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THE COLD WEATHER 83 ALUATION OF THE MOBILE D SERVICE UNIT AND TRAY PACKS

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URATE FOR SYSTEMS ANALYSIS AND CONCEPT DEVELOPMENT

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This report details the field evaluation of the Mobile Food Service Unit and T Rations, two key elements of the proposed new USMC field feeding system for the 1990's, during the NATO exercise Cold Weather-83. Major conclusions drawn from this evaluation include: the Mobile Food Service Unit (MFSU) is a highly effective, labor efficient concept for extreme cold weather environments; proposed new system staffing levels which provide an overall

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66% reduction in manpower requirements are adequate; and hot T Ration meals, to include regular and single hot-item meals (large portion of casserole or stew-type item) are highly acceptable in cold environments.

SUMMARY

In FY82, the Directorate for Systems Analysis and Concept Development of U.S. Army Natick Research and Development Center was tasked with designing a field food service system with the responsiveness, mobility, and flexibility required to support the assigned US Marine Corps (USMC) combat role of the future (1990's). Given the above performance characteristics, system design objectives were to maximize the frequency and acceptability of hot meals given troops in the tactical situation, and to minimize (1) system support requirements and (2) development of USMC - unique field feeding equipment.

The proposed system consists entirely of components of the new Army Combat Field Feeding System (ACFFS), which have been reconfigured to support USMC requirements. Major new system components include: the Mobile Food Service Unit (MFSU), a heat-on-the-move trailer-mounted Tray Pack heating system for highly mobile combat units; Modular Field Kitchens (MFK), modular tent based kitchens for nonground combat elements which can be configured to support from 100 to 2,200 troops; and the T Ration, which incorporates Tray Packs, precooked thermostabilized heat and serve food items, for the entree, starch, vegetable, and dessert meal components. In addition, proposed new system benefits include a projected 66% reduction in personnel requirements, 73% reduction in water requirements, and a 92% reduction in fuel requirements.

This report documents the field evaluation of the MFSU and T Rations with the USMC during the NATO exercise Cold Weather-83 in northern Norway. During the exercise the single MFSU was utilized to provide hot Tray Pack meals to the infantry and artillery battalions and various headquarter elements. As shown by the following data, the evaluation demonstrated that the MFSU with T Rations provide the responsiveness, mobility and flexibility characteristics required to support the USMC's combat role of the 1990's, even in extreme cold environments.

- 65% of the MFSU's total use time was spent traveling to, between, or from remote sites, while only 35% of total time was spent at the remote sites (set-up, serving, pack-up, and waiting).

- Average MFSU set-up time was eight minutes.

- Average MFSU pack-up time was six minutes.

In addition, test data demonstrated that T Rations are highly acceptable in cold weather environments (entrees average 7.9 on 9.0 hedonic rating scale) and that the new system provides manpower reductions in excess of the 66% projected.

Additional field testing of the MFSU and MFK demonstrators with T Rations is scheduled for FY84. Testing will be conducted in environments ranging from extreme cold (Arctic) to extreme hot (desert).

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PREFACE

This field evaluation was conducted by the US Army Natick Research and Development Center (NRDC) as part of the Department of Defense (DoD) Food Program under Military Service Requirement, M83-5, "Cold Weather Arctic Feeding".

The successful completion of this field evaluation can be attributed in part to the diligent efforts of MAJ Thomas W. Parker, NRDC US Marine Corps Joint Technical Staff representative, CWO2 Leon Hill, 26th MAU Food Service Advisor, and MGySgt Jacob D. Sattler, Marine Corps Development and Education Command.

Special recognition is accorded to Mr. Bruce Thomas of the Food Engineering Laboratory at NRDC. Mr. Thomas identified and coordinated the required equipment modifications to the Mobile Food Service Unit (MFSU) for cold weather operations. In addition, Mr. Thomas instructed assigned Marine Corps food service personnel in proper MFSU starting, operating, and maintenance procedures. Also at NRDC, Dr. Herbert Meiselman, Science and Advance Technology Laboratory, and Michael Ostrowsky, Directorate for Systems Analysis and Concept Development are acknowledged for their data collection efforts relative to the test objectives.

Because the food information in this report relates to US troop service only, US customary units are used throughout the report.

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I. INTRODUCTION

The key elements of the new combat field feeding system being developed for the US Marine Corps are the Mobile Food Service Unit (MFSU), Modular Field Kitchens (MFKs), and Tray Packs. Benefits of the Marine Corps new field feeding system include a projected 66% reduction in personnel requirements (food service personnel and KP's) relative to the current system.

A field evaluation of a modified MFSU and Tray Packs was conducted with the US Marine Corps during NATO exercise Cold Weather 83 (CW-83) in northern Norway. Specific objectives of this test were to:

- Evaluate the effectiveness of the MFSU concept in extreme cold environments;
- Determine the MFSU requirement per battalion;
- Validate the adequacy of the proposed new system staffing levels;
- Evaluate troop acceptance of regular and single hot-item Tray Pack meals; and
- Determine Tray Pack item food temperatures as served at remote sites.

The entire evaluation was conducted during the Cold Weather-83 exercise in northern Norway. All data were collected from March 11 to 15 1983. During this period ambient temperatures ranged between about -20°F and +35°F.

A variety of commercially available Tray Pack items were used in the Cold Weather-83 test. Tray Packs are thermostabilized bulk food items in half steamtable size trays (Figure 1). The items are fully cooked and require only heating prior to serving. The items provided during CW-83 are listed in Table 1 and include 16 entree, 5 vegetables, 5 starch, and 4 dessert items. In total, a sufficient number of Tray Pack items were provided for 6,000 T Ration meals.

No specific T ration menus were planned prior to the start of the exercise. During CW-83, T Ration menus were jointly planned one day in advance by the MAU Food Service Advisor and NRDC personnel based on the next day's anticipated feeding schedule. Factors taken into consideration included: data collection requirements, expected headcounts at remote sites, Tray Pack item availability, and prior Tray Pack meals, if any, provided to the units to be supported.

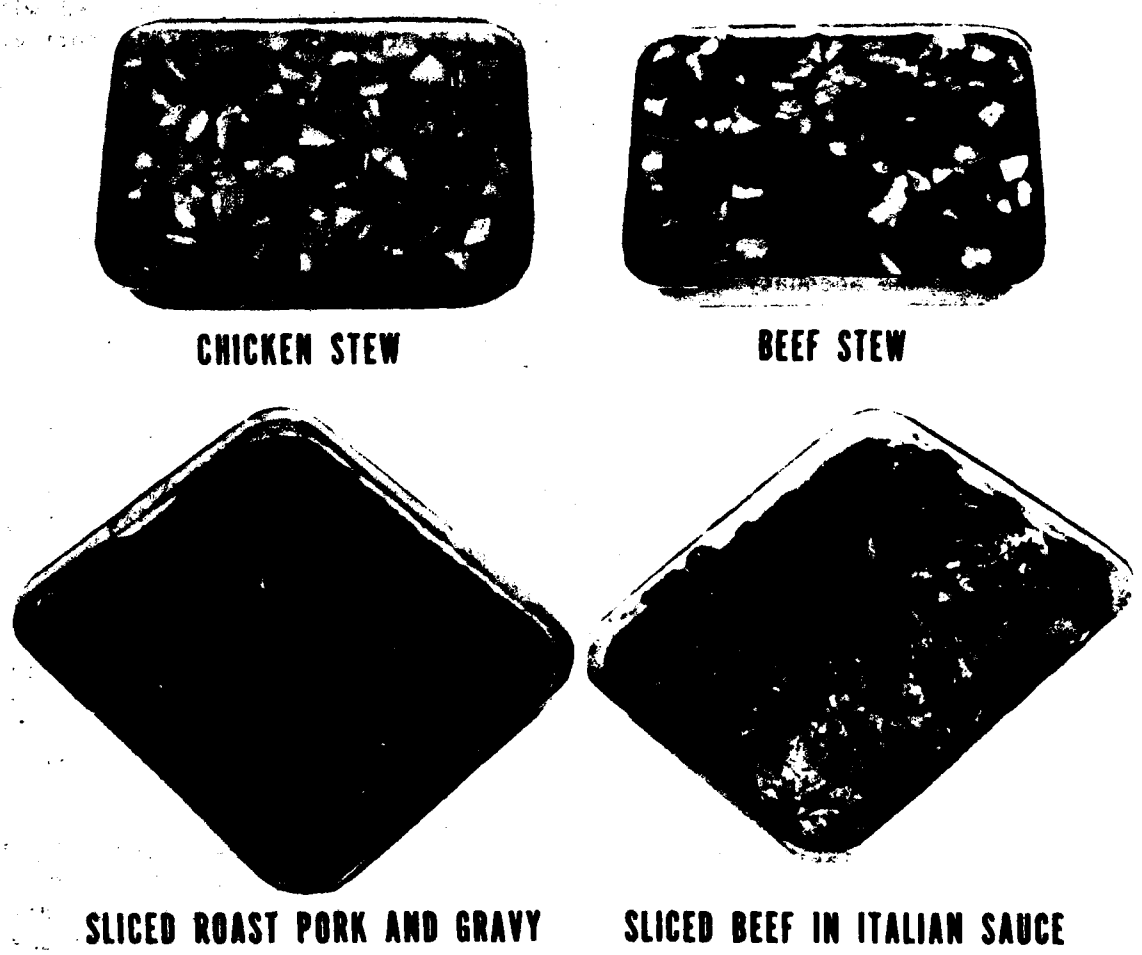

Figure 1. T Ration Tray Pack items

TABLE 1. Commercial Tray Pack Items
Provided for Cold Weather 83

Entrees	Vegetables
Beef Slices in BBQ Slices	Corn
Beef Slices, Roast	Green Beans
Beef Stew	Lima Beans
Beef Tips	Peas
Breakfast Bake	Stewed Tomatoes
Chicken Breasts	
Chicken Cacciatore	Starches
Chicken Noodles	
Chicken Stew	Baked Beans
Chili con Carne	German Potato Salad
Cream Beef	Escalloped Potatoes
Ham & Eggs	Macaroni & Cheese
Lasagna	Potatoes, Cut
Sloppy Joe	
Stuffed Cabbage	Desserts
Stuffed Peppers	
	Apple Compote
	Blueberry Compote
	Cherry Compote
	Peach Compote

II. EQUIPMENT, PROCEDURES, AND CONCEPT OF OPERATION

MODIFIED MOBILE FOOD SERVICE UNIT

The Mobile Food Service Unit (MFSU) represents a major component of the proposed new USMC field feeding system for the 1990's. This system, and especially the MFSU, was not explicitly designed for extreme low temperature operation. The major problem with the MFSU in low temperature environments is the potential for freezing and subsequent equipment damage to the circulating hot water Tray Pack heating system as well as to the hot and cold water distribution system.

Two modifications of equipment and procedures were made to facilitate the operation and testing of the MFSU and Tray Pack concept in an Arctic environment. First, the hot and cold water distribution system was removed from the MFSU. As a result, hot and cold beverages for remote site feeding were premade at the basecamp and transported to the remote site in insulated jugs. In addition, slight adjustments were made to the hot water heater (gap change) and three-kW generator (glow plug) to facilitate cold weather starting. To prevent freezing of the MFSU circulating hot water Tray Pack heating system, especially when shut-off and not in use, a food grade antifreeze (propylene glycol, USP) was added. During the Cold Weather-83 test, the MFSU was filled and operated with an approximate 50% propylene glycol and 50% water solution. This mixture provided protection from freezing down to -28°F. Ambient temperatures during the exercise test period dropped as low as -20°F. The equipment layout of the modified MFSU is presented in Figure 2.

EQUIPMENT PRETEST

The modified MFSU was pretested in the Natick R. and D. Center's arctic chamber at -20°F to identify potential generator and hot water heater startup and operational problems in cold weather environments before the unit was shipped to Norway. Based on the results of the pretests, the electrode gap of the hot water heater was shortened, and a glow plug setup was added to the diesel-fired three-kW generator.

In Norway, the modified MFSU was also tested from March 7 to 10, 1983, during the pre-exercise training period. During this period, the modified MFSU was started and operated daily. No problems were detected, thus further modifications were not needed. Food service personnel were instructed in MFSU operating procedures and concept of operation. For food service personnel training purposes, the MFSU was used during this period to provide a total of three hot meals to units at remote training locations.

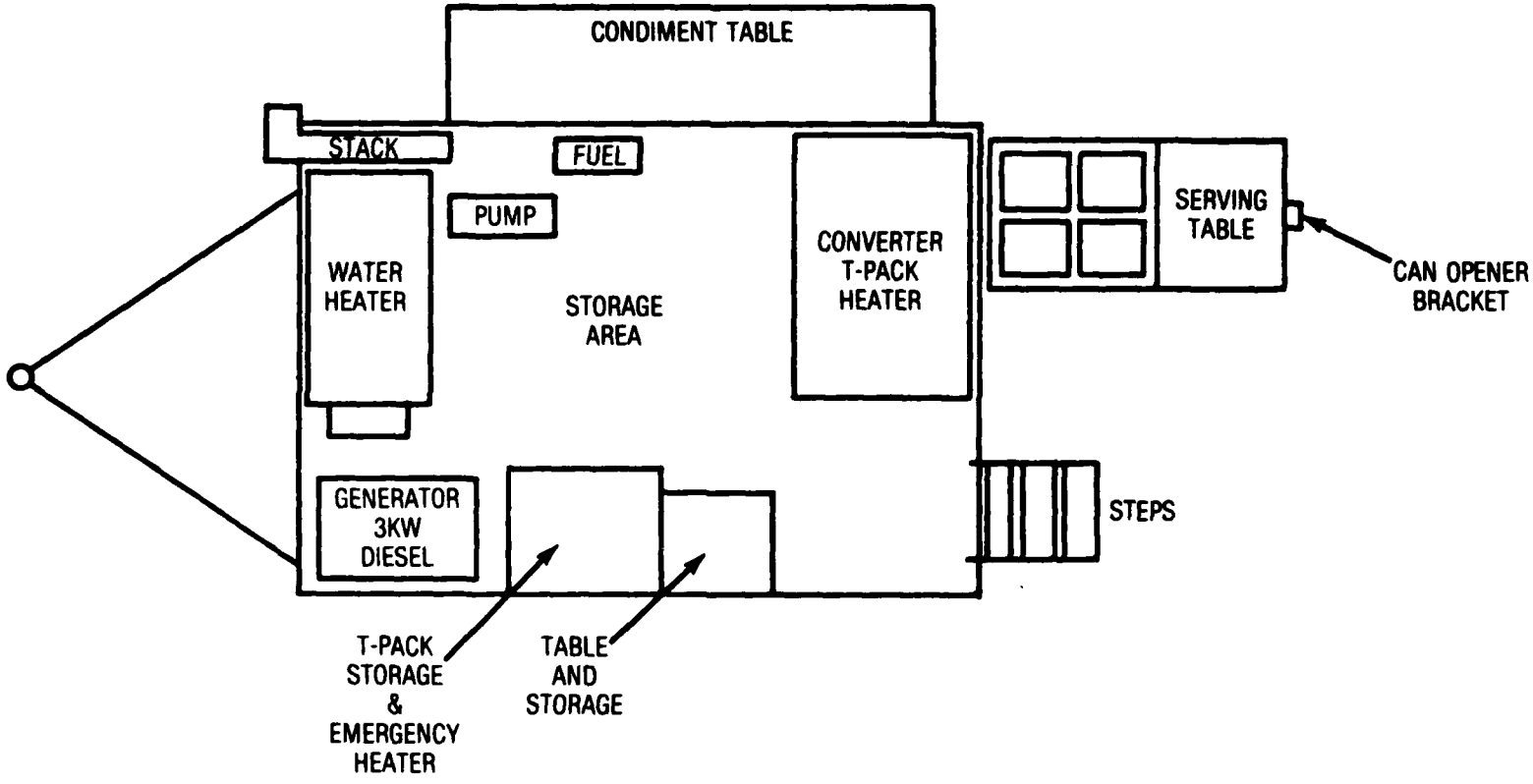

Figure 2. Mobile Food Service Unit equipment layout

PROCEDURES AND CONCEPT OF OPERATION

The proposed concept of operation for the Marine Corps new field feeding system would have MFSUs assigned to the headquarters company or battery of combat battalions. From this location, MFSUs would deploy on an as-required basis to support subordinate line companies of the same battalion. During Cold Weather-83, the single modified MFSU was used to support elements of the infantry and artillery battalions and various headquarter units. For this reason, the modified MFSU was assigned to and operated from the Beach Support Area (BSA).

For planning purposes a tentative, flexible feeding schedule was set one day in advance. However, due to the "real-time" nature of the field training exercise, which included nonanticipated unit movements, the actual feeding schedule varied considerably from that planned. All planned feeding from 1530 March 13 thru March 14, for example, was cancelled at the last minute because the BSA had to be relocated. Troops subsisted entirely on Meal Ready-to-Eat (MRE's) during this interval. The actual units supported, including the number of troops, are listed in Table 2.

When possible, hot Tray Pack meals for troops at remote locations were provided directly from the modified MFSU. However, based on the feeding schedule, on three occasions troops were required to be supported at two distant locations at about the same time. In these instances, Tray Packs for one location were preheated by the MFSU at the BSA. The preheated Tray Packs were loaded into insulated containers and transported to support troops at one location while the MFSU was then reloaded and towed to support troops at the other location.

Based on the feeding schedule, unit locations, and distances, the MFSU serviced troops at one to five locations before returning to the BSA. Depending on the estimated travel time to the first feeding site, Tray Packs were either partially preheated by the MFSU prior to departure from the BSA or heated entirely while in transport. When supporting troops at multiple sites, additional supplies such as Tray Packs, beverages, disposables, bread, crackers, and condiments were loaded onto the five-ton towing vehicle. Before leaving one feeding site for another, the MFSU was loaded with sufficient Tray Packs to support the next location.

The entire hot Tray Pack food service operation was maintained by a maximum of six on-duty food service personnel (excluding the Marine Amphibious Unit Food Service Officer) with additional personnel available if needed. Due to the long duration of the work days on March 15 and 16, two separate shifts, each of six food service personnel, were employed. For remote site feeding, the MFSU deployed with either three or four food service personnel. When a fourth individual traveled with the MFSU, he acted merely as an observer and was not actively involved with the food service operation. On the three occasions when troops were supported simultaneously at two separate locations, all six on-duty food service personnel (three per site) were remote; none remained at the base camp.

TABLE 2. Units Supported With T Ration Meals

Date	Site No.	Unit Designation	No. Fed.
11 March	1	Bravo Co, Battalion Landing Team (BLT)	140
12 March	2	Bravo Cmd, BLT	93
	3	Bravo Co, BLT	175
	4	Mike Btry, 3/10 Bn	91
	5	Alpha Co, BLT	120
13 March	6	Alpha Cmd, BLT	160
	7	Bravo Co, BLT	0*
15 March	8	Bravo Cmd, BLT	93
	9	Beach Service Support Group (BSSG)-Site A	57
	10	BSSG-Site B	47
	11	Mike Btry, 3/10 Bn, Site A	55
	12	Mike Btry, 3/10 Bn, Site B	22 (15)**
	13	Hq Btry, 3/10 Bn, Site A	36 (8)
	14	Oscar Btry, 3/10 Bn	64 (15)
	15	Hq Btry, 3/10 Bn, Site B	40
16 March	16	Alpha Cmd, Regimental Landing Team (RLT) Hq	53
	17	Mike Btry, 3/10 Bn	91
	18	Bravo Co, BLT	135
	19	Hq Btry, 3/10 Bn	48
	20	Oscar Btry, 3/10 Bn	64 (15)
	21	Alpha Co, BLT	180
	22	Weapons Co, BLT	43

*Unit could not be located, thus the MFSU returned without feeding these troops.

**Number of unit personnel who could not leave positions and go to the MFSU. For these personnel appropriate numbers of heated, sealed Tray Packs were transported to the troops for serving purposes.

III. TEST RESULTS AND DISCUSSION

BACKGROUND

The data collection period extended from March 11 to 15, 1983. The types of data collected were work sampling, MFSU remote site clock times, number of troops supported per site, troop acceptance and food item serving temperatures.

REMOTE CLOCK TIMES

To evaluate the number of MFSUs required per battalion, elapsed clock time data were collected relative to the remote feeding operation. During the exercise, troops were furnished hot Tray Pack meals at a total of 21 different remote locations. Eighteen sites were serviced by the MFSU; troops at the other three sites were supported with preheated Tray Packs from insulated containers. All clock times were recorded on the data collection form to the nearest minute. Based on this data, the total elapsed remote site clock time was separated into 10 distinct time elements as defined in Table 3. The resulting remote site clock times are summarized in Table 4 by time element for those sites supported by the MFSU only and for all supported remote sites.

Travel To Site. Travel times from the BSA to the first feeding site ranged from 17 to 87 minutes and depended on unit locations, travel distance, road types, and weather conditions. The longer travel times occurred during the final two days of the exercise due to the forward advancement (and associated longer distances) of units supported away from the BSA.

Travel Between Sites. Travel times between feeding sites ranged from 2 to 46 minutes. Shorter times tended to occur when traveling between two separate parts of the same company unit set up in different locations. The longer travel times were associated with travel between units of different battalions; for example, it took 31 minutes for the MFSU to travel from Mike Battery, 3/10 Battalion to Bravo Company, Battalion Landing Team (BLT); and 46 minutes to travel from Bravo Company, BLT to Headquarters Battery, 3/10 Battalion.

Delay (before setup): The time between arrival at the general remote site feeding location and the start of setup usually was short (0 to 5 minutes). During this period the unit commander/first sergeant was contacted, a setup site selected, and the MFSU maneuvered to the selected site. On one occasion 26 minutes passed before the MFSU could be relocated to the selected setup location due to road blockage by other tactical vehicles.

Setup. This element corresponds to the total time from setup start to completion (ready-to-serve). MFSU setup times ranged from 4 to 12 minutes and averaged about 7 minutes.

Delay (before serving). Usually food service personnel began serving hot T Ration meals immediately following setup at the remote site. On occasion, the food service personnel had to wait up to eight minutes before the troops were ready. On average, the delay was less than two minutes.

TABLE 3. Time Element Definitions

Time Element	Definition		
	Time 1		Time 2
Travel To Site	Arrive Site 1	-	Depart BSA
Travel Between Sites	Arrive Site	-	Depart Site (Prior)
Delay (before setup)	Start Setup	-	Arrive Site
Setup	Finish Setup	-	Start Setup
Delay (before serving)	Start Serving	-	Finish Setup
Serve	Finish Serving	-	Start Serving
Delay (before packup)	Start Packup	-	Finish Serving
Packup	Finish Packup	-	Start Packup
Delay (before departure)	Depart Site	-	Finish Packup
Travel Return to BSA	Arrive BSA	-	Depart Site (Final)

TABLE 4. Remote Site Clock Times (minutes) by Time Element

Time Element	MFSU Only			All Remote Sites		
	N*	Mean	Median	N	Mean	Median
Travel To Site	7	48.0	31.0	10	44.8	32.0
Travel Between Sites	11	16.5	16.0	11	16.5	16.0
Delay (before setup)	18	5.0	3.0	21	4.3	2.0
Setup	18	7.3	7.5	21	8.3	8.0
Delay (before serving)	18	1.6	1.0	21	1.6	1.0
Serve	18	24.7	21.0	21	27.2	22.0
Delay (before packup)	18	5.0	2.5	21	5.0	3.0
Packup	18	5.9	4.0	21	6.1	5.0
Delay (before departure)	18	3.7	3.0	21	3.4	3.0
Travel Return	7	35.6	40.0	10	32.0	29.5

*N = number of sites

Serving. Serving times varied considerably from site to site and depended on the total number of troops supported and the average serving rate experienced. Serving times per site ranged from 8 to 56 minutes.

Delay (before packup). The time from the end of serving to the start of pickup ranged from 0 to 27 minutes. However, this delay was usually two minutes or less. The longer delays occurred when there was slack time available before the move to the next scheduled feeding site.

Packup. This time element corresponds to the total time from the start to finish of the packup/cleanup process. Packup times ranged from 3 to 15 minutes and averaged about 6 minutes. Factors affecting packup times included members of the food service team, ambient temperatures, and the remaining feeding schedule.

Delay (before departure). Following packup, there usually was a short delay before leaving for the next feeding site or BSA. The delays ranged from 0 to 10 minutes and averaged between three and four minutes. Reasons for these delays included discussions with unit personnel about possible next day feeding arrangements, obtaining and understanding directions to the next feeding location, or blocking of the MFSU's movement by other tactical vehicles.

Travel to BSA. Return travel times to the BSA varied considerably from 10 to 65 minutes and depended on distances, types of roads, and weather conditions.

Summary of Remote Time Data. The MFSU elapsed clock times, headcounts and resultant serving rates at each site are listed in Table 5. The "non-productive time" defined in this table represents the summation of the four "delay" time elements defined in Table 3. As shown in Table 5, the serving rate varies considerably from site to site. These rates ranged from 2.0 to 5.5 troops per minute. However, a more important statistic is the average serving rate, which over all sites is 3.3 troops fed per minute. It should also be noted that high and low serving rates were experienced for small (22 to 65 troops) as well as large (91 to 180 troops) feeding sites. But the average serving rates for smaller sites (3.02) and larger sites (3.47) are not much different than the serving rates for all sites combined.

Based on the Cold Weather-83 experience, serving rate per site varied primarily as a function of factors other than the number of troops supported at a site. Factors affecting serving rates included unit activity at time of arrival, troop disposition and distances from the MFSU, food service personnel assigned, remaining feeding schedules, time of day, and ambient temperature.

Table 6 summarizes the percent of total remote time accorded per time element. Sixty-five percent of the total remote time was spent traveling either to, between, or back from remote site feeding while only 35 of the total remote time was spent at the actual feeding sites, including setup, serving, packup, and delays.

TABLE 5. Mobile Food Service Unit (MFSU) Remote Site Time Summary

Clock Time (minutes)					
Setup/ Packup	Serving	Non Productive	Total	Head-Count	Serving Rate/min
7	8	8	23	22	2.8
8	8	9	25	36	4.5
15	15	30	60	40	2.7
14	22	7	43	43	2.0
17	15	16	48	47	3.1
8	15	14	37	48	3.2
10	12	20	42	53	4.4
12	15	11	38	55	3.7
14	22	17	53	57	2.6
9	23	12	44	64	2.8
11	20	7	38	64	3.2
AVG*		13.7			3.0
12	32	25	69	91	2.8
20	17	46	83	93	5.5
22	50	23	95	120	2.4
12	35	9	56	135	3.9
10	43	9	62	140	3.3
24	49	0	73	175	3.6
14	43	13	70	180	4.2
AVG		17.9			3.5
0 AVG**		15.3			3.3

*AVG is the average for sites where headcounts ranged from 22 to 64, and for 91 to 180.

**0 AVG is the overall average for all sites.

TABLE 6. Remote Site Clock Time Summary by Time Element

Time Element	Clock Time (%)
Travel (to, between and from sites)	65%
At Site	
Setup and Pack-up	9
Serving	16
Delays (before setup, serving pack-up, and departure)	10
Total	100%

It should be noted that, as stated earlier, the concept of operations for this test was to operate the MFSU out of the BSA to support headquarter, infantry, and artillery elements. Were the MFSU to be operated from a combat battalion's headquarters unit location (as proposed for the new USMC field feeding system), more effective use of time might be possible. The percent of total remote time (and actual time) spent traveling would be lower since the MFSU would be closer to the supported units and these units would likely be deployed in close proximity to each other or to the headquarters unit itself. However, the setup, packup, waiting time, and serving rate per site would probably be about the same.

WORK SAMPLING

Work sampling data were collected to assess the productive effort expended at the base camp in support of the remote operation. Productive effort expended was primarily in support of the remote feeding operation but also included providing hot Tray Pack breakfast meals daily to about 40 troops in the base camp area. Observations were taken at 10-minute intervals and covered four entire workdays. Workdays (time from initial to final productive activity) ranged from 9 hours to over 16 hours. For each observation, each on-duty food service personnel was classified as performing one of a defined set of activities. The work sampling activity descriptions are presented in Table A-1 .

The work sampling data are summarized in Table 7 in terms of number of observations per activity, percent of total observations per activity, and average number of hours expended per day per activity. Since observations were taken every 10 minutes (six times per hour), the average number of hours expended per activity is estimated by dividing the number of observations per activity by six. A brief explanation of each activity and interpretation of the work sampling data follow.

M-2 Burner. During the exercise the M-2 burners were mostly used to heat water for coffee and also to preheat the insulated containers used to transport hot Tray Packs for remote site feeding (March 12-13 only). On 16 March, hot coffee was not prepared for the last three sites due to the lack of fuel for the burners. On average, about 2.2 worker-hours per day were expended on productive activities associated with the M-2 burners.

Beverages. The only beverages made were hot coffee and a cold beverage base drink (March 15-16 only). Productive efforts recorded in this activity include those expended to prepare the beverages and to prepare and fill the insulated jugs with hot coffee, cold beverage base, or cold water for remote site feeding. An average of less than one productive worker-hour per day was expended in this activity.

Preparation, Non Tray Pack Items. The hot T Ration meals were augmented with hot and cold beverages and bread and/or crackers. Efforts recorded in this activity primarily represent the time expended slicing and repackaging bread for remote site feeding. Often bread was not used the same day it was sliced. This activity consumed about an average of one hour of productive effort per day.

TABLE 7. Base Camp Work Sampling Data Summary

Activities	Total (Four Days)		Daily Average	
	N*	%**	N	Worker-Hours/ Day
M-2 Burners	53	3	13.3	2.2
Beverages	22	1	5.5	0.9
Non Tray Pack Preparation	25	1	6.3	1.0
Tray Pack Preparation	56	3	14.0	2.3
Load/Unload	63	3	15.8	2.6
Sanitation	9	1	2.3	0.4
General Cleanup	7	1	1.8	0.3
Resupply	24	1	6.0	1.0
MFSU	25	1	6.3	1.0
Other Productive	17	1	4.3	0.7
Sub-Total (Productive)	301	16	75.3	12.5
Remote Time	776	41	194.0	32.3
Nonproductive Time	809	43	202.3	33.7
Total	1,886	100	471.5	78.6

*Number of times individuals were observed performing the activity.

**The number of observations in a category divided by the total number of observations, which was 1,886.

Heat Tray Pack Items. This activity represents only those productive efforts expended to preheat Tray Packs at the base camp with the MFSU for remote site feeding from insulated containers (March 12-13 only), and to load the MFSU with Tray Packs prior to departure for remote site feeding. This activity, on average, required about 2.3 productive worker-hours per day.

Load/Unload. Items loaded on and unloaded from the truck and/or MFSU before and after remote site feeding included insulated containers with preheated Tray Packs, insulated beverage jugs, additional Tray Packs, bread/crackers, condiments, disposables, and rubbish. Loading and unloading consumed an estimated average 2.6 productive worker-hours per day.

Sanitation. Sanitation efforts consisted of washing the T Ration serving utensils and rinsing the beverage containers. The productive effort expended on this activity was minimal.

General Cleanup. As shown by the data, only minimal efforts, an average of 0.3 productive worker-hours per day, were expended to clean the general base camp food service shelter area. This low level of effort was sufficient because only about 40 hot Tray Pack meals per day were served in the base camp area and following return from remote feeding all items, including rubbish, were off-loaded and deposited at their proper location.

Resupply. Resupply consisted primarily of picking up water and fuel required to supply the food service operation. Because the Tray Pack supply was maintained in the base camp food service shelter, none were picked up during the data collection period. One productive worker-hour per day was expended on average on resupply activities. On March 16, the final day of feeding, no productive effort was observed for this activity.

MFSU. Time expended to repair, clean, or maintain the MFSU was minimal and averaged one productive worker-hour per day.

Other Productive. All other base camp food service productive efforts were classified in this category. On average only about 0.7 productive worker-hours were expended on all other productive efforts daily.

Subtotal (Productive). The total productive effort expended at the base camp ranged from 10 to 15 worker-hours and averaged 12.5 worker-hours per day.

Remote Time. Food service personnel away from the base camp in support of the remote feeding operation were recorded in this category. The estimated number of worker-hours ranged from 18 on March 13 when two sites and 160 total troops were supported to 49 on March 16 when seven sites and 614 total troops were supported for an average of 32 worker-hours per day.

Nonproductive. All on-duty food service personnel not supporting the remote feeding operation or performing any productive effort at the base camp were classified as being nonproductive. As shown in Table 7, an average 43% of all observations or slightly more than 32 on-duty worker-hours per day were classified as nonproductive.

CONSUMER ACCEPTANCE

During the exercise, consumer acceptance data were collected at several of the remote sites supported with hot T Ration meals. At these sites, troops completing their meal were verbally asked to give their impression of each meal component except beverages. Their responses are based on the nine-point acceptance (hedonic) scale shown in Figure 3.

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

Figure 3. Customer acceptance (hedonic) rating scale

Table 8 summarizes the troop acceptance ratings for each Tray Pack item. With one exception, the average rating for each entree item ranged from 7.0 to 8.4 on the 9-point rating scale. The one exception, scrambled eggs with ham, had an average rating of 5.1. However, as will be shown in a subsequent section, the serving temperature for this item was notably lower than for other items. The low acceptance rating thus may be due in part to the lower temperature of the product as served.

Two of the entree items, lasagna and chicken stew, were served as single hot-item meals. With these items, troops were given a double portion (yielding six servings per Tray Pack). These items were augmented with a hot Tray Pack dessert item. No separate starch or vegetable items were furnished. As shown by the ratings, the single hot-item meals were highly acceptable. No negative troop comments regarding this meal concept were registered; nor were there requests for additional hot items by troops consuming these meals. These data confirm the high acceptability of the single hot-item meal concept, originally evaluated during exercise Alloy-Express 82.*

For vegetable items, the average rating varied from 6.8 for lima beans to 8.2 for corn. The only item that rated below 7.0 was lima beans. The lower rating for lima beans is probably due to lower troop preference for the item rather than lower item quality. The Tray Pack starch items were uniformly acceptable and the average ratings ranged from 7.6 to 7.8. Dessert items were both extremely and uniformly acceptable. For these items the average ratings ranged from 8.4 to 8.5.

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* Harry Kirejczk, D. Paul Leitch and Edward Hirsch, "Tray Pack Related Evaluations at Alloy Express 82," NATICK/TN-83/005, December 1982

TABLE 8. Acceptance Ratings of Tray Pack Items

Item	N	Mean
Lasagna*	23	8.4
Chicken Stew*	20	8.3
Creamed Beef	18	8.1
Chicken with Dumplings	38	7.9
Sliced Pork	18	7.9
Chili	14	7.9
Stuffed Peppers	38	7.8
Stuffed Cabbage	19	7.7
Sloppy Joes	41	7.6
Breakfast Bake	16	7.0
Scrambled Eggs with Ham	15	5.1
Entrees	260	7.7
Corn	32	8.2
Peas	28	7.2
Green Beans	11	7.1
Lima Beans	16	6.8
Vegetables	87	7.5
Macaroni & Cheese	16	7.8
Cut Potatoes	18	7.7
Baked Beans	36	7.6
Starches	70	7.7
Peach Compote	41	8.5
Apple Compote	90	8.4
Blueberry Compote	52	8.4
Cherry Compote	36	8.4
Desserts	219	8.4

* Served as single, hot-item meals

SERVING TEMPERATURES

To assess the typical Tray Pack item serving temperature, the product temperature of several open Tray Pack items was taken while the items were on the serving line. The MFSU serving line was made of stainless steel and was not heated. For those sites supported by preheated Tray Packs from insulated containers, the opened Tray Pack items were placed on top of the insulated containers.

Product temperatures were taken shortly after the Tray Packs were opened and still while quite full. Because an opened Tray Pack remained on the serving line until it was emptied, this time period varied depending on the serving rate and type of item. Based on the average serving rate of 3.3 troops per minute, the average time to empty a Tray Pack item in a single hot-item meal was two minutes. For meals with four components, entree, vegetable, starch and dessert, the times were four minutes for the entree and six minutes for each of the other components.

Table 9 presents the recorded temperatures of Tray Pack items served from insulated containers and directly from the MFSU. As shown in the table, the preheated Tray Packs from insulated containers were held for 1.0 to 2.7 hours prior to being served. The length of time the Tray Packs were heated and their temperature when placed in the insulated containers were not recorded.

In general, the temperatures recorded were acceptable at 140°F or higher with two minor exceptions: lasagna (129°F) and apple compote (126°F). None of the troops served lasagna mentioned the entree being too cold. Tray Pack dessert items are completely acceptable at a warmed or ambient (not frozen) temperature.

With one exception, Tray Pack items served directly from the MFSU were extremely hot when opened, with typical temperatures in the range of 160°F to 170°F. The one exception was scrambled eggs, which were only 120°F when opened. It should be noted that the creamed beef (160°F) and scrambled eggs were placed in and removed from the MFSU at the same time. The difference in product temperatures is therefore attributable to differences in product heat transfer characteristics.

Based on troop comments, Tray Pack item temperatures as served were sufficiently hot. No troops complained that the food was too cold. At sites supported by the MFSU, troops on several occasions had to wait for the food to cool because it was too hot to consume right after serving. In addition, for those situations where troops must be provided hot meals at multiple sites at about the same time, insulated containers will maintain the temperature of preheated tray packs sufficiently for extended periods of time.

EQUIPMENT PERFORMANCE

During the exercise, the modified MFSU operated without equipment problems or failures. Total equipment operating time during the test is estimated at about 50 hours. The modified MFSU diesel-fired generator and hot water heater started when tried in ambient temperatures as low as -20°F. Based on equipment performance, the modified MFSU is an effective means of providing hot T Ration meals in cold weather environments.

TABLE 9. Typical Serving Temperatures of Tray Pack Items

Item	From Insul. Containers		From MFSU
	Hold Time	Temp.	Temp.
Cabbage Rolls	1.5 hr	142°F	170°F
Chicken w/ Dumplings		-	170°F
Chicken Stew	-	-	170°F
Chili w/ Beans	1.0	142°F	-
Creamed Beef	-	-	160°F
Eggs, Scrambled	-	-	120°F
Lasagna	2.0	129°F	-
Pork Slices	2.7	144°F	-
Sloppy Joe	-	-	165°F
Stuffed Peppers	1.5	140°F	168°F
Corn	1.5	160°F	-
Green Beans	1.0	144°F	-
Limas	1.5	140°F	-
Peas	-	-	170°F
Baked Beans	-	-	165°F
Cut Potatoes	-	-	145°F
Apple Compote	2.0	126°F	-
Blueberry Compote	1.5	140°F	-
Cherry Compote	-	-	170°F
Peach Compote	-	-	165°F

IV. PROJECTED REQUIREMENTS

MOBILE FOOD SERVICE UNIT REQUIREMENTS

The number of MFSUs required per combat battalion is estimated based on the elapsed clock time data collected relative to the remote feeding operation. To generate these estimates, the following Cold Weather-83 average times per time element (see Tables 3 and 4) were used.

Travel to Site	48 minutes
Travel between sites	17 minutes
Setup and packup (total)	13 minutes/site
Nonproductive	15 minutes/site
Return travel	36 minutes
Serving rate (troops fed/min)	3.3 troops/minute

Table 10 presents the estimated clock time at a "typical" remote site as a function of the number of troops supported. This time estimate comprises a fixed component and a serving time component. The fixed component, 28 minutes, represents the average setup and packup and nonproductive time per site. The serving time component varies as a function of the number of troops to be supported and is based on an average serving rate of 3.3 troops per minute. It should be emphasized that the estimated times in Table 10 do not include travel to, between, or return from remote sites.

These estimates show that the fixed time component represents a large portion of the total time at small group feeding sites. At the remote sites as the number of troops served increases, the fixed time component of total time decreases. Because of this pattern, a unit separated into two or more remote locations requires more total time than one unit at one location. For example, a company of 200, all at one remote location would take an estimated 89 total minutes to support, but about 172 (4 x 43) total minutes or 93% more time if separated into four remote feeding sites. Therefore, the number of MFSUs required per battalion is a function of both the number of troops supported and the number of feeding locations.

Having drawn a relationship between the number of troops to be fed and the estimated remote site time requirements, the next step is to estimate the maximum number of troops supported per MFSU (with one shift of food service personnel) as a function of the number of different feeding locations. These computations are based on the following assumptions.

- One mobile food service unit is used.
- Personnel work a 12 hour shift.
- One hour is required to load the truck/MFSU with supplies
- One hour is required to off-load the truck/MFSU upon return to the BSA.

TABLE 10. Estimated Clock Time Per Remote Site (Excluding Travel)

Number of Troops	Estimated Time (Minutes)*
25	36
50	43
75	51
100	58
150	73
200	89

*Time = Setup + Delay + Packup + (No. Troops/3.3)
= 28 + No. Troops/3.3

In order to relate the number of troops that could be fed at a successively increasing number of sites, within a 600-minute (10-hour) period, the following equation was used:

$$N_t = (600 - T_{ts} - T_{fs} - (NP \times N_s) - (T_{bs} \times (N_s - 1))) \times SR$$

where: N_t = estimated maximum number of troops that can be fed
T_{ts} = travel time to first site
T_{fs} = travel time from last site
NP = setup, backup and nonproductive time per site
N_s = number of sites
T_{bs} = travel time between sites
SR = serving rate.

In applying this equation to generate the information shown in Table 11, the data reported earlier have been used; (i.e., serving rate = 3.3 persons/minute). The resulting estimates show that, as the number of sites increases, the maximum number of troops that can be supported decreases. This occurs because of the increased portion of the trip time consumed by travel, remote site setup and packup and nonproductive time, and the resulting decreased portion of total time dedicated to serving troops.

Based on these estimates, an MFSU with one set of food service personnel would be sufficient to provide hot T Ration meals to the five companies of an infantry battalion (total strength 966) even if each company was served in a different location. However, if the battalion troops were separated into six or more feeding locations, one MFSU with one set of food service personnel would not be sufficient.

It is important to note that the estimates in Table 11 assume no scheduled problems and that troops will be available to eat irrespective of the tactical situation, ongoing activities, or the time of day. Given these

considerations, and the real-time nature of combat situations, the actual number of troops that could be supported would be less than that shown. Thus, another MFSU may be required if only in a back-up role.

To provide frequent hot meals to combat troops on future battlefields, the Marine Corps new field feeding system must be capable of quickly responding to on-demand (not scheduled) remote-site feeding requirements with minimal delay time. Table 12 presents an estimated total remote trip clock time, based on Cold Weather-83 results, as a function of the number of feeding sites and total troops supported. The equation used to derive these estimates is as follows:

$$N_m = T_{ts} + T_{fs} + (NP \times N_s) + (T_{bs} \times (N_s - 1)) + (N_t/SR)$$

Where: N_m = estimated number of minutes
T_{ts} = travel time to first site
T_{fs} = return travel time from last site to BSA
NP = setup, packup and nonproductive time per site
N_s = number of sites
T_{bs} = travel between sites
N_t = number of troops to be fed
SR = serving rate in troops/minute.

To provide a high degree of responsiveness in an "on demand" feeding system, an MFSU allocation of one per two line companies (two MFSUs per combat battalion) would be sufficient. Actual system responsiveness would be even greater (shorter total remote trip time) than that indicated in Table 12 under this allocation rule since the MFSU would operate from a location closer to the supported companies, and the supported companies, all from the same battalion, would tend to be closer together.

Depending on the tactical situation, an MFSU could deploy and support multiple sites during a remote trip or return to the base camp between feeding sites and redeploy on a demand basis. The two MFSUs in an infantry battalion, for example, could deploy and support the entire 700 (approximately) battalion line troops at a total of four different locations in less than 4.5 hours. Or an MFSU could deploy and support two rifle companies (400 troops in total) separated into three locations during one trip in about 5.4 hours. If a different tactical situation dictated, an MFSU could be deployed to feed one company at one location, return to the base camp, and then redeploy to support the other company at two locations. In this case the entire cycle would be completed in roughly 6.5 hours. The major point of these examples is that a highly responsive, on demand, and flexible feeding system to provide hot meals to dispersed troops can be achieved with but one MFSU per two line companies.

TABLE 11. Estimated Maximum Number Troops Supported Per 10-Hour Remote Trip

Number of Feeding Sites	Estimated Maximum Total Number Troops*
11	125
10	274
9	422
8	571
7	719
6	868
5	1016
4	1165
3	1313
2	1462
1	1610

*Number Troops = (533 -(45 x Sites)) x 3.3

TABLE 12. Estimated Total Remote Trip Clock Time (minutes)* As Function of Total Number of Troops and Feeding Sites

No. Troops	No. Sites					
	1	2	3	4	5	6
100	142 min	187 min	232 min	277 min	-	-
200	173	218	263	308	353 min	398 min
300	203	248	293	338	383	428
400	233	278	323	368	413	458
600	294	339	384	429	474	519
800	354	399	444	489	534	579

* Minutes = 67 + (45 x Sites) + (No. Troops/3.3)

BATTALION FOOD SERVICE PERSONNEL STAFFING REQUIREMENT.

Food service staffing requirements in a battalion are a function of several factors. Among the more important are the number of separate feeding sites, the number of MFSUs required to support remote site feeding operations, the number of troops supported, and the number of hot meals served per day. The staffing requirements for a battalion with multiple remote site feeding, for example, are greater than the staffing requirements for the same battalion consolidated in one location, simply because in the latter case there is no labor tied up in transit to remote sites and setups, delays and tear down times. Although this is a rather obvious point, it is fundamental to the following battalion labor requirements projections.

Battalion food service staffing levels must be adequate to cover both the productive work efforts required at the base camp in support of the remote site feeding operations as well as at the remote site feeding operation itself. To evaluate the battalion level staffing requirements, the base camp and remote site feeding operation workloads are combined into a common unit of measure denoted as worker-hours.

Base Camp Workloads. The base camp workload represents those efforts expended in the base camp area in support of the actual feeding operation (remote or consolidated onsite) itself. This workload includes activities such as maintenance/operation of M-2 burners, preparation of beverages and other non Tray Pack menu items; and resupply of rations, water, and fuel. This workload is a function of the total number of troops to be supported and not the number of separate feeding locations. For example, 400 troops would require twice the quantity of beverages, other non Tray Pack items, and Tray Pack items required by 200 troops, irrespective of the number of separate feeding locations.

The productive work activities performed at the base camp in support of the actual feeding operation are flexible in nature to facilitate scheduling so to minimize both peak workloads and slacktime. Based on the Cold Weather-83 work sampling data (summarized in Table 7), an average 12.5 productive worker-hours were expended in the base camp to support an average of 417 troops per day with one hot T Ration meal. This translates into 3.0 base camp productive worker-hours per 100 meals. Military food service staffing requirements are typically based on a 75% productivity planning factor: that is, one worker-hour of time yields 45 minutes of productive effort. The remaining 15 minutes includes slack time, attention to personnel needs, and so forth. Based on the 75% productivity factor, 4.0 base camp worker-hours are required per 100 meals. This workload can be easily extrapolated to any feeding level. For example, to provide one hot T Ration meal to a battalion of 900 troops would generate a workload of 36 base camp worker-hours.

Remote Site Workloads. Due to the rigid, nonflexible nature of the remote site feeding operation, all remote site time is assumed to be work time. Clearly the travel to and between sites, the set-up, serving, tear down and return travel times fall into this category. The time spent waiting at remote sites for any of a variety of reasons is not so clearly a productive time element. However it is an unavoidable occurrence and therefore is considered to be worktime.

MFSU Remote Site Clock Times. The number of worker-hours generated to support the remote site feeding operation is primarily a function of four factors: total number of troops supported, number of separate MFSU trips, total number of feeding sites, and the staffing assigned to each MFSU. In order to quantify these parameters, a Direct Support Artillery battalion with five companies and 682 troops, and an Infantry battalion also with five companies containing 990 troops were selected. Using the results reported previously (see Table 4), remote site clock times were estimated for these battalions. These figures are reported in Tables 13 and 14 and show the estimated times to serve one hot meal as functions of the number of MFSU trips and the total number of separate feeding sites.

The estimated remote site clock hours range from 3.9 for an artillery battalion feeding at one site to 17.6 hours when the MFSU is used to feed one hot meal to an infantry battalion dispersed over 10 separate locations. If, as suggested earlier, two MFSUs are allocated to each battalion, then these time estimates would be halved when both MFSUs are deployed.

MFSU Staffing Levels. The suggested MFSU staffing levels for the Artillery and Infantry Battalions are presented in Table 15 as a function of the type feeding: single (consolidated) or multiple (nonconsolidated) site feeding; and the number of hot meals per day for battalion troops. As shown in Table 15, the suggested MFSU staffing is four when the potential number of troops per site is large, such as with consolidated battalion-level feeding, or multiple-site, company-level feeding with the infantry battalion (180 troops/rifle company). The fourth person is needed to add cold trays to the MFSU as hot ones are removed, ensure that only properly heated Tray Packs are removed from the MFSU and opened, and to ensure sufficient quantities of each Tray Pack item are heated to support all troops at each site. When the expected number of troops per site does not significantly exceed the MFSU single-load capacity, the suggested staffing level is three. In these situations, an individual to reload the MFSU and monitor the Tray Pack heating process throughout the serving period is not required. If the MFSU is supporting multiple sites on a given trip, the MFSU can be reloaded prior to departing one site for the next site. Since the artillery battery strengths are about 125 troops each, the suggested MFSU staffing when supporting artillery troops at multiple sites is only three.

The suggested MFSU staffing includes one KP when providing two or three hot meals per day to battalion troops and no KPs when providing only one hot meal per day. The single KP is used when providing multiple hot meals to minimize total battalion food service personnel requirements. Only food service personnel are employed when one hot meal per day is provided, due to

TABLE 13. Total Remote Site Clock Time* to Feed One Artillery Battalion (Five Companies, 682 Troops) One Hot T Ration Meal

Total Number Sites	Number of Separate Trips					
	0**	1	2	3	4	5
1	3.9	-	-	-	-	-
2	-	5.8	-	-	-	-
3	-	6.5	7.7	-	-	-
4	-	7.3	8.4	9.5	-	-
5	-	8.0	9.1	10.3	11.4	-
6	-	8.8	9.9	11.0	12.1	13.3
7	-	9.5	10.7	11.8	12.9	14.0
8	-	10.3	11.4	12.5	13.6	14.8
9	-	11.0	12.2	13.3	14.4	15.5
10	-	11.8	12.9	14.0	15.1	16.3

*Time(h) = ((No. Troops/3.3) + (84 x No. Trips) + (28 X No. sites) + (17 x (No. Sites - No. Trips - 1))) /60

**Corresponds to consolidated battalion level feeding

TABLE 14. Total Remote Clock Time* to Feed One Infantry Battalion (Five Companies 940 Troops) One Hot T-Ration Meal

Total Number Sites	Number of Separate Trips					
	0**	1	2	3	4	5
1	5.2[1]	-	-	-	-	-
2	-	7.1	-	-	-	-
3	-	7.8	9.0	-	-	-
4	-	8.6	9.7	10.8	-	-
5	-	9.3	10.5	11.6	12.7	-
6	-	10.1	11.2	12.3	13.4	14.6
7	-	10.8	12.0	13.1	14.2	15.3
8	-	11.6	12.7	13.8	14.9	16.1
9	-	12.3	13.5	14.6	15.7	16.8
10	-	13.1	14.2	15.3	16.4	17.6

* Time(h) = ((No. Troops/3.3) + (84 x No. Trips) + (28 x No. sites) + (17 x(No. sites - No. trips -1))) /60

**Corresponds to consolidated battalion level feeding

TABLE 15. Mobile Food Service Unit Staffing Levels

Type Feeding	Meals/Day	Infantry Battalion FSP*	Infantry Battalion KP	Artillery Battalion FSP	Artillery Battalion KP
Consolidated**	1	4	0	4	0
	2,3	3	1	3	1
Nonconsolidated***	1	4	0	3	0
	2	3	1	2	1

* Food Service Personnel

** Required KPs assigned to food service operation.

*** One individual from unit designated to perform KP-type duties at each site.

the reduced total workload and the number of food service personnel available. When providing two hot meals per day to troops at multiple sites, the single required KP can be drawn from the unit being supported at each site. The person designated to be KP functions as such only while the MFSU is at the site and returns to the primary duty when the MFSU departs.

A battalion would be provided three hot meals per day at one consolidated location only when in a reserve or other noncombat status. In this situation, required KPs are drawn from the battalion and assigned to the food service operation on a full-time basis without degrading battalion effectiveness.

Total Battalion Workload and Staffing. Based on the information shown in Tables 13 through 15, Table 16 summarizes the projected infantry and artillery battalion level workloads for a variety of feeding situations. When serving three hot meals per day to a battalion in one consolidated location, only the total workload rather than a separate food service personnel and KP workload is indicated. In this situation, the total workload can be subdivided and met by a variety of different food service personnel and KP work efforts.

As shown in Table 16, two hot meals per day with multiple site feeding generates a total workload equivalent to about 12.6 food service personnel and 1.2 KP worker-days, or 13.8 total work days for the infantry battalion. A three hot meal per day operation, such as when the unit is consolidated, generates a total workload of 14.6 workdays. For the three-meal operation, provided the number of KPs drawn from the battalion is two or more, the number of food service personnel worker-days required to support the operation is the same or less than that required to support the two meal per day multiple site feeding operation.

TABLE 16. Total Battalion Workloads

Battalion (strength		Infrantry (940 Troops)				Artillery (682 Troops)			
No. Meals/Day		1	1	2	3	1	1	2	3
No. Sites/Meal*		5	9	5	1	5	9	5	1
No. Trips/Meal**		4	4	4	0	4	4	4	0
	FSP	37.6	37.6	75.2	-	27.3	27.3	54.6	-
Base Camp	KP	-	-	-	-	-	-	-	-
Worker-Hrs	FSP or KP	-	-	-	112.8	-	-	-	81.9
	Total	37.6	37.6	75.2	112.8	27.3	27.3	54.6	81.9
	FSP	50.8	62.8	76.2	-	34.2	43.2	45.6	-
Remote	KP	-	-	14.2	-	-	-	11.6	-
Worker-Hrs***	FSP or KP	-	-	-	62.4	-	-	-	46,8
	Total	50.8	62.8	90.4	62.4	34.2	43.2	57.2	46.8
	FSP	88.4	100.4	151.4	-	61.5	70.5	100.2	-
Total	KP	-	-	14.2	-	-	-	11.6	-
Worker-Hrs	FSP or KP	-	-	-	175.2	-	-	-	128.7
	Total	88.4	100.4	165.6	175.2	61.5	70.5	111.8	128.7
	FSP	7.4	8.4	12.6	-	5.1	5.9	8.3	-
Total	KP	-	-	1.2	-	-	-	1.0	-
Worker-days	FSP or KP	-	-	-	14.6	-	-	-	10.7
	Total	7.4	8.4	13.8	14.6	5.1	5.9	9.3	10.7

*Total number of different feeding sites to provide the entire battalion one hot meal.

**Total number of MFSU trips taken to provide troops at all sites one hot meal. For each trip a MFSU may support troops at one or more sites.

***For consolidated battalion level feeding (0 trips/meal) corresponds to worker hours expended setting up and tearing down the serving line and serving all battalion troops.

Based on the above rationale, the maximum food service personnel workload (worker-days) is generated based on the two hot meal multiple site feeding situation. This workload equates to 12.6 and 8.3 food service personnel worker-days for infantry and artillery battalions respectively.

Therefore, the proposed new system staffing levels: 16 food service personnel and 6 KPs, making a total of 22 personnel for the infantry battalion and 11 food service personnel and 5 KPs, or 16 personnel total for the artillery battalion are more than adequate. Table 17 presents battalion food service personnel assignments based on the proposed new system staffing levels. These assignments assume two teams of food service personnel per MFSU when two or three hot meals are furnished. Each team is on duty for 12 hours providing a 24-hour per day on-demand hot food capability. When providing one hot meal per day only one team of food service personnel per MFSU is provided. Base camp productive workloads are supported by food service personnel assigned base camp duty and on-duty MFSU food service personnel not at remote sites.

TABLE 17. Battalion Food Service Staffing Assignments

Type Battalion	Duty Assignment	Meals/Day 1	Meals/Day 2-3
Infantry	Base Camp Personnel	8	4
	MFSU Teams	2	4
	Personnel/MFSU Team	4	3
	MFSU Personnel	8	12
	Total Battalion Personnel	16	16
Artillery	Base Camp Personnel	5	3
	MFSU Teams	2	4
	Personnel/MFSU Team	3	2
	MFSU Personnel	6	8
	Total Battalion Personnel	11	11

The proposed new system battalion staffing levels are more than sufficient to support the maximum workloads generated. For the infantry and artillery battalions, the proposed food service personnel staffing level exceeds the maximum food service personnel workload by 3.4 (16.0 - 12.6) and 2.7 (11.0 - 8.3) work-days respectively. The excess authorized manpower is available to cover for illnesses or other absences by food service personnel, or to perform other assigned nonfood service functions, such as perimeter guard duty.

IV. CONCLUSIONS AND RECOMMENDATIONS

Based on the results obtained in the Cold Weather-83 field evaluation of Tray Packs the following conclusions are drawn:

- The modified MFSU with tray packs is an effective, labor-efficient means to provide highly acceptable hot meals to combat troops in extreme cold environments.

- The appropriate MFSU allocation criteria is two per combat battalion.

- The proposed new system staffing levels are definitely adequate and possibly high.

- Hot T Ration meals, including regular and single hot-item meals, are highly acceptable in cold environments.

These conclusions support the recommendations that:

- The Marine Corps also adopt the MFSU with Tray Packs for cold weather operations.

- The Marine Corps include a core group of five to seven single-item meals in any T Ration menu developed.

APPENDIX

Work Sampling Activity Definitions

TABLE A-1. Work Sampling Activity Descriptions

Activity	Descriptions
M-2 Burners	Fueling, maintaining, repairing, adjusting, M-2 burners utilized for heating hot water for beverages sanitations, etc.
Beverages	Making beverages preparing and filling insulated beverage jugs.
Preparation Non Tray Pack Items	Preparing/slicing non T Ration items to include bread, vegetables, cheeses or any other T Ration/non beverage item.
Tray Pack Preparation	Heating T Rations to be placed in insulated containers for transport to remote sites, loading/unloading Ts into MFSU.
Load/Unload	Load/Unload MFSUs, trucks, helos, other vehicles with Ts insulated containers, other food items, disposables, etc. for or after return from remote feeding.
Sanitation	General Cleanup of MSSG Food Service Shelter area to include: Disposal of rubbish, rearrange supplies and equipment, etc.
Resupply	Pickup rations, water fuel, and misc. items required for Food Service Personnel.
MFSU	Repair, maintain, clean MFSU.
Other Productive	Other productive efforts, not included elsewhere, which occur on an infrequent basis.
Gone Remote	Record number of personnel supporting the Remote Feeding Operation.
Nonproductivity	Idle, not performing any productive activity.