Spiced Sce	8 March
Cheese Spread	4 March
MRE VIII	
Corned Beef Hash	9 March
Escalloped Potatoes with Ham	9 March
Apple Sauce	12 March

When considered against the number of MREs issued for consumption to those turning-in Dietary Log Sheets, the number of pouches damaged represents 7 entrees from the 2031 MRE VIs issued (0.0025%) and 2 (0.0011%) entrees from the 1862 MRE VIIIs issued over the study.

However, what is not evident, but a factor highlighted at a recent workshop meeting held to discuss feeding in a cold environment (35), is that damage sustained to the pouches only becomes apparent when unused and unconsumed rations are returned at the end of the exercise. At this stage it then becomes necessary to open and check each ration to ensure the pouch's integrity. Soldiers confronted by a frozen but damaged pouch in the field may not have appreciated this fact and consumed the ration. Only on return to Garrison when the ration defrosts does this become evident. On Exercise Brimfrost 1989 approximately 20% of the

returned pouches were damaged (35). This was supported by responses in the final questionnaire in the present study where the packaging of both the MREs and the supplement pack held up well; 94% of the troops reported that the brown outer MRE bag was never torn or damaged, while 84% said the individual food packets were never torn or damaged. Almost all of the soldiers indicated that the packaging for the supplemental pack items was undamaged which, in view of the nature of the products, is to be expected.

A number of subjects recorded and commented during discussions that they had 'burned' the retort pouches on the Yukon stove. Five subjects recorded such incidents on 2 March whilst 3 further such incidents were recorded later in the study. It would seem that a customary practice, when in tents, was to lay the pouches on the stove in order to defrost or heat them, a practice not officially taught but one used by soldiers for ease and convenience. As a consequence of the stove being too hot, the pouch burnt. It is not clear whether the smaller number of incidents reported after 2 March was due to soldiers becoming more adept at heating the rations or their realizing that the practice did not work.

MRE Preparation

In the final questionnaire soldiers were asked their opinions about various aspects of preparing the MRE. These results are summarized in Table 29. Only two of the responses showed differences between the four groups. In the response to the general question about heating (i.e. independent of test methods) soldiers in all four groups felt it 'somewhat easy' to heat food, water and beverages. Soldiers in the four groups also did not report difficulty eating more than one item at a time, avoiding spilling the rations, or rehydrating the dehydrated items. However, opening the brown outer meal bag was found to be 'somewhat difficult'. Soldiers in all four groups also found it 'moderately difficult' to keep food and water from freezing. Over half of them said that the food in their MREs froze at least once a day, and 72% said that the water froze in their canteen that often. On the other hand, the supplement items, as would be expected, generally did not freeze.

The only differences between the four groups were found in their reported difficulty opening the individual food packets and keeping their hands warm while preparing and eating the MRE. Overall there was no difficulty in opening the individual food packets. However, group 1 (MRE VI) found it a significantly easier task than did group 2 (MRE VIII) and group 3 (MRE VI +

supplemental pack). Similarly, it was neither easy nor difficult for the soldiers to keep their hands warm while preparing and eating the MRE. However, group 4 (MRE VIII + supplemental pack) kept their hands significantly warmer than group 2 (MRE VIII) which reported it to be a somewhat 'difficult task'.

TABLE 29. Mean Ratings of Ease of Preparation.

	Group 1 MRE VI	Group 2 MRE VIII	Group 3 MRE VI + Suppl	Group 4 MRE VIII + Suppl	ANOVA Results
Opening the Outer Bag	3.51 (.25)	2.97 (.20)	3.07 (.30)	3.06 (.27)	NS
Opening Individual Food Packets	5.40 ^a (.25)	4.32 ^b (.25)	4.38 ^b (.32)	5.15 ^{ab} (.26)	F(3,131)=4.09*
Keeping Food from Freezing	2.38 (.30)	2.53 (.26)	2.50 (.31)	2.11 (.22)	NS
Eating More than One Item at a Time	4.39 (.30)	4.61 (.29)	4.79 (.29)	5.12 (.28)	NS
Keeping Water from Freezing	2.03 (.27)	1.89 (.22)	2.20 (.26)	1.71 (.20)	NS
Mixing Water with Dry Items	4.63 (.30)	4.14 (.28)	4.20 (.28)	4.82 (.28)	NS
Heating Water/Beverages	5.14 (.25)	4.44 (.22)	5.14 (.26)	5.24 (.29)	NS
Heating Food	5.24 (.24)	4.89 (.22)	5.10 (.26)	5.34 (.26)	NS
Avoiding Spilling Rations	5.06 (.24)	4.41 (.22)	4.62 (.29)	5.06 (.29)	NS
Keeping Hands Warm While Preparing and Eating the MRE	4.63 ^{ab} (.28)	4.00 ^a (.26)	4.55 ^{ab} (.27)	5.21 ^b (.22)	F(3,131)=3.75**

Notes: Mean ratings of ease of preparation are based on the following scale:

1 = Extremely Difficult... 5 = Neither Easy Nor Difficult... 9 = Extremely Easy...

Items with different superscripts differ significantly from one another ($p < 0.05$, Student-Newman-Keuls multiple comparison test).

Numbers in parentheses are standard errors.

* $p < 0.01$ (One-way Analysis of Variance).

** $p < 0.05$ (One-way Analysis of Variance).

Soldiers' Additional Comments About the MREs

In the final questionnaire soldiers were asked to comment on what they thought should be added or dropped from the MRE menus, as well as what they liked most and least about the MREs. Most of the additions suggested for the MRE VI are items that are now included in the MRE VIII, for example, hot sauce, fruit beverage powders and better candy. The MRE VIII group requested more candy and desserts. The groups who tested the supplemental pack suggested adding some of the items such as bread, beef jerky and trail mix to the MRE.

Most of the foods that troops felt should be dropped from the MRE VI are items that have not been retained in the MRE VIII: these include fruit cake, orange nut cake, beef with gravy, beef with barbecue sauce, beef with spiced sauce and ham/chicken loaf. The most frequently requested deletion from the MRE VIII was chicken ala king and one out of six soldiers also suggested that the brownie, dried fruit and beef stew be dropped.

The MRE's convenience and compactness were the features liked most in the MRE VI. The foods liked the best were cocoa, the sweets and the cheese and crackers. The new entrees, additional variety and better taste were the qualities liked best about the MRE VIII. The desserts and candy were the foods liked the most.

The qualities liked the least about the MRE VI were the lack of variety and small portion size. Although the portion size of the entrees has been increased in the MRE VIII, a number of subjects who received the MRE VIII felt that the overall quantity of food and the portions of some of the other items such as the fruit and candy were still too small. Others mentioned that the rations were messy to eat in the field and suggested longer spoons or opening the individual food packages vertically instead of horizontally.

Soldiers' Comments About the Supplemental Pack

Soldiers who received the supplemental pack with their MRE had mostly positive things to say about it. They suggested that other types of candy be added to the pack, in particular, chocolate candy such as 'M&M's'.

When asked what they liked most about the supplemental pack, the most frequent response was the bread. A number of soldiers also mentioned the beef jerky and the trail mix. The only consistent criticism of the supplemental pack was that the trail mix was too bland. Generally, the supplemental pack was thought to be a good idea. Some soldiers indicated these items should

be included with every meal. Several soldiers commented that the "pogey bait" brought to the field would be significantly reduced if the supplemental pack was issued with the MRE.

Heater Evaluation

Soldiers were issued one ration heater pad (RHP) with each of their meals although on many occasions they chose not to take them. As previously mentioned, water was limited and sometimes difficult to obtain. Even when it was supplied regularly, it was difficult to keep the water from freezing in the canteen. Soldiers were generally not willing to use the limited supply of unfrozen water to heat the rations with the RHP. Since the yukon stove served as a reliable heating method and did not require water, the RHP was not generally used in the tents. The soldiers rarely ate outside; when asked, 56% of them said they never ate outside. When they did, they were on the move and ate mostly snack foods that did not need to be heated.

In response to questions about heating the ration, which were included on the final questionnaire (Appendix E) 88% of all soldiers reported heating the food in the MRE at least once a day. More than half of the soldiers heated water for beverages on a daily basis. Ninety-six percent of the troops used the yukon stove for heating purposes; only 12% reported that they used the RHP. Of those who used more than one method to heat MREs and/or water, 91% used the yukon stove most frequently. The fact that the RHP was not regularly used is also apparent when considering that even though soldiers were offered one heater pad per meal, they did not always take it because they had not used previously issued pads.

Of the 110 soldiers who filled out the RHP questionnaire, only 48 (44%) had used the RHP during the evaluation period. Sixty percent of these (26% of the total) had used them only once, while only 8% who used them (4% of the total) had used them more than a few times. The following results are therefore based on the limited experience of a minority of soldiers who were in the field, and should be interpreted accordingly. On the final questionnaire only 12% of the soldiers who responded to that survey reported using the RHP, while 44% reported using the heater pads on the heater questionnaire. This discrepancy can be explained by the fact that most of them tried the RHP only once. On the final questionnaire, when answering the question about which type of heat source they used, they may have only chosen the heating method that they used the majority of the time.

Most troops who used the RHP felt that it took too long to heat the MREs. Only half of these soldiers described the temperature of the MRE entree as "hot" after heating with one RHP, and then half of them felt that the MRE got hot enough only some of the time. Ten of the soldiers reported using two RHPs at one time to heat the MRE entree. Under this condition, the results were more favorable; seven of the ten felt that the entree got hot enough most of the time. Soldiers were asked about potential problems relating to the heating process using the RHP such as the smell and the foam created by the heating reaction, water spilling out of the MRE bag and keeping the MRE bag closed during heating. On average, these were not found to be major problems.

Soldiers felt that it was slightly difficult to use the RHP. None of those who responded to the questionnaire used the heater pads to heat water for beverages. Without additional supplies (such as resealable bags), heating water with this method is clearly a problem. In a study conducted at Ft. McCoy, Wisconsin, in January 1989 (36), Marines were issued Ziploc^R bags with the RHP. Even with the bags available, they found heating water to be cumbersome and inefficient, and drank fewer hot beverages than Marines using other heating methods.

When asked which heating method they preferred (the RHP or the method they usually use) 93% of the soldiers in the present evaluation said they preferred the method they usually use. Most use the yukon stove, while some use heat tabs.

In order to determine whether or not the RHP would be an effective heating method if no alternatives were available, they need to be tested under those conditions. The study conducted in January 1989 at Ft. McCoy, Wisconsin, included a group of Marines who were issued the RHP as their sole method of heating during a five-day field exercise. After using this method, Marines reported that they generally liked the RHP and found that it heated the MRE entree sufficiently when two pads were used at one time. They reported that the entree almost always got hot enough. The RHP group also indicated that the entree got hot enough more often than it did for a group who used a canteen cup stand and heat tabs to heat their MRE. However, they did indicate that heating water with the pads was a problem. They reported that they would use the RHP to heat the MRE if it was available.

The Ft. McCoy study took place in a moderately cold environment. The infrequent usage and the small number of soldiers who used the RHP in the present evaluation makes it difficult to draw conclusions about the feasibility of using the heater pads in the extreme cold. Whether

the RHP would heat the MRE sufficiently in an extremely cold environment if no other heating source was available needs to be further addressed as does the problem of heating water for beverages with this method. One comment from a soldier in the present study may shed some light on this question: "If we didn't have the use of yukon stoves, which many times we don't, I would have either starved, or frozen to death trying to thaw them [the MREs]."

Amount Eaten vs Food Acceptability

The ultimate objective in any field feeding system is for soldiers to consume the ration. It has been argued that one of the best ways of predicting whether people will eat a particular food and how much of it they will eat, is to ask them how well they like it (37), for it appears that food preferences expressed in a questionnaire are a fair predictor of consumption (38).

The assessment of food preferences is normally undertaken using the hedonic scale (39) which has been employed in a number of field studies, either as a single measure, or in conjunction with other techniques, for example, food intake. However, the liking of a food may not always be reflected in consumption. A soldier may be hungry and eat a food even though he dislikes it. On the other hand, a food may be liked although not consumed for a variety of reasons. While studies have been conducted in a laboratory, no recent field studies have compared food intake data with acceptability data collected in the field. Using a Chi-square test, the mean intake for the entire study has been compared with the mean hedonic rating. Where consumption was less than 10, that food item has not been included. Results are presented in Table G 1, Appendix G.

A positive correlation ($p < 0.05$) can be observed between the mean food intake and mean hedonic rating for most individual food items, which on initial examination re-enforces the original hypothesis; however, on further examination, this may not be the case.

In the first report (1), the hedonic ratings were summed and the mean values calculated. This may not always reflect a true picture as, for example, in the case of entrees in MRE VI, 80% of the subjects rated food items 'like slightly' or better although only 6% of those ate more than one. Similarly 12% of the subjects disliked the entrees either 'slightly' or worse although from that group 61% still ate them. Alternative methods exist to present preference data and one, involving the relative popularity of food components is given in Table G 1. Taking the number of subjects ranking each food 'like slightly' [6], or better, divided by the total number of cases,

provides, albeit subjectively, a value and ranking for each food component and food group. Although this technique may be beneficial during ration development, it is suggested that once a ration has been developed, actual consumption in the field should be considered as the primary criteria on which decisions are based.

Dietary Logs vs Collected Wrappers

In addition to recording food consumed in the Dietary Log Sheets, empty wrappers and unwanted food were also collected in a plastic Ziploc^R trash bag. These bags were recovered daily although care was exercised to ensure that the Dietary Logs were not completed on the basis of the empty wrappers were being turned in.

This procedure was different from that normally followed by soldiers in the field as trash is usually collected and removed centrally thereby relieving them of the need to carry it with them. This situation was made even more difficult as soldier not involved in the study continued to have their trash removed as normal. As a result, some of the trash was not placed in the plastic bags but was thrown away for centralized collection.

Trash, when collected in Ziploc^R bags, has been used on previous studies to reinforce and confirm the Dietary Log Sheets. It has also been used to compare with the Dietary Log Sheets. On the 10-day study comparing the Ration, Cold Weather and the Meal, Ready-to-Eat (2) it was found that the Log Books were more complete than the wrapper collection with wrappers averaging 65% of Log Book entries. In the study comparing the Meal, Ready-to-Eat; Ration, Cold Weather; and the Ration, Light Weight, the wrappers for one day averaged 94% of Log Book entries (13).

On the present study trash was collected separately and again the opportunity taken to compare the two data collection methods. Trash was analyzed for 4, 2, 5 and 4 days from the respective groups and a t-test used to compare the mean amounts of food consumed, by food groups, against the amounts as recorded on the Dietary Log Sheets. Results with correlation coefficients are given in Table 30. With the exception of 'other foods' in Group 2 there were no significant differences between the 2 methods with correlation coefficients indicating a good agreement. Wrappers in all but 6 cases (1 starch, 1 fruit, 2 desserts and 2 supplemental packs) were under-reported by an average of 6%, 13% 8% and 8% for the respective groups.

TABLE 30. A Comparison of Food Consumed Using Dietary Log Sheets and Food Wrappers

Food Group	Group 1	Group 2	Group 3	Group 4
	Correlation Coefficient			
Entrees	.908	.943	.591	.424
Starches	.657	.616	.486	.469
Spreads	.655	.755	.335	.537
Fruits	.755	.655	.424	.461
Desserts	.740	.621	.554	.530
Beverages	.678	.947	.731	.715
Others	.331	.151	.174	.537
Supplemental Pack	---	---	.794	.647

SUMMARY AND CONCLUSIONS

To determine the suitability of using the Meal, Ready-to-Eat (MRE) in a cold environment, the validity of a supplemental pack as a cold weather energy supplement and the effectiveness a chemical Ration Heater (RHP), four groups of soldiers, each of approximately 35 strong were studied during a ten-day exercise in Alaska. One group of soldiers ate 4 MRE VIs daily, the second 3.5 MRE VIs, the third 3 MRE VIs and 1 supplemental pack and the fourth group 3 MRE VIs and 1 supplemental pack. Each soldier was also given a RHP to his heat meals.

Prior to deployment, initial measurements were taken. Thereafter, daily food intakes were recorded using 24-hour Dietary Log Sheets and hydration status ascertained from urine samples. At the end of the exercise further measurements were taken in order to ascertain what physiological changes had taken place since the start of the exercise.

This second of two reports focuses on those aspects which due to a number of constraints were not addressed or considered in the first report. The opportunity was also taken to realign the data by calendar days and exclude the days of deployment and the last days of the study as previous experience has shown that the turbulence and uncertainty of the

situation can sometimes be reflected in the data collected. The results, however, show little variation and do not compromise the data and conclusions of the first report.

The mean daily energy intake for the seven-day period was slightly less (1-6%) than the mean for the total period but nonetheless confirms the success of the supplemental pack. While the figures for the group consuming MRE VIII and the supplemental pack demonstrate a higher energy intake than earlier studies, they still only represent between 42% and 78% of the Military Recommended Dietary Allowances (MRDA) of 4500 kcal. Failure to consume sufficient calories over the total period resulted in a body weight loss ranging from 2.8% in the group consuming MRE VI to 1.7% in the group consuming MRE VIII with supplemental pack. These figures are within the test criteria of 3%.

Activity levels during the study indicate that the 4 groups (2 Companies) had similar sleep-wake patterns. The amount of sleep, in this study, was not a major influencing factor in the quantity of food and water consumed.

Environmental temperatures were recorded daily and during the seven day period, the minimum temperature ranged from -40°F to -20°F . No discernible correlation can be observed between environmental temperature and caloric intake possibly because the temperature was uniformly low.

Empty wrappers and unwanted food items were collected daily from soldiers in the field and used to compare with the 24-hour Dietary Log Sheets. With the exception of 'other foods' in one of the groups there were no significant differences between the two methods although due to the exercise scenario Dietary Log Sheets are more likely to be accurately completed.

A comparison was made between the amount of food eaten and food acceptability as measured on a 9-point hedonic scale. A positive correlation was observed for most individual food items although it is suggested that while food acceptability is beneficial during the developmental stages of a ration, it is actual consumption that is the important indicator in the field.

In order to meet the MRDA of 4500 kcal, 4 MREs are normally issued. When using MRE VI this provides 3918 kcal and 5224 kcal using the MRE VIII. Over the seven day period, the group consuming MRE VIII was issued 3 and 4 MREs on alternate days and the group consuming MRE VIII with supplement pack, 3 MREs per day. Despite the additional MRE, the frequency of consumption, intake of energy, protein, fat and carbohydrate between groups were not significantly different.

It could be concluded that the supplemental pack provides a viable alternative to issuing a fourth MRE VIII and is therefore suitable for use as a cold weather calorie supplement. All items within the supplemental pack were well received and in the case of the bread well consumed. Bread is therefore an ideal medium should fortification of selected nutrients be deemed necessary. It could also be used as a replacement for some crackers.

Despite the advantages offered by the supplemental pack due consideration must be given to the percentages of energy obtained from protein, fat and carbohydrate in addition to the amount of salt contained in operational rations, particularly where water supplies may be limited. This is because to the slightly increased amount of water liberated by the complete oxidation of carbohydrate and the increased amount of water required to excrete protein, fat and salt.

Hydration status was estimated on a daily basis by measurement of the urine specific gravity. The results show that by day three, two groups (one company) were hypohydrated. This was due almost exclusively to the low water consumption which was less than two liters per man per day. Only after reporting this factor and direct intervention by senior commanders did water intake and consequently hydration status improve. Water and food intake were also found to be strongly correlated although it is not clear whether food induced water consumption or water induced food consumption.

In addition to measuring hydration status using urine specific gravity, a number of value judgements were made by soldiers on qualitative aspects of their urine. These included judgements of color, lightness/darkness, frequency and amount of urine. Although the correlations were not strong, the results do provide a broad indication of hydration status and remain a valid yardstick for commanders in the field.

Difficulties encountered by soldiers using the MRE were ascertained from comments made on the 24-hour Dietary Log Sheets supported by interviews and from the final questionnaire administered at the end of the study. While some damage was reported to pouches as a result of freezing, the failure rate is considered to be very small. However, in most cases, damage only becomes apparent when unconsumed rations are returned and thaw out at the end of the exercise. In these situations a failure rate as high as 20% has been reported. Under harsh environmental circumstances where rations are subjected to freezing and rough handling, a wet pack item may not be the ideal ration.

Soldiers were issued one RHP with each of their meals although in many cases chose not to take or use them. This was not necessarily due to short-comings in the RHP but because other heat sources were available and more suited to this type of harsh environment. The low use of this type of heater precludes any definitive conclusion from being drawn.

RECOMMENDATIONS

1. The supplemental pack provides a viable alternative to issuing a fourth MRE in a cold environment.
2. Efforts to improve the overall intake of the MRE, in particular energy, need to be progressed.
3. Pouched bread could be used as a replacement for some crackers and represents an ideal medium should fortification of selected nutrients be deemed necessary.
4. In developing operational rations care needs to be taken to ensure the correct ratios of protein, fat and carbohydrate; and total salt particularly where water supplies may be limited.
5. Until technology is able to produce a pouch that can withstand the rigors of this type of environment, consideration should be given to replacing the MRE with a dehydrated ration.
6. Food acceptability, remains a valuable tool in ration design although in the field, the more important indicator is actual consumption.
7. Further work is required to assess the suitability of the Ration Heater Pad and whether it is a feasible method of increasing the intake of the entree.
8. Efforts to encourage better water consumption either through improved water discipline, forced drinking or alternative methods of supplying unfrozen water need to be investigated.

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APPENDIX A

NUTRITIONAL CONTENTS OF THE PROPOSED SUPPLEMENTAL PACK

NUTRITIONAL CONTENTS OF THE PROPOSED SUPPLEMENTAL PACK

Nutrient	Unit	Supplemental	
		Pack 1	Pack 2
	70 gm	Pouched Bread	Pouched Bread
	34 gm	Beverage Base	Beverage Base
	5 gm	Tabasco Sauce	Tabasco Sauce
	28 gm	Candy (Charms)	Candy (Charms)
	43 gm	Beef Jerky	57 gm Nuts & Raisins
Energy	kcal	661	821
Protein	gm	28.45	17.29
Fat	gm	17.54	27.87
Carbohydrate	gm	97.26	125.00
Vitamin A	mcg RE	0	0
Vitamin E	mg TE	2.43	3.4
Ascorbic Acid	mg	24.84	24.84
Thiamin	mg	0.41	0.48
Riboflavin	mg	0.28	0.17
Niacin	mg NE	5.80	4.36
Vitamin B6	mg	0	0.08
Folacin	mcg	15.9	33.39
Vitamin B12	mcg	0.6	0
Calcium	mg	61.34	95.98
Phosphorus	mg	290.6	224.3
Magnesium	mg	41.6	73.6
Iron	mg	4.12	1.93
Zinc	mg	4.18	1.47
Sodium	mg	1178	665

APPENDIX B

VOLUNTEER AGREEMENT AFFIDAVIT

VOLUNTEER AGREEMENT AFFIDAVIT

For use of this form, see AR 70-25, the proponent agency is DTIC

PRIVACY ACT OF 1974

Authority: 10 USC 3013, 44 USC 3101, and 10 USC 1071-1087.

Principle Purpose: To document voluntary participation in the Clinical Investigation and Research Program. BSN and home address will be used for identification and locating purposes.

Routine Uses: The BSN and home address will be used for identification and locating purposes. Information derived from the study will be used to document the study, implementation of medical programs, adjudication of claims, and for the mandatory reporting of medical conditions as required by law. Information may be furnished to Federal, State and local agencies.

Disclosure: The furnishing of your BSN and home address is mandatory and necessary to provide identification and to contact you if future information indicates that your health may be adversely affected. Failure to provide the information may preclude your voluntary participation in this investigational study.

PART A(1) - VOLUNTEER AFFIDAVIT

Volunteer Subjects in Approved Department of the Army Research Studies

Volunteers under the provisions of AR 40-38 and AR 70-25 are authorized all necessary medical care for injury or disease which is the proximate result of their participation in such studies.

I, _____ BSN _____

having full capacity to consent and having attained my _____ birthday, do hereby volunteer/give consent as legal

representative for _____ to participate in _____

of the Nutritional Intake and Acceptability of the MRE VI and VIII and the

MRE VI and VIII with Supplements. Conducted in a GDI Environment

under the direction of MAJ John S. A. Edwards

conducted at Fort Greely, Alaska

The implications of my voluntary participation/consent as legal representative, duration and purpose of the research study, the methods and means by which it is to be conducted, and the inconveniences and hazards that may reasonably be expected have been explained to me by

Contact telephone(s): AW 256-4979 Commercial (308) 651-4979

I have been given an opportunity to ask questions concerning the investigational study. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights/the rights of the person I represent on study-related injury, I may contact

OFFICE of the Chief Counsel

U.S. Army Natick Research, Development and Engineering Center (308) 651-4422

(Name, Address and Phone Number of Hospital (Include Area Code))

I understand that I may at any time during the course of this study revoke my consent and withdraw/have the person I represent withdrawn from the study without further penalty or loss of benefits; however, if the person I represent may be required (military volunteer) or requested (civilian volunteer) to undergo certain examination if, in the opinion of the attending physician, such examinations are necessary for my/the person I represent's health and well-being. My/the person I represent's refusal to participate will involve no penalty or loss of benefits to which I am/the person I represent is otherwise entitled.

PART A (2) - ASSENT VOLUNTEER AFFIDAVIT (MINOR CHILD)

I, _____ BSN _____ having full

capacity to consent and having attained my _____ birthday, do hereby volunteer for _____

to participate in _____

under the direction of _____

conducted at _____

(Name of Institution)

Continue on Reverse)

FORM A(4) - ASSENT VOLUNTEER AFFIDAVIT (MINOR CHILD) (Cont'd.)

The implications of my voluntary participation; the nature, duration and purpose of the research study; the methods and means by which it is to be conducted; and the inconveniences and hazards that may reasonably be expected have been explained to me by

I have been given an opportunity to ask questions concerning this investigational study. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights I may contact

at

(Name, Address, and Phone Number of Hospital (Institute Area Code))

I understand that I may at any time during the course of this study revoke my assent and withdraw from the study without further penalty or loss of benefits; however, I may be requested to undergo certain examination if, in the opinion of the attending physician, such examinations are necessary for my health and well-being. My refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled.

PART B - TO BE COMPLETED BY INVESTIGATOR

INSTRUCTIONS FOR ELEMENTS OF INFORMED CONSENT: (Provide a detailed explanation in accordance with Appendix E, AR 40-38 or AR 70-25.)

The purpose of this study is to assess the suitability and acceptability of the Meal Ready-to-Eat (MRE) and a supplemental pack eaten in a cold environment. The study will last for 14 days and will be conducted in conjunction with your normal cold weather military training except that you will only be given MREs to eat. You will not be permitted to supplement these rations by bringing your own food into the field.

Prior to the start of the exercise you will be weighed and your height measured, a small blood sample will be taken from a vein in your arm using a hypodermic type needle and you will be asked to give a sample of your urine and saliva. The amount of blood that we will draw will be less than three tablespoons. Trained personnel will be used although localized pain and a small bruise may occur. There is a slight chance of infection at the site although this is no greater than that experienced in a hospital. Measurements, similar to those taken in hospital to monitor your heart rate, may be taken by attaching sensors to your hand and foot and measuring the resistance. This is a widely used technique being both safe and painless. You may be asked to drink a small glass of modified water and you may also be asked to wear a lightweight activity monitor attached to your wrist. You will be asked to fill out daily food logs and you will receive training on how to do this. Urine samples will be collected daily.

I do ☐ do not ☐ (check one & initial) consent to the inclusion of this form in my outpatient medical treatment record.

SIGNATURE OF VOLUNTEER	DATE	SIGNATURE OF LEGAL GUARDIAN (if volunteer is a minor)	
PERMANENT ADDRESS OF VOLUNTEER	TYPED NAME OF WITNESS		
	SIGNATURE OF WITNESS		DATE

65

REVERSE OF DA FORM 5303-R, MAY 88

At the end of the trial, a further blood sample (less than three tablespoons), saliva sample and weight will be taken, you may be asked to drink another small glass of modified water and measurements again taken using sensors attached to your hand and foot.

The blood sample will be analyzed to determine if any changes occur in your nutritional and hydration status during the course of this trial, while urine is required to establish whether or not you receive or drink sufficient water. The modified water will enable us to determine your energy expenditure and the activity monitor will measure the levels of activity between participating groups. The measurement obtained by attaching sensors to your body will enable us to determine your total body water.

You will be asked to answer questions about yourself, your background, medical history and past dietary patterns, habits and attitudes. This will assist us when analyzing the results. The information you give, together with the other information that we will collect, will be treated in the strictest confidence and will not be revealed to any person who is not authorized to receive it or has no need to know. However you should know that complete confidentiality cannot be promised, particularly to subjects who are military personnel, because information bearing on your health may be required to be revealed to appropriate medical or command authorities. Information about you may be inspected by the Institutional Review Boards for Human Studies, the Food and Drug Administration and officials of the US Army Research and Development Command.

You will be participating in a field exercise and consuming Meal Ready-to-Eat rations for 14 day as part of your regular Army activity. You will receive no direct benefit from participating in this study other than to know that you helped shape future changes in combat rations. Participation in this study is on a voluntary basis. If you choose not to take part or if you choose to withdraw from the study you will not be excused or withdrawn from the field. A decision to remove you from the field would be taken by your local senior military commander.

A second copy of this Agreement Form is provided here for your information and retention.

SIGNATURE OF VOLUNTEER	DATE SIGNED	SIGNATURE OF LEGAL GUARDIAN (If volunteer is a minor)	
PERMANENT ADDRESS OF VOLUNTEER	TYPED OR PRINTED NAME AND SIGNATURE OF WITNESS		DATE SIGNED

APPENDIX C
24 HOUR DIETARY LOG SHEETS

FOODS EATENRATING OF FOODREASONS FOR NOT EATING/FINISHING

Please circle below the number that indicates how much of each item you ate today. If you ate an amount that is not listed, write it on the line to the right.
For example: If you ate 1/2 Beef Stew Entrees circle 1/2.

Please circle below the number that indicates how much you Liked or Disliked the ration items that you ate today.
For example: If you Like Beef Stew, Slightly circle 6.

Please write in the number of the MAIN REASON that you did not Eat or Finish any food.

All food items issued or traded should be accounted for in the columns below as AMOUNT EATEN, NOT EATEN/FINISHED.

CODE	FOOD ITEM	AMOUNT EATEN										RATING OF FOOD										REASONS FOR NOT EATING/FINISHING				
ENTREES		1/4	1/2	3/4	1	2		Dislike	Extremely	Dislike	Very Much	Dislike	Moderately	Dislike	Slightly	Neither	Like/Dislike	Like	Slightly	Like	Moderately	Like	Very Much	Like	Extremely	

51	Pork Patties (Dehydrated)	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
52	Beef Patties (Dehydrated)	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
53	Ham & Chicken Loaf	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
54	Beef Slices with BBQ Sauce	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
55	Beef Stew	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
56	Frankfurters	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
57	Turkey, Diced with Gravy	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
58	Beef, Diced with Gravy	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
59	Chicken a la King	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
60	Meatballs with BBQ Sauce	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
61	Ham Slices	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
62	Beef Ground with Spiced Sauce	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											

STARCHES

63	Beans in Tomato Sauce	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
64	Crackers	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											

SPREADS

65	Cheese Spread	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
66	Jelly	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
67	Peanut Butter	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											

FRUIT

68	Apple Sauce	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
69	Fruit Mix	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
70	Peaches	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
71	Strawberries	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
72	Pineapple	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											

DESSERT

73	Chocolate Covered Brownie	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
74	Cherry Nut Cake	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
75	Chocolate Nut Cake	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
76	Maple Nut Cake	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
77	Orange Nut Cake	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
78	Fruit Cake	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
79	Chocolate Covered Cookie	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											

BEVERAGES

80	Cocoa Powder	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
81	Coffee	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
82	Cream Substitute	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
83	Sugar	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											

OTHERS

84	Soup & Gravy Base	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
85	Catsup	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
86	Salt	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
87	Caramel Bar	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
88	Chocolate Fudge Bar	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
89	Chocolate with Almonds	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
90	Vanilla Fudge Bar	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
91	Coconut Bar	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
92	Gum	1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
93		1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											
94		1/4	1/2	3/4	1	2	—	1	2	3	4	5	6	7	8	9											

Please circle below the number that indicates how much of each item you ate today. If you ate an amount that is not listed, write it on the line to the right.
For example: If you ate 1/2 the Pouched Bread, circle 1/2.

Please circle below the number that indicates how much you Liked or Disliked the ration items that you ate today.
For example: If you Like Beef Jerky, Slightly, circle 6.

number of the MAIN REASON that you did not Eat or Finish any food.

All food items issued or traded should be accounted for in the columns below as AMOUNT EATEN, NOT EATEN/NOT FINISHED.

CODE	FOOD ITEM	AMOUNT EATEN																			
SUPPLEMENTAL	PACK	1/4	1/2	3/4	1	2		Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like/Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely					
101	Pouched Bread	1/4	1/2	3/4	1	2	---	1	2	3	4	5	6	7	8	9					
102	Cold Beverage Base Powder	1/4	1/2	3/4	1	2	---	1	2	3	4	5	6	7	8	9					
103	Hot Pepper Sauce	1/4	1/2	3/4	1	2	---	1	2	3	4	5	6	7	8	9					
104	Charms	1/4	1/2	3/4	1	2	---	1	2	3	4	5	6	7	8	9					
105	Beef Jerky	1/4	1/2	3/4	1	2	---	1	2	3	4	5	6	7	8	9					
106	Raisin Nut Trail Mix	1/4	1/2	3/4	1	2	---	1	2	3	4	5	6	7	8	9					

1. Taste
2. Smell
3. Bland
4. Looks
5. Dieting
6. Full up
7. Traded
8. Saved
9. Too Cold
10. No Water
11. No Heat
12. No Time
13. Damaged
14. Frozen
15. Other

NOT EATEN/NOT FINISHED

WATER CONSUMPTION

1. Please estimate the number of canteen cups of water that you consumed at different times today by writing the number of cups in the appropriate column.
For example, write in 0 1/4 1/2 3/4 1 2 3.

TIME PERIOD	NUMBER OF CANTEEN CUPS		
	Drunk as Plain Water	Drunk as Beverages eg. coffee, cocoa.	Mixed with Food
Morning	---	---	---
Afternoon	---	---	---
Evening	---	---	---

2. What was the main source of this water ?

Melted Snow _____ (Please check one)
Water Buffalo _____
Other Sources _____

URINE

Please answer these question before going to sleep at night.

3. How LIGHT or DARK was your urine today ? Circle one number only to each question.

Extremely Light	Moderately Light	Slightly Light	Neither Light nor Dark	Slightly Dark	Moderately Dark	Extremely Dark
1	2	3	4	5	6	7

4. Rate the color of your urine as it occurred today.

Light Yellow	Dark Yellow	Orange	Brown
1	2	3	4

5. Did you urinate more or less often today ?

Extremely Less	Moderately Less	Slightly Less	Neither Less nor More	Slightly More	Moderately More	Extremely More
1	2	3	4	5	6	7

6. Was the amount you urinated more or less than usual ?

Extremely Less	Moderately Less	Slightly Less	Neither Less nor More	Slightly More	Moderately More	Extremely More
1	2	3	4	5	6	7

PACKAGING

7. Were any of the pouches or other packaging damaged as a result of freezing?

Please write down the name of the pouch/package. _____

APPENDIX D

EXAMPLES OF THE FORMS USED TO RECORD EMPTY WRAPPERS

SUBJ# 0 1 2 3 4 5 6 7 8 9

DATE

GRP#

AMOUNT CONSUMED

MEAL

B L D S

FEB

MAR

DAY

S

M

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GRP#

1

2

3

4

2 1.25 1.50 1.25 1 .75 .50 .25 0	ENTREES
☐	PORK PATTIES (DEHYD)
☐	BEEF PATTIES (DEHYD)
☐	HAM & CHICKEN LOAF
☐	BEEF SLICES W/BBQ SAUCE
☐	BEEF STEW
☐	FRANKFURTERS
☐	TURKEY, DICED W/GRAVY
☐	BEEF, DICED W/GRAVY
☐	CHICKEN A LA KING
☐	MEATBALLS W/BBQ SAUCE
☐	HAM SLICES
☐	BEEF GROUND W/SPICED SAUCE
STARCHES	
☐	BEANS IN TOMATO SAUCE
☐	CRACKERS
SPREADS	
☐	CHEESE SPREAD
☐	JELLY
☐	PEANUT BUTTER
FRUIT	
☐	APPLE SAUCE
☐	FRUIT MIX
☐	PEACHES
☐	STRAWBERRIES
☐	PINEAPPLE
DESSERT	
☐	CHOCOLATE COVERED BROWNIE
☐	CHERRY NUT CAKE
☐	CHOCOLATE NUT CAKE
☐	MAPLE NUT CAKE
☐	ORANGE NUT CAKE
☐	FRUIT CAKE
☐	CHOCOLATE COVERED COOKIE

WRAPPERS MRE VI

NAME: _____ GROUP No: _____ SUBJECT No: _____ DAY: _____ DATE: _____

<u>CODE</u>	<u>AMOUNT CONSUMED</u>					<u>FOOD ITEM</u>
						<u>ENTREES</u>
51	1/4	1/2	3/4	1	_____	Pork Patties (Dehydrated)
52	1/4	1/2	3/4	1	_____	Beef Patties (Dehydrated)
53	1/4	1/2	3/4	1	_____	Ham & Chicken Loaf
54	1/4	1/2	3/4	1	_____	Beef Slices with BBQ Sauce
55	1/4	1/2	3/4	1	_____	Beef Stew
56	1/4	1/2	3/4	1	_____	Frankfurters
57	1/4	1/2	3/4	1	_____	Turkey, Diced with Gravy
58	1/4	1/2	3/4	1	_____	Beef, Diced with Gravy
59	1/4	1/2	3/4	1	_____	Chicken a la King
60	1/4	1/2	3/4	1	_____	Meatballs with BBQ Sauce
61	1/4	1/2	3/4	1	_____	Ham Slices
62	1/4	1/2	3/4	1	_____	Beef Ground with Spiced Sauce
						<u>STARCHES</u>
63	1/4	1/2	3/4	1	_____	Beans in Tomato Sauce
64	1/4	1/2	3/4	1	_____	Crackers
						<u>SPREADS</u>
65	1/4	1/2	3/4	1	_____	Cheese Spread
66	1/4	1/2	3/4	1	_____	Jelly
67	1/4	1/2	3/4	1	_____	Peanut Butter
						<u>FRUIT</u>
68	1/4	1/2	3/4	1	_____	Apple Sauce
69	1/4	1/2	3/4	1	_____	Fruit Mix
70	1/4	1/2	3/4	1	_____	Peaches
71	1/4	1/2	3/4	1	_____	Strawberries
72	1/4	1/2	3/4	1	_____	Pineapple
						<u>DESSERT</u>
73	1/4	1/2	3/4	1	_____	Chocolate Covered Brownie
74	1/4	1/2	3/4	1	_____	Cherry Nut Cake
75	1/4	1/2	3/4	1	_____	Chocolate Nut Cake
76	1/4	1/2	3/4	1	_____	Maple Nut Cake
77	1/4	1/2	3/4	1	_____	Orange Nut Cake
78	1/4	1/2	3/4	1	_____	Fruit Cake
79	1/4	1/2	3/4	1	_____	Chocolate Covered Cookie
						<u>BEVERAGES</u>
80	1/4	1/2	3/4	1	_____	Cocoa Powder
81	1/4	1/2	3/4	1	_____	Coffee
82	1/4	1/2	3/4	1	_____	Cream Substitute
83	1/4	1/2	3/4	1	_____	Sugar
						<u>OTHERS</u>
84	1/4	1/2	3/4	1	_____	Soup & Gravy Base
85	1/4	1/2	3/4	1	_____	Catsup
86	1/4	1/2	3/4	1	_____	Salt
87	1/4	1/2	3/4	1	_____	Caramel Bar
88	1/4	1/2	3/4	1	_____	Chocolate Fudge Bar
89	1/4	1/2	3/4	1	_____	Chocolate with Almonds
90	1/4	1/2	3/4	1	_____	Vanilla Fudge Bar
91	1/4	1/2	3/4	1	_____	Coconut Bar
92	1/4	1/2	3/4	1	_____	Gum
93	1/4	1/2	3/4	1	_____	_____
94	1/4	1/2	3/4	1	_____	_____
						<u>SUPPLEMENTAL PACK</u>
101	1/4	1/2	3/4	1	_____	Pouched Bread
102	1/4	1/2	3/4	1	_____	Cold Beverage Base Powder
103	1/4	1/2	3/4	1	_____	Hot Pepper Sauce
104	1/4	1/2	3/4	1	_____	Charms
105	1/4	1/2	3/4	1	_____	Beef Jerky
106	1/4	1/2	3/4	1	_____	Raisin Nut Trail Mix

APPENDIX E
SAMPLES OF THE FINAL QUESTIONNAIRES

HEATER QUESTIONNAIRE

SUBJECT I.D. NUMBER _____

The following questions refer to the MRE Heater Pads you were issued during this exercise. Your answers to these questions will help determine if this heating system will be useful to you in the future.

1. How often did you use the MRE Heater Pads to heat the MRE ENTREE (main course)?

NEVER ONCE A FEW TIMES ABOUT EVERY OTHER DAY DAILY TWICE A DAY MORE THAN 2X A DAY

☐ ☐ ☐ ☐ ☐ ☐ ☐

2. After heating with the heater pads, how would you describe the TEMPERATURE of the ENTREE? Fill in the circle below your answer.

EXTREMELY COLD MODERATELY COLD SLIGHTLY COLD NEITHER HOT NOR COLD SLIGHTLY HOT MODERATELY HOT EXTREMELY HOT

☐ ☐ ☐ ☐ ☐ ☐ ☐

3. How often did the ENTREE get HOT ENOUGH using the following number of heater pads?

NEVER ALMOST NEVER INFREQUENTLY SOMETIMES FREQUENTLY ALMOST ALWAYS ALWAYS

1 2 3 4 5 6 7

a. one heater pad ☐ 1 2 3 4 5 6 7

b. Two heater pads ☐ 1 2 3 4 5 6 7

c. _____ heater pads (fill in) ☐ 1 2 3 4 5 6 7

4. How do you feel about the AMOUNT OF TIME that is needed to heat the MRE entree with the heater pads?

NOT TOO LONG SOMEWHAT TOO LONG MODERATELY TOO LONG MUCH TOO LONG

☐ ☐ ☐ ☐

5. Were any of the following a problem for you while using the MRE Heater Pad?

	NOT A PROBLEM	EXTREMELY SMALL PROBLEM	MODERATE PROBLEM	EXTREMELY LARGE PROBLEM				
	0	1	2	3	4	5	6	7
a. burning hands	☐	☐	☐	☐	☐	☐	☐	☐
b. heater pad not heating up (no foam/heat)	☐	☐	☐	☐	☐	☐	☐	☐
c. smell caused by the heater pad	☐	☐	☐	☐	☐	☐	☐	☐
d. white foam caused by heating process	☐	☐	☐	☐	☐	☐	☐	☐
e. water spilling out of the MRE meal bag	☐	☐	☐	☐	☐	☐	☐	☐
f. keeping the MRE meal bag closed	☐	☐	☐	☐	☐	☐	☐	☐
g. heater pad heating up by mistake	☐	☐	☐	☐	☐	☐	☐	☐
h. other _____	☐	☐	☐	☐	☐	☐	☐	☐

75

6. Did you use the heater pack to heat WATER for beverages?
 YES ☐ NO ☐ If NO, skip to question #7.

7. If YES, how:

Did the water get HOT ENOUGH? YES ☐ NO ☐

8. How EASY DID YOU FIND using the HRE heater pack that were intended for you during this exercise?

VERY DIFFICULT DIFFICULT SLIGHTLY DIFFICULT NEITHER DIFFICULT NOR EASY SLIGHTLY EASY DIFFICULTLY EASY VERY EASY

☐ ☐ ☐ ☐ ☐ ☐ ☐

9. In past field exercises, how often did you HEAT each of the following items:

NEVER A FEW TIMES ALMOST EVERY DAY TWICE A DAY MORE THAN TWICE A DAY

1 2 3 4 5 6 7

a. the food in the MRE
 b. water for beverages

1 2 3 4 5 6 7
☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ ☐ ☐ ☐ ☐ ☐ ☐

9. During past field exercises, what type of HEAT SOURCE did you use to heat water and/or the MRE? Please fill in the circle next to all that apply.

☐ a. have never heated water or rations in the field
☐ b. squad stove
☐ c. yukon stove
☐ d. mounted vehicle heater
☐ e. sterno
☐ f. heat tabs
☐ g. sixteen cups and heat tabs
☐ h. heated ration on engine block of vehicle
☐ i. other (specify) _____

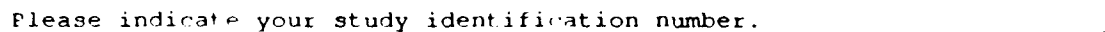
10. Which do you prefer:

☐ a. The Ertan Heater Pack you used during this exercise
☐ b. the heating method you usually use (STATION)
☐ c. other _____

11. Please fill in any comments or suggestions you have about the HRE heater pack here.

y
 rs

Proper Mark



DO NOT WRITE
IN THIS BOX

- | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|----|---|---|---|---|---|---|---|---|---|
| E | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| O | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| WO | ○ | ○ | ○ | ○ | | | | | |

- | | |
|-----------------------|----------|
| ☐ | under 18 |
| ☐ | 18-20 |
| ☐ | 21-25 |
| ☐ | 26-30 |
| ☐ | 31-40 |
| ☐ | 41+ |

- Fill in one answer.

- ☐ 0-2 years
☐ 3-5 years
☐ 6-10 years
☐ 11-15 years
☐ 16-20 years
☐ More than 20 years

- FT IN

DO NOT WRITE IN THIS BOX

5. What is your weight? lbs

DO NOT WRITE IN THIS BOX

6. What is your gender?

- Male
Female

7. Were you trying to LOSE weight during this exercise? ☐ YES ☐ NO

8. Were you trying to GAIN weight during this exercise? ☐ YES ☐ NO

9. How would you describe the climate in the area that you lived in for the longest period of time in your life?

- ☐ 1. hot climate (for example, Texas, Florida, Arizona)
☐ 2. cold climate (for example, Minnesota, Alaska)
☐ 3. mixed climate (hot summers, cold winters; for example, Massachusetts, Ohio, Iowa)
☐ 4. temperate climate (mild weather; for example, North Carolina, Hawaii, Northern California)

10. How would you describe your level of physical activity during this exercise? Fill in the circle next to your answer.

- ☐ 1. Heavy daily physical activity
☐ 2. Moderate daily physical activity
☐ 3. Light daily physical activity
☐ 4. Mixed activity day-to-day

11. WHEN did you eat your MRE during this exercise? Fill in the circle next to your answer.

- ☐ 1. At specific meal times (imposed by command)
☐ 2. At specific meal times (my own choice)
☐ 3. Throughout the day (as time permitted)
☐ 4. Both 1 and 3
☐ 5. Both 2 and 3

12. Overall, how often were you HUNGRY during this exercise? Fill in the circle below your answer.

- | | | | | | | |
|-------------------------|---------------------------|-------------------------|-------------------------|-------------------------|----------------------------|-------------------------|
| NEVER
HUNGRY | ALMOST
NEVER
HUNGRY | INFREQUENTLY
HUNGRY | SOMETIMES
HUNGRY | FREQUENTLY
HUNGRY | ALMOST
ALWAYS
HUNGRY | ALWAYS
HUNGRY |
| ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 | ☐ 7 |

13. For what reason(s) did you NOT eat enough during the exercise? Fill in the circle next to ALL the reasons that apply to you. If you ALWAYS ate enough during this exercise, choose "a" only. If you choose more than one reason, mark an "X" next to the most frequent reason for not eating enough.

- ☐ a. Always ate enough during this exercise.
☐ b. Disliked the food in the MRE.
☐ c. Not enough food in the MRE.
☐ d. Not enough time to eat the MRE.
☐ e. Too much trouble to eat the MRE.
☐ f. Too cold outside to eat.

(continued on next page)

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13. (continued)
- ☐ g. Not enough time to heat the MRE.
 - ☐ h. No heat source to heat the MRE.
 - ☐ i. Poor heat source to heat the MRE.
 - ☐ j. Not enough water to prepare the MRE.
 - ☐ k. Got bored with the food in the MRE - not enough variety.
 - ☐ l. MRE packaging was damaged.
 - ☐ m. MRE was frozen.
 - ☐ n. Tried to avoid having to go to the bathroom.
 - ☐ o. Did not feel hungry.
 - ☐ p. Other (please explain) _____

14. How hungry are you RIGHT NOW? Fill in the circle below your answer.

NOT AT ALL HUNGRY	SLIGHTLY HUNGRY	SOMEWHAT HUNGRY	MODERATELY HUNGRY	VERY HUNGRY	EXTREMELY HUNGRY
1	2	3	4	5	6
☐	☐	☐	☐	☐	☐

15. How did you obtain water during the exercise? Fill in the circle next to all answers which apply.

☐ a. melted snow	☐ e. 5 gallon cans
☐ b. melted ice	☐ f. water buffalo
☐ c. from an unfrozen stream	☐ g. other _____
☐ d. from an unfrozen lake or pond	

16. If you chose more than one answer in the above question (#15), which was the MOST FREQUENT way of obtaining water? Please fill in the circle under the letter from the list above.

a	b	c	d	e	f	g
☐	☐	☐	☐	☐	☐	☐

17. How EASY or DIFFICULT was it to obtain water?

EXTREMELY DIFFICULT	MODERATELY DIFFICULT	SOMEWHAT DIFFICULT	NEITHER EASY NOR DIFFICULT	SOMEWHAT EASY	MODERATELY EASY	EXTREMELY EASY
☐	☐	☐	☐	☐	☐	☐

18. Overall, how often were you THIRSTY during this exercise? Fill in the circle below your answer.

NEVER THIRSTY	ALMOST NEVER THIRSTY	INFREQUENTLY THIRSTY	SOMETIMES THIRSTY	FREQUENTLY THIRSTY	ALMOST ALWAYS THIRSTY	ALWAYS THIRSTY
1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐ 79

19. For what reason(s) did you NOT drink enough during the exercise? Fill in the circle next to ALL the reasons that apply to you. If you ALWAYS drank enough during this exercise, choose "a" only. If you choose more than one reason, mark an "X" next to the most frequent reason for not drinking enough.

- ☐ a. Always drank enough during this exercise.
- ☐ b. Too much trouble to melt snow or ice.
- ☐ c. Hands got too cold while preparing water.
- ☐ d. Not enough time to melt snow or ice.
- ☐ e. Water source was too far from site.
- ☐ f. No equipment (pots, pans) to melt snow.
- ☐ g. Not enough equipment to melt snow.
- ☐ h. No heat source or stove.
- ☐ i. Not enough heat sources or stoves for the group.
- ☐ j. Water in canteen kept freezing.
- ☐ k. Not enough beverages (cocoa, coffee, etc.) in MRE.
- ☐ l. Water buffalo water supply was empty.
- ☐ m. Tried to avoid having to go to the bathroom.
- ☐ n. Did not feel thirsty.
- ☐ o. Did not feel that I needed more water.
- ☐ p. Other (specify) _____

20. How thirsty are you RIGHT NOW? Fill in the circle below your answer.

NOT AT ALL	SLIGHTLY	SOMEWHAT	MODERATELY	VERY	EXTREMELY
THIRSTY	THIRSTY	THIRSTY	THIRSTY	THIRSTY	THIRSTY
☐	☐	☐	☐	☐	☐

21. Please rate how EASY or DIFFICULT you found each of the following aspects of preparing the MRE. Fill in the circle under one number for each aspect.

EXTREMELY	MODERATELY	SOMEWHAT	NEITHER	SOMEWHAT	MODERATELY	EXTREMELY
DIFFICULT	DIFFICULT	DIFFICULT	EASY NOR	EASY	EASY	EASY
			DIFFICULT			
1	2	3	4	5	6	7

- a. Opening the brown outer bag
- b. Opening individual food packets
- c. Keeping food from freezing
- d. Eating more than one item at a time
- e. Keeping water from freezing
- f. Mixing water with the dry items
- g. Heating water/beverages
- h. Heating food
- i. Avoiding spilling rations
- j. Keeping hands warm while preparing and eating MRE

	1	2	3	4	5	6	7
a.	☐	☐	☐	☐	☐	☐	☐
b.	☐	☐	☐	☐	☐	☐	☐
c.	☐	☐	☐	☐	☐	☐	☐
d.	☐	☐	☐	☐	☐	☐	☐
e.	☐	☐	☐	☐	☐	☐	☐
f.	☐	☐	☐	☐	☐	☐	☐
g.	☐	☐	☐	☐	☐	☐	☐
h.	☐	☐	☐	☐	☐	☐	☐
i.	☐	☐	☐	☐	☐	☐	☐
j.	☐	☐	☐	☐	☐	☐	☐

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22. Please use the following scale to rate how much you like or dislike the following aspects of the MRE that you ate during this exercise.

DISLIKE	DISLIKE	DISLIKE	DISLIKE	NEITHER	LIKE	LIKE	LIKE	LIKE	LIKE
EXTREMELY	VERY	MODERATELY	SLIGHTLY	NOR	SLIGHTLY	MODERATELY	VERY	EXTREMELY	
	MUCH			DISLIKE			MUCH		
1	2	3	4	5	6	7	8	9	

	1	2	3	4	5	6	7	8	9
a. How the food tastes	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. How the food looks	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. How much food there is in one MRE (NOT including the Supplement Pack)	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. How much food there is in one MRE (including the Supplement Pack)	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. How much variety there is - meal to meal	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. Eating the MRE for breakfast	☐	☐	☐	☐	☐	☐	☐	☐	☐
g. Eating the MRE for lunch	☐	☐	☐	☐	☐	☐	☐	☐	☐
h. Eating the MRE for dinner	☐	☐	☐	☐	☐	☐	☐	☐	☐

23. What did you usually wear on your hands while preparing and eating the MRE outside?

☐	a. did not eat outside (skip to question #25)
☐	b. wool mitten insert with trigger finger
☐	c. wool glove insert
☐	d. black leather outer glove
☐	e. Arctic Mitten
☐	f. nothing
☐	g. other (specify) _____

24. How cold did your hands get while preparing or eating the MRE outside?

NOT AT ALL	SLIGHTLY	SOMEWHAT	MODERATELY	VERY	EXTREMELY
COLD	COLD	COLD	COLD	COLD	COLD
1	2	3	4	5	6
☐	☐	☐	☐	☐	☐

25. How often did the following problems occur during the field exercise? Fill in the circle under one number for each item.

NEVER	ONCE	A FEW	ABOUT EVERY	DAILY	MORE THAN
1	2	TIMES	OTHER DAY	5	ONCE A DAY
		3	4		6

	1	2	3	4	5	6
a. the food in the MRE froze	☐	☐	☐	☐	☐	☐
b. the water in the canteen froze	☐	☐	☐	☐	☐	☐
c. the MRE brown outer bag was torn or damaged	☐	☐	☐	☐	☐	☐
d. the individual food packets were torn or damaged	☐	☐	☐	☐	☐	☐

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26. How often did you HEAT each of the following items during the field exercise?

NEVER	ONCE	A FEW TIMES	ABOUT EVERY OTHER DAY	DAILY	MORE THAN ONCE A DAY
1	2	3	4	5	6

- a. the food in the MRE
b. water for beverages
c. water for washing

1	2	3	4	5	6
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐

27. During this exercise, what type of HEAT SOURCE did you use to heat water and/or the MRE? Please fill in the circle next to all that apply.

- ☐ a. did not heat water or rations in the field
☐ b. squad stove
☐ c. yukon stove
☐ d. mounted vehicle heater
☐ e. sterno
☐ f. heat tabs
☐ g. canteen cup stand and heat tabs
☐ h. heater pads
☐ i. other (specify) _____

28. If you heated your MREs and/or water using MORE THAN ONE method, what was the most frequent method that you used? Please fill in the circle under the letter from the list above.

a	b	c	d	e	f	g	h	i
☐	☐	☐	☐	☐	☐	☐	☐	☐

29. How important do you think it is to include a heating system with the MRE?

EXTREMELY UNIMPORTANT	MODERATELY UNIMPORTANT	SLIGHTLY UNIMPORTANT	NEITHER NOT IMPORTANT	SLIGHTLY IMPORTANT	MODERATELY IMPORTANT	EXTREMELY IMPORTANT
--------------------------	---------------------------	-------------------------	--------------------------	-----------------------	-------------------------	------------------------

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

30. We would like your honest evaluation of the MPE items you ate. Using the following scale, please fill in the circle below the number that best describes your opinion of each item. For items that you did not try during this exercise, fill in the circle under "0".

NEVER TRIED	DISLIKE EXTREMELY	DISLIKE VERY MUCH	DISLIKE MODERATELY	DISLIKE SLIGHTLY	NEITHER LIKE NOR DISLIKE	LIKE SLIGHTLY	LIKE MODERATELY	LIKE VERY MUCH	LIKE EXTREMELY
0	1	2	3	4	5	6	7	8	9
1. Beef w/ Barbecue Sauce	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Beef w/ Gravy	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Beef w/ Spiced Sauce	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Beef Steak	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Beef Patties	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Beef Stew	☐	☐	☐	☐	☐	☐	☐	☐	☐
7. Chicken a la King	☐	☐	☐	☐	☐	☐	☐	☐	☐
8. Frankfurters	☐	☐	☐	☐	☐	☐	☐	☐	☐
9. Chicken Loaf	☐	☐	☐	☐	☐	☐	☐	☐	☐
10. Ham/Chicken Loaf	☐	☐	☐	☐	☐	☐	☐	☐	☐
11. Ham Slices	☐	☐	☐	☐	☐	☐	☐	☐	☐
12. Meatballs w/ Barbecue Sauce	☐	☐	☐	☐	☐	☐	☐	☐	☐
13. Pork Sausage Patties	☐	☐	☐	☐	☐	☐	☐	☐	☐
14. Turkey w/ gravy	☐	☐	☐	☐	☐	☐	☐	☐	☐
15. Crackers	☐	☐	☐	☐	☐	☐	☐	☐	☐
16. Beans w/ Tomato Sauce	☐	☐	☐	☐	☐	☐	☐	☐	☐
17. Potato Patty	☐	☐	☐	☐	☐	☐	☐	☐	☐
18. Cheese	☐	☐	☐	☐	☐	☐	☐	☐	☐
19. Peanut Butter	☐	☐	☐	☐	☐	☐	☐	☐	☐
20. Jelly	☐	☐	☐	☐	☐	☐	☐	☐	☐
21. Applesauce	☐	☐	☐	☐	☐	☐	☐	☐	☐
22. Fruit Mix	☐	☐	☐	☐	☐	☐	☐	☐	☐
23. Peaches	☐	☐	☐	☐	☐	☐	☐	☐	☐
24. Strawberries	☐	☐	☐	☐	☐	☐	☐	☐	☐
25. Pears	☐	☐	☐	☐	☐	☐	☐	☐	☐
26. Pineapple	☐	☐	☐	☐	☐	☐	☐	☐	☐
27. Brownie	☐	☐	☐	☐	☐	☐	☐	☐	☐
28. Cherry Nut Cake	☐	☐	☐	☐	☐	☐	☐	☐	☐
29. Chocolate Covered Cookie	☐	☐	☐	☐	☐	☐	☐	☐	☐
30. Fruitcake	☐	☐	☐	☐	☐	☐	☐	☐	☐

(Continued on next page)

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(Continued)

NEVER TRIED	DISLIKE EXTREMELY	DISLIKE VERY MUCH	DISLIKE MODERATELY	DISLIKE SLIGHTLY	NEITHER LIKE NOR DISLIKE	LIKE SLIGHTLY	LIKE MODERATELY	LIKE VERY MUCH	LIKE EXTREMELY
0	1	2	3	4	5	6	7	8	9

	0	1	2	3	4	5	6	7	8	9
31. Maple Nut Cake	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
32. Orange Nut Cake	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
33. Chocolate Nut Cake	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
34. Pineapple Nut Cake	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
35. Cocoa	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
36. Coffee	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
37. Cream Substitute	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
38. Catsup	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
39. Soup/Gravy Base	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
40. Chocolate Fudge Bar	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
41. Chocolate Covered Coconut Bar	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
42. Caramel	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
43. Vanilla Fudge	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
44. Starch Jelly Bar	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
45. Chocolate Toffee Bar	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
46. Chocolate Almond Bar	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
47. Additional Items _____	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
48. _____	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
49. _____	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

31. Please use the scale below to rate the PORTION SIZE of the following items.
PORTION SIZE IS:

MUCH TOO SMALL	MODERATELY TOO SMALL	SLIGHTLY TOO SMALL	JUST RIGHT	SLIGHTLY TOO LARGE	MODERATELY TOO LARGE	MUCH TOO LARGE
1	2	3	4	5	6	7

	1	2	3	4	5	6	7
a. entrees (main course)	☐	☐	☐	☐	☐	☐	☐
b. starches (potatoes, crackers)	☐	☐	☐	☐	☐	☐	☐
c. fruits	☐	☐	☐	☐	☐	☐	☐
d. desserts (cakes, brownie)	☐	☐	☐	☐	☐	☐	☐
e. candy	☐	☐	☐	☐	☐	☐	☐
f. cold beverage powders	☐	☐	☐	☐	☐	☐	☐
g. hot beverage powders	☐	☐	☐	☐	☐	☐	☐
h. non-sweet snacks	☐	☐	☐	☐	☐	☐	☐
i. seasonings (salt, hot sauce)	☐	☐	☐	☐	☐	☐	☐

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32. Did you consume any foods or beverages during this exercise that were NOT MRE items? Please be honest.

YES ☐

NO ☐

If yes, what did you eat and/or drink and how often?

33. Are there any items that you would like to see ADDED to the MRE that you ate during this exercise?

34. Are there any items that you would like to see DROPPED from the MRE?

35. What did you like most about the MRE?

36. What did you like least about the MRE?

37. Please use this space for any other comments you have about the MRE.

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THE FOLLOWING QUESTIONS REFER TO THE SUPPLEMENT PACK THAT WAS INCLUDED WITH YOUR MRE. YOUR ANSWERS TO THESE QUESTIONS WILL HELP DETERMINE IF THE SUPPLEMENT PACK WILL BE STANDARD ISSUE IN THE FUTURE.

38. WHEN did you eat the following items from the MRE Supplement Pack?

	NEVER	WITH BREAKFAST	WITH LUNCH	WITH DINNER	WITH OR AS A SNACK
a. pouched bread	☐	☐	☐	☐	☐
b. cold beverage base powder	☐	☐	☐	☐	☐
c. hot pepper sauce	☐	☐	☐	☐	☐
d. charms	☐	☐	☐	☐	☐
e. beef jerky	☐	☐	☐	☐	☐
f. raisin nut trail mix	☐	☐	☐	☐	☐

39. How OFTEN did the following problems occur with the Supplement Pack?

NEVER 1	ONCE 2	A FEW TIMES 3	ABOUT EVERY OTHER DAY 4	DAILY 5	MORE THAN ONCE A DAY 6
a. the food was frozen				☐	☐
b. the outer bag was torn or damaged				☐	☐
c. the individual food packets were torn or damaged				☐	☐

40. Using the following scale, please fill in the circle below the number that best describes your opinion of each MRE supplement item.

NEVER TRIED 0	DISLIKE EXTREMELY 1	DISLIKE VERY MUCH 2	DISLIKE MODERATELY 3	DISLIKE SLIGHTLY 4	NEITHER LIKE NOR DISLIKE 5	LIKE SLIGHTLY 6	LIKE MODERATELY 7	LIKE VERY MUCH 8	LIKE EXTREMELY 9
a. pouched bread	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. cold beverage base powder	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. hot pepper sauce	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. charms	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. beef jerky	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. raisin nut trail mix	☐	☐	☐	☐	☐	☐	☐	☐	☐

41. Please use the following scale to rate the PORTION SIZE of the Supplement items.
PORTION SIZE IS:

MUCH TOO SMALL	MODERATELY TOO SMALL	SLIGHTLY TOO SMALL	JUST RIGHT	SLIGHTLY TOO LARGE	MODERATELY TOO LARGE	MUCH TOO LARGE
1	2	3	4	5	6	7

	1	2	3	4	5	6	7
a. pouched bread	☐	☐	☐	☐	☐	☐	☐
b. cold beverage base powder	☐	☐	☐	☐	☐	☐	☐
c. hot pepper sauce	☐	☐	☐	☐	☐	☐	☐
d. charms	☐	☐	☐	☐	☐	☐	☐
e. beef jerky	☐	☐	☐	☐	☐	☐	☐
f. raisin nut trail mix	☐	☐	☐	☐	☐	☐	☐

42. How important do you think it is to include the Supplement Pack with the MRE?

EXTREMELY UNIMPORTANT	MODERATELY UNIMPORTANT	SLIGHTLY UNIMPORTANT	NEITHER UNIMPORTANT NOR IMPORTANT	SLIGHTLY IMPORTANT	MODERATELY IMPORTANT	EXTREMELY IMPORTANT
1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

43. Which items (if any) do you think should be dropped from the Supplement Pack, and which items do you think should be included with some or all of the MREs?

	DROP	ADD TO SOME MRE MEALS	ADD TO MOST MRE MEALS	ADD TO ALL MRE MEALS
a. pouched bread	☐	☐	☐	☐
b. cold beverage base powder	☐	☐	☐	☐
c. hot pepper sauce	☐	☐	☐	☐
d. charms	☐	☐	☐	☐
e. beef jerky	☐	☐	☐	☐
f. raisin nut trail mix	☐	☐	☐	☐

44. Are there any items that you would like to see ADDED to the Supplement Pack?
Please be realistic.



45. What did you like most about the MRE Supplement Pack?

46. What did you like least about the MRE Supplement Pack?

47. Are there any other comments or suggestions you would like to make about the Supplement Pack?

48. Please use this space for any other general comments you may have.

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APPENDIX F

EXAMPLES OF ENERGY AND NUTRIENT INTAKES
WHEN CONSUMING THE MEAL, READY-TO-EAT

TABLE F 1. Mean Daily Intake Obtained From Prolonged Feeding of the Meal, Ready-to-Eat.

Nutrient	Unit	Amount Consumed
Energy	kcal	2189
Protein	gm	81
Fat	gm	97
Carbohydrate	gm	247
Vitamin A	mcg IU	6837
Ascorbic Acid	mg	106
Thiamin	mg	4.4
Riboflavin	mg	1.8
Niacin	mg NE	18.4
Vitamin B6	mg	3.3
Calcium	mg	579
Phosphorus	mg	1298
Magnesium	mg	220
Iron	mg	12
Sodium	mg	4744
Potassium	mg	2046

Reference: 10.

TABLE F 2. Mean Daily Intake Obtained when Comparing the Meal, Ready-to-Eat and the Ration, Lightweight Consumed for 30 Days.

Nutrient	Unit	Amount Consumed
Energy	kcal	2782
Protein	gm	112
Fat	gm	119
Carbohydrate	gm	318
Vitamin A	mcg RE	1021
Ascorbic Acid	mg	194
Thiamin	mg	5.13
Riboflavin	mg	2.09
Niacin	mg NE	27.02
Vitamin B6	mg	4.03
Calcium	mg	694
Phosphorus	mg	1450
Magnesium	mg	289
Iron	mg	17.33
Sodium	mg	5051

Reference: 12.

TABLE F 3. Mean Daily Intake Obtained When Comparing the Various Meals, Ready-to-Eat

Nutrient	Unit	MRE VIII		MRE VII		MRE I-V	
		Available	Consumed	Available	Consumed	Available	Consumed
Energy	kcal	3939	2842	4017	2517	3669	2517
Protein	gm	135	106	152	107	130	97
Fat	gm	146	104	162	106	167	118
Carbohydrate	gm	522	374	487	288	412	268
Vitamin A	mcg RE	2608	1439	2068	1021	2137	1538
Ascorbic Acid	mg	267	146	297	133	228	140
Thiamin	mg	8.7	5.2	7.4	3.9	7.7	5.0
Riboflavin	mg	3.9	2.7	3.1	2.1	3.0	2.1
Niacin	mg NE	52	36.7	38	26.4	33	23.7
Vitamin B6	mg	6.3	3.4	5.7	3.3	5.8	4.3
Calcium	mg	1062	739	1053	648	1053	713
Phosphorus	mg	2244	1564	2190	1334	2130	1491
Magnesium	mg	387	249	405	241	393	266
Iron	mg	26	17.1	25	16.3	23	15.7
Sodium	mg	5853	4966	6882	4645	6516	4904
Potassium	mg	4092	2783	4047	2294	3846	2551

Reference: 6.

TABLE F 4. Mean Daily Intake Obtained When Comparing the Meal, Ready-to-Eat and the Ration, Cold Weather Consumed for Ten Days.

Nutrient	Unit	Amount Available	Amount Consumed
Energy	kcal	4892	2733
Protein	gm	173	99
Fat	gm	223	123
Carbohydrate	gm	548	302
Sodium	mg	7188	4859

Reference: 2.

TABLE F 5. Mean Daily Intake Obtained When Comparing the Meal, Ready-to-Eat, the Cold Weather and the Ration Lightweight Consumed at Moderate Altitude, Cold Weather.

Nutrient	Unit	Amount Consumed
Energy	kcal	3217
Protein	gm	133.0
Fat	gm	135.7
Carbohydrate	gm	368.8
Vitamin A	mcg RE	2201.0
Ascorbic Acid	mg	224.3
Thiamin	mg	7.7
Riboflavin	mg	2.96
Niacin	mg NE	34.6
Vitamin B6	mg	5.42
Calcium	mg	1170.3
Phosphorus	mg	2014.1
Magnesium	mg	316.9
Iron	mg	17.32
Sodium	mg	5804.5
Potassium	mg	3148.5

Reference: 13

APPENDIX G

A COMPARISON BETWEEN THE AMOUNTS OF FOOD CONSUMED
AND FOOD ACCEPTABILITY

TABLE G. 1. A Comparison Between the Amount Consumed, Food Acceptability and an Alternative Method of Rating Popularity.

Food Item	Total Cases n	Correlation Coefficient	Number of Subjects ranking 4 or less	Number of Subjects consuming 0	Number of Subjects ranking 6 or more	Number of Subjects consuming 2 or more	Popularity Index	Ranking
<u>ENTREES MRE VI</u>								
Pork Patties (Dehydrated)	165	.4708	19	8	137	10	83.0	5
Beef Patties (Dehydrated)	108	.4450	8	1	96	6	88.9	2
Ham & Chicken Loaf	100	.5658	19	10	71	3	71.0	7
Beef Slices with BBQ Sauce	8	--	--	--	--	--	----	--
Beef Stew	195	.4248	11	5	133	15	86.7	4
Frankfurters	124	*.0110	6	0	109	3	87.9	3
Turkey, Diced with Gravy	13	*.2927	5	1	8	1	61.5	11
Beef, Diced with Gravy	142	.3382	30	11	95	8	66.9	9
Chicken a la King	174	.4142	24	9	140	16	80.5	6
Meatballs with BBQ Sauce	20	.4332	4	2	14	0	70.0	8
Ham Slices	58	.3468	1	1	54	3	93.1	1
Beef Ground with Spiced Sauce	84	.5785	18	8	52	5	61.9	10
Group Total	1191	.3739	145	56	952	70	79.9	--
<u>ENTREES MRE VIII</u>								
Pork with Rice in BBC See	134	.5388	5	1	124	4	92.5	7
Corned Beef Hash	137	.4816	9	3	123	1	89.8	9
Chicken Stew	123	.4566	5	2	112	3	91.1	8
Omelet with Ham	135	.5825	3	2	125	1	92.6	6
Spaghetti, Meat & Sauce	138	.4062	0	0	135	1	97.8	1
Chicken a la King	95	.2604	8	1	82	4	86.3	11
Beef Stew	111	.5151	6	1	98	2	88.3	10
Ham Slice	114	.3722	2	2	109	4	95.6	4
Meatballs, Rice & Sauce	86	.4155	8	3	74	1	86.0	12
Tuna with Noodles	123	.3478	3	2	118	4	95.9	3
Chicken & Rice	118	.4661	5	3	112	3	94.9	5
Escalloped Potatoes with Ham	119	.4970	0	0	116	3	97.5	2
Group Total	1433	.4461	54	18	1328	31	92.7	--

Popularity Index calculated as $\frac{\text{Number of Subjects Ranking 6 or More}}{\text{Number of Cases}}$

* Significant Difference $p < 0.05$

TABLE G 1 (continued). A Comparison Between the Amount Consumed, Food Acceptability and an Alternative Method of Rating Popularity.

Food Item	Total Cases n	Correlation Coefficient	Number of Subjects ranking 4 or less	Number of Subjects consuming 0	Number of Subjects ranking 6 or more	Number of Subjects consuming 2 or more	Popularity Index	Ranking
<u>STARCHES MRE VI</u>								
Beans in Tomato Sauce Crackers	207 301	.4873 .2660	32 16	15 3	153 227	31 104	73.9 75.4	2 1
Group Total	508	.3143	48	18	380	135	74.8	--
<u>STARCHES MRE VIII</u>								
Potato au Gratin Crackers	219 313	*.1083 .2335	7 4	3 1	206 292	20 136	94.1 93.3	1 2
Group Total	532	.1817	11	4	498	156	93.6	--
<u>SPREADS MRE VI</u>								
Cheese Spread Jelly Peanut Butter	343 201 169	.2531 .1938 .3595	29 11 5	9 6 2	292 171 149	116 33 27	85.1 85.1 88.2	2 2 1
Group Total	713	.2518	45	17	612	176	85.8	--
<u>SPREADS MRE VIII</u>								
Cheese Spread Jelly Peanut Butter	330 269 277	.1980 .2875 .3119	4 4 10	0 1 3	315 255 257	67 42 63	95.5 94.8 92.8	1 2 3
Group Total	876	.2601	18	4	827	172	94.4	--

Popularity Index calculated as $\frac{\text{Number of Subjects Ranking 6 or More}}{\text{Number of Cases}}$

* Significant Difference $p < 0.05$

TABLE G 1 (continued). A Comparison Between the Amount Consumed, Food Acceptability and an Alternative Method of Rating Popularity.

Food Item	Total Cases n	Correlation Coefficient	Number of Subjects ranking 4 or less	Number of Subjects consuming 0	Number of Subjects ranking 6 or more	Number of Subjects consuming 2 or more	Popularity Index	Ranking
<u>FRUIT MRE VI</u>								
Apple Sauce	158	*.1242	7	2	150	10	94.9	2
Fruit Mix	162	.6126	16	9	140	24	86.4	3
Peaches	147	.4351	26	13	107	30	72.8	4
Strawberries	2	--	--	--	--	--	--	--
Pineapple	1	--	--	--	--	--	--	--
Pears	32	.4710	0	0	32	7	100	1
Group Total	502	.4462	49	24	432	71	86.1	--
<u>FRUIT MRE VIII</u>								
Apple Sauce	251	.3852	4	3	244	24	97.2	1
Fruit Mix	178	.4382	8	5	164	27	92.1	2
Peaches	83	.6421	4	2	72	1	86.7	5
Strawberries	73	.4451	2	0	67	5	91.8	3
Pears	120	.4445	7	3	106	4	88.3	4
Group Total	705	.4397	25	13	653	67	92.6	--

Popularity Index calculated as $\frac{\text{Number of Subjects Ranking 6 or More}}{\text{Number of Cases}}$

* Significant Difference $p < 0.05$

TABLE G 1 (continued). A Comparison Between the Amount Consumed, Food Acceptability and an Alternative Method of Rating Popularity.

Food Item	Total Cases n	Correlation Coefficient	Number of Subjects ranking 4 or less	Number of Subjects consuming 0	Number of Subjects ranking 6 or more	Number of Subjects consuming 2 or more	Popularity Index	Ranking
<u>DESSERT MRE VI</u>								
Chocolate Covered Brownie	195	.3864	24	5	155	38	79.5	3
Cherry Nut Cake	142	.4816	18	10	115	16	81.0	2
Chocolate Nut Cake	4	---	---	---	---	---	---	---
Maple Nut Cake	11	.6254	3	3	7	2	63.6	4
Orange Nut Cake	32	.6716	9	6	17	1	53.1	6
Fruit Cake	106	.5146	37	17	64	11	60.4	5
Chocolate Covered Cookie	193	.1982	3	1	184	27	95.3	1
Group Total	683	.3977	95	43	545	95	79.6	-
<u>DESSERT MRE VIII</u>								
Chocolate Covered Brownie	230	.4310	30	14	194	26	84.3	5
Cherry Nut Cake	114	.3604	4	1	105	9	92.1	3
Chocolate Covered Cookie Bar	194	.2152	3	0	189	21	97.4	1
Chocolate Nut Cake	120	.3170	1	0	116	7	96.7	2
Maple Nut Cake	119	.5637	13	9	100	4	84.0	6
Oatmeal Cookie Bar	197	.2182	14	7	178	26	90.4	4
Group Total	974	.3610	65	31	882	93	90.6	--

Popularity Index calculated as $\frac{\text{Number of Subjects Ranking 6 or More}}{\text{Number of Cases}}$

TABLE G 1 (continued). A Comparison Between the Amount Consumed, Food Acceptability and an Alternative Method of Rating Popularity.

Food Item	Total Cases n	Correlation Coefficient	Number of Subjects ranking 4 or less	Number of Subjects consuming 0 or more	Number of Subjects ranking 6 or more	Number of Subjects consuming 2 or more	Popularity Index	Ranking
<u>BEVERAGES MRE VI</u>								
Cocoa Powder	275	.3795	2	2	263	130	95.6	1
Coffee	138	.5855	3	2	125	63	90.6	2
Cream Substitute	137	.5903	4	3	123	58	89.8	3
Sugar	152	.4932	0	0	136	65	89.5	4
Group Total	702	.5089	9	7	647	316	92.2	--
<u>BEVERAGES MRE VIII</u>								
Beverage Base Powder	249	.3811	1	1	247	115	99.2	1
Cocoa Powder	280	.3173	2	2	271	125	96.8	2
Coffee	99	.3723	11	10	84	34	84.8	5
Cream Substitute	108	.3977	5	4	92	37	85.2	4
Sugar	114	.4200	5	4	100	40	87.7	3
Group Total	850	.3807	24	21	794	351	93.4	--

Popularity Index calculated as $\frac{\text{Number of Subjects Ranking 6 or More}}{\text{Number of Cases}}$

TABLE G 1 (continued). A Comparison Between the Amount Consumed, Food Acceptability and an Alternative Method of Rating Popularity.

Food Item	Total Cases n	Correlation Coefficient	Number of Subjects ranking 4 or less	Number of Subjects consuming 0 or more	Number of Subjects ranking 6 or more	Number of Subjects consuming 2 or more	Popularity Index	Ranking
<u>OTHERS MRE VI</u>								
Soup & Gravy Base	23	.6023	5	3	17	0	73.9	6
Catsup	48	.6128	7	3	28	3	58.3	8
Salt	47	.3142	3	2	31	6	66.0	7
Caramel Bar	51	.4310	1	0	49	4	96.1	1
Chocolate Fudge Bar	98	.3683	6	3	84	10	85.7	5
Chocolate with Almonds	26	.5210	2	2	23	3	86.5	4
Vanilla Fudge Bar	11	.7949	3	2	6	2	54.5	9
Coconut Bar	4	---	---	---	---	---	---	---
Gum	126	.2630	3	2	121	49	96.0	2
Chocolate with Toffee	28	*.2839	2	1	25	3	89.3	3
Group Total	462	.4243	32	18	388	81	84.0	---
<u>OTHERS MRE VIII</u>								
Tootsie Roll	18	*.2996	1	1	16	2	88.9	5
Charms	267	.2778	2	1	257	60	96.3	2
M & M	157	.1996	1	1	152	12	96.8	1
Caramel	136	.2000	2	1	130	12	95.6	3
Gum	143	.1548	0	0	135	44	94.4	4
Tabasco Sauce	132	.3956	11	9	110	23	83.3	6
Salt	74	.3626	5	5	53	13	71.6	7
Group Total	927	.2178	22	18	853	166	92.0	---

Popularity Index calculated as $\frac{\text{Number of Subjects Ranking 6 or More}}{\text{Number of Cases}}$

* Significant Difference $p < 0.05$

TABLE G 1 (continued). A Comparison Between the Amount Consumed, Food Acceptability and an Alternative Method of Rating Popularity.

Food Item	Total Cases n	Correlation Coefficient	Number of Subjects ranking 4 or less	Number of Subjects consuming 0	Number of Subjects ranking 6 or more	Number of Subjects consuming 2 or more	Popularity Index	Ranking
SUPPLEMENTAL PACK CONSUMED WITH MRE VI								
Pouched Bread	254	.3282	1	0	250	9	98.4	3
Cold Beverage Base Powder	162	.6128	1	0	157	27	96.9	5
Hot Pepper Sauce	93	.8677	8	8	83	5	89.2	6
Charms	181	.6278	0	0	180	5	99.4	1
Beef Jerky	99	.6173	1	0	97	3	98.0	4
Raisin Nut Trail Mix	148	.4893	0	0	147	5	99.3	2
Group Total	937	.6428	11	8	914	54	97.5	--
SUPPLEMENTAL PACK CONSUMED WITH MRE VIII								
Pouched Bread	287	.4836	0	0	286	16	99.7	2
Cold Beverage Base Powder	221	.5438	2	0	219	21	99.1	3
Hot Pepper Sauce	122	.6442	12	9	106	4	86.9	6
Charms	214	.5782	1	1	210	11	91.1	5
Beef Jerky	119	.5254	0	0	119	7	100.0	1
Raisin Nut Trail Mix	165	.4524	3	0	156	6	95.5	4
Group Total	1128	.5562	18	10	1096	65	97.2	--

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