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FIELD FEEDING SYSTEM TO SUPPORT USMC FORCES IN THE 1990s

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The proposed new field feeding system provides the responsiveness, mobility, and flexibility required to support the USMC's combat role of the 1990s and to ensure combat troops receive frequent, high quality, highly acceptable hot meals. Major components of the system include Mobile Food Service Units, Modular Field Kitchens, and the T Ration. The T Ration incorporates Tray Packs, (precooked heat-and-serve food items for the entree, starch vegetable,

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20. Abstract (continued)

and dessert meal components) as well as bread products, condiments, and beverages. In addition, the new system offers a 9% reduction in total cost, 66% reduction in personnel requirements, a 73% reduction in water requirements, and a 94% reduction in fuel requirements.

SUMMARY

In FY82, the Directorate for Systems Analysis and Concept Development was tasked with a project within the DoD Food and Nutrition Research and Engineering Program to design a field food service system with the responsiveness, mobility, and flexibility characteristics necessary to support the assigned USMC combat role of the future and to ensure that combat troops are provided frequent, highly acceptable hot meals. System design objectives were to maximize the frequency and acceptability of hot meals, minimize system support requirements, and to minimize the development of USMC-unique field feeding equipment while providing for the above performance characteristics.

Major components of the proposed system 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 (MFKs), tent based kitchens for nonground combat elements that can be configured to support from 100 to 2,200 troops, and the T Ration which incorporates Tray Packs, which are precooked thermostabilized heat and serve food items, as well as bread products, condiments and beverages. In addition to providing the necessary responsiveness, mobility and flexibility, compared to the USMC's current system, the new system offers a 9% reduction in total system cost, a 66% reduction in personnel requirements, a 73% reduction in water requirements and a 94% reduction in fuel requirements.

It is recommended, therefore, that the proposed new system be adopted by the USMC. In particular, it is recommended that:

° the T Ration be adopted as the USMC's standard bulk operational ration,

° MFSUs be allocated on the basis of two per combat battalion,

° MFKs be allocated on the basis of assigned field kitchen feeding strengths, and

° disposable messgear be adopted, and if necessary permanent messgear be maintained as a backup.

PREFACE

This project was conducted by the Directorate for Systems Analysis and Concept Development of the U.S. Army Natick Research and Development Center (NRDC) as part of the Department of Defense Food and Nutrition Research, and Engineering Program under Military Service Requirement, M84-6, "Combat Food Services for USMC Ground Forces in the 1990's."

The author acknowledges Mr. Lloyd Cox and Mr. James Carozza, who provided extensive input into the development and review of the numerous tables in this report. In addition, a special appreciation is extended to Ms. Maura Severance and Ms. Maureen Savage, who provided excellent secretarial support throughout the development of this final report.

Because this report relates to a field feeding system for U.S. troops, U.S. customary units are used throughout.

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FIELD FEEDING SYSTEM TO SUPPORT USMC FORCES IN THE 1990s

INTRODUCTION

This report details the proposed new field food service system, which provides the responsiveness, mobility, and flexibility characteristics required to support the USMC's combat role of the future (1990s). The system design objectives were to maximize the frequency and acceptability of hot meals given the tactical situation, minimize system support requirements, and to minimize the development of USMC-unique field feeding equipment, while providing the above performance characteristics.

SYSTEM DESCRIPTION

The proposed system concept consists entirely of components of the original Army Combat Field Feeding System (ACFFS) reconfigured to support the USMC's 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), tent-based kitchens for nonground combat elements, which can be configured to support from 100 to 2,200 troops with A, B, or T Ration meals;

° the T Ration, which incorporates Tray Packs (pre-cooked, thermostabilized heat and serve food items) as well as bread products, condiments, and beverages.

T RATIONS

With the T Ration, Tray Pack items are provided for the entree, starch, vegetable, and dessert meal components. Other meal components, for example, beverages, condiments, bread, soups, and cereals are the same as with the B or A Rations. Tray Pack items are precooked thermostabilized bulk food items in half steamtable size trays (Fig. 1). Each tray holds about 6½ pounds of food. The items are fully preprepared and require only heating prior to serving. Following heating, for about 30 minutes, the trays are opened and placed on the serving line. The food items are served directly from the opened trays, which are discarded when empty. In essence, with the T Ration, the labor-intensive B Ration items (which are scratch-prepared from shelf-stable ingredients) are replaced with low-labor, high-response, heat and serve Tray Pack items. Without this ration, the new system would lack the responsiveness and flexibility required to provide frequent, highly acceptable hot meals to forward deployed combat troops.

Figure 1. T Ration Items

Several Tray Pack items are being developed at NRDC under the Tray Pack Product and Menu Development Program. This program is being conducted in accordance with a plan approved by the military services, including the USMC, and the Armed Forces Product Evaluation Committee (AFPEC). The program includes 44 basic Tray Pack items and 22 alternate Tray Pack items as listed in Table 1. Following successful production and acceptance testing, and final approval by AFPEC, the 44 basic Tray Pack items will be introduced into the supply system and are expected to be available for recurring procurements during 2Q FY85. Similarly, the alternate Tray Pack items are expected to become available by the same process in FY86.

TABLE 1. Tray Pack Basic and Alternate Menu Items

Component	Basic Menu Items	Alternate Menu Items
Entrees	Beef Stew	Pork Slices/Gravy
	Beef w BBQ Sauce	Lasagna
	Beef Pepper Steak	Swedish Meatballs
	Ham Slices	Beef Pot Roast/Gravy
	Franks/Brine	Chili Con Carne
	Roast Beef/Gravy	Spaghetti/Meatballs
	Canadian Bacon/Brine[a]	Stuffed Peppers
	Roast Chicken/Gravy	Pork/BBQ Sauce
	Creamed Ground Beef[a]	Beef Swiss Steak/Gravy
	Pork Sausage Links[a]	
	Scrambled Eggs/Ham[a]	
	Turkey Slices/Gravy	
	Breakfast Bake[a]	
	Chicken a la King	
	Meatloaf/Mushroom Gravy	
	Eggloaf/Mushrooms[a]	
	Eggloaf/Cheese[a]	
Vegetables	Three Bean Salad	Creamed Corn
	Carrots/Brine	Glazed Carrots
	Whole Kernel Corn	Lima Beans
	Green Beans	Peas/Carrots
	Mixed Vegetables	Stewed Tomatoes
	Peas/Mushrooms	
Starches	Escalloped Potatoes	Spanish Rice
	Beans w Bacon	Potatoes/Chicken Sauce
	Macaroni & Cheese	Macaroni Salad
	Glazed Sweet Potatoes	
	Buttered Noodles	
	Rice/White	
	Potatoes/Butter Sauce	
	Potato Salad	
Desserts	Orange Nut Cake	Marble Cake
	Cherry Nut Cake	Pound Cake
	Spice Cake	Fruit Cake
	Peaches/Syrup	Blueberry Dessert
	Apple Dessert	Cherry Dessert
	Pears/Syrup	
	Applesauce	
	Fruit Cocktail	
	Apple Coffee Cake	
	Chocolate Pudding	
	Chocolate Cake	
	Blueberry Cake	
	Pineapple/Syrup	

[a] Breakfast menu item.

MOBILE FOOD SERVICE UNIT

The Mobile Food Service Unit (MFSU) is a trailer-mounted Tray Pack heating system intended for highly mobile ground combat units. This unit has the high response, heat-on-the-move capability required to provide forward deployed combat troops with frequent, hot T Ration meals. In the proposed new system, the components of the MFSU are mounted on a 1½-ton trailer. However, if desired, they could be mounted on and operated from a 2½-ton truck, a 5-ton truck, or the ground. For example, nonground combat units (air wing, force service support group) do not require heat-on-the-move capability. For these units, the major components of the MFSU are skid mounted and operated at the Modular Field Kitchen.

Major equipment components of the MFSU, as depicted in Fig. 2, include the diesel hot water heater, 3 kW diesel generator, and the Tray Pack or T Pack heater. The T Pack heater is designed to hold a maximum load of 24 trays, which is a sufficient quantity of the hot meal components (entree, starch, vegetable, and sometimes dessert) for 120 to 130 troops. In the T Pack heater, the Tray Packs are heated by means of a circulating hot water bath, which is in turn heated by the hot water heater. The thermostatically controlled hot water heater shuts off when the water temperature reaches about 190°F and restarts automatically when the water temperature drops to about 170°F. In addition, for other than cold weather use, the MFSU can be equipped with about an 80 gallon hot and/or ambient temperature potable water supply. For cold weather operations, this feature can be removed.

The MFSU provides both the mobility and responsiveness required to deliver frequent hot T Ration meals to deployed combat troops. On a moment's notice, the T Pack heater can be loaded and with the flipping of one switch the MFSU's Tray Pack heating system is operational. The prime mover can then depart and the MFSU will heat the Tray Packs while enroute to the remote feeding site. The total time requirement to heat trays from ambient (not frozen) to serving temperature is 30 minutes or less. Further, due to the low 170-190°F water temperature the trays may be maintained in the T Pack heater for extended periods of time (two to three hours) without any noticeable degradation in food quality.

The T Pack heating capacity was set at 24 so to provide a nonstop hot Tray Pack meal serving capability for large group feeding situations. From extensive field observations, the maximum serving rate that can be maintained for extended periods of time is not more than four troops per minute. Therefore, provided cold Tray Packs are inserted as hot ones are removed, the MFSU is capable of supporting and maintaining a nonstop serving rate of four troops per minute indefinitely.

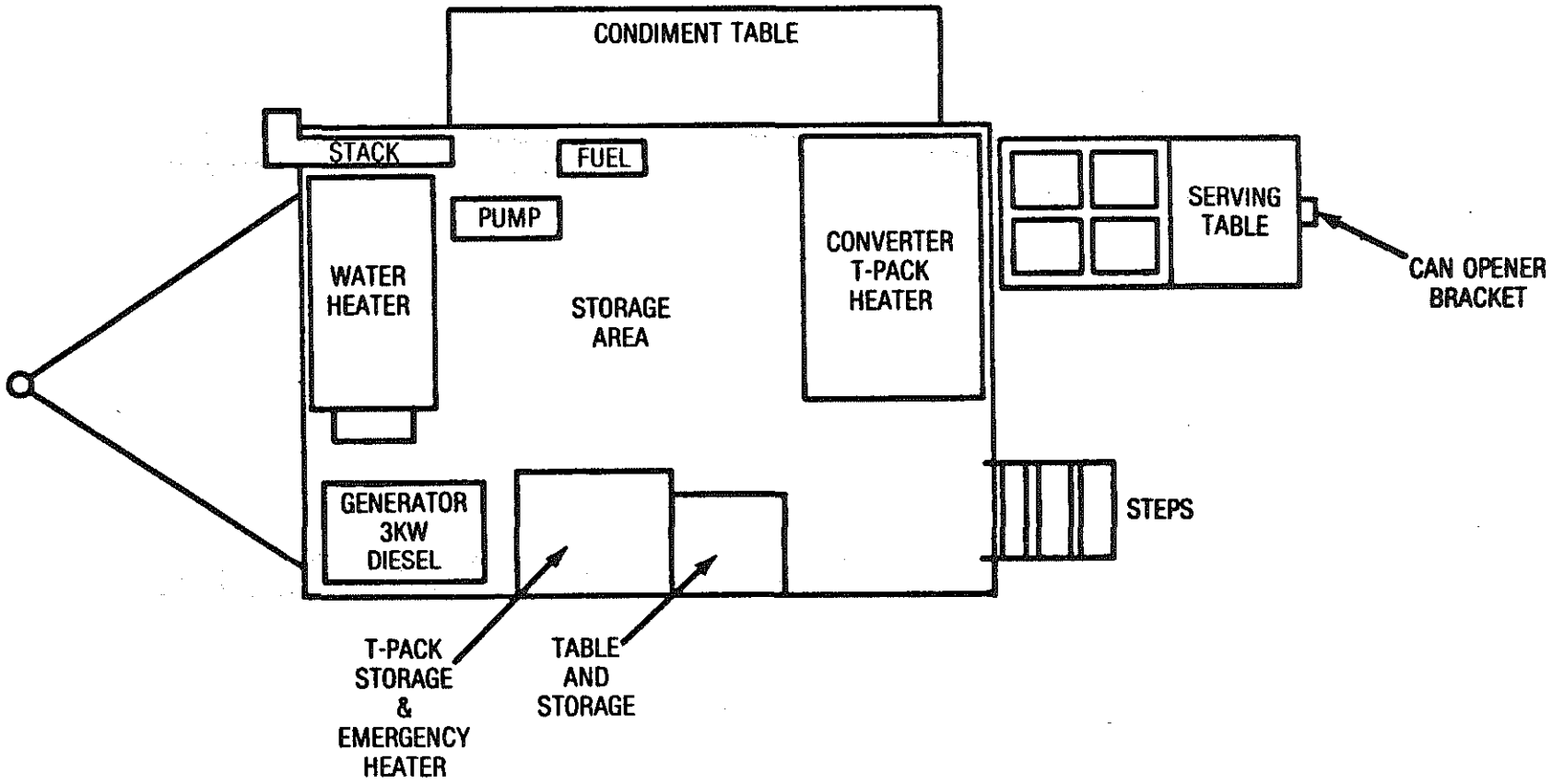

Figure 2. Typical Mobile Food Service Unit layout (T Rations).

MODULAR FIELD KITCHENS

The Modular Field Kitchens (MFKs) are designed and intended for those units or situations for which a highly mobile, heat on the move capability is not required. With the proposed new system, Marine Air Wing and Force Service Support Group units are authorized MFKs only. For these units, the MFK is equipped with a complete T, B, or A Ration (less refrigeration) capability. However, divisional combat units that are authorized MFSUs are also authorized or issued MFKs for those situations (typically the later stages of a conflict) for which the heat on the move capability is not always required. For these units, the MFK could be equipped with a B or A Ration capability only since any required T Ration capability could be provided by the authorized MFSUs.

The MFKs are housed in the Army's TEMPER (Tent, Modular, Personnel) tents, which represent an extendable, frame-supported shelter system. However, MFKs could be housed in other suitable modular or extendable shelter sytems. The TEMPER tent (frame and fabric) comes in sections 20' wide and 8' long which can be joined together lengthwise to provide a tent of any desired length (in 8' increments). Each section of tent fabric is provided with a doorway or a window on each side. In addition, a large screened roof vent is provided on each side of the ridge pole. These vents can be opened or shut as desired to let out fumes and to regulate kitchen temperatures. The entire tent is covered by a fabric fly which reduces the solar load and permits the roof vents to be open even during inclement weather. The new system's field kitchen requirements were projected based on a typical small, medium, and large MFK configuration. The medium and large MFKs are depicted in Figs. 3 and 4. These three kitchens have all the necessary equipment (less refrigeration) to provide A, B, or T Ration meals. The small kitchen (not shown) is designed to feed up to 260 troops, the medium kitchen 261 to 450 troops, and the large kitchen from 451 to 1100 troops. Each kitchen contains exactly the same equipment items with the only difference being the quantity of each item and the amount of work space. These kitchens can also be complexed together to support feeding strengths above 1100 troops. For example, as shown in Figs. 5 and 6, large and medium MFKs can be joined to support up to 1550 troops, and two large MFKs can be joined to support up to 2200 troops from a single field kitchen.

For the small and medium MFKs, the sanitation function is within the kitchen shelter. In addition, no specific area is set aside for ration storage. However, for the large MFK, slightly over one section of kitchen tent is set aside for ration storage and the sanitation function is housed in a separate two-section tent. For these larger kitchen complexes (Figs. 5 and 6), both the ration storage and sanitation functions are housed in separate shelters.

The MFKs include several new field equipment items. These items eliminate the numerous equipment deficiences associated with current field kitchens. In essence, current authorized field feeding equipment consists of only four items: the range outfit for heating or cooking food items and beverages; the immersion heater with garbage cans for

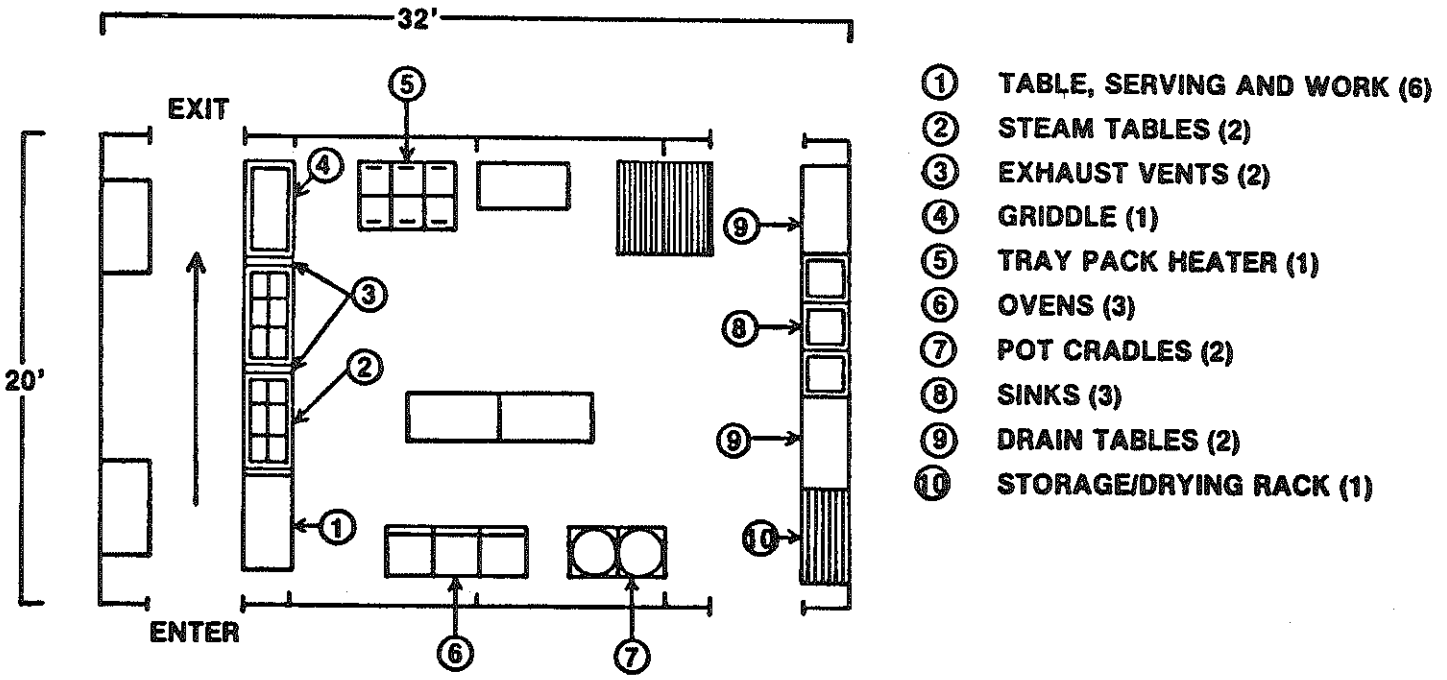

Figure 3. Medium Modular Field Kitchen (261 to 450 troops) for A, B, or T Rations.

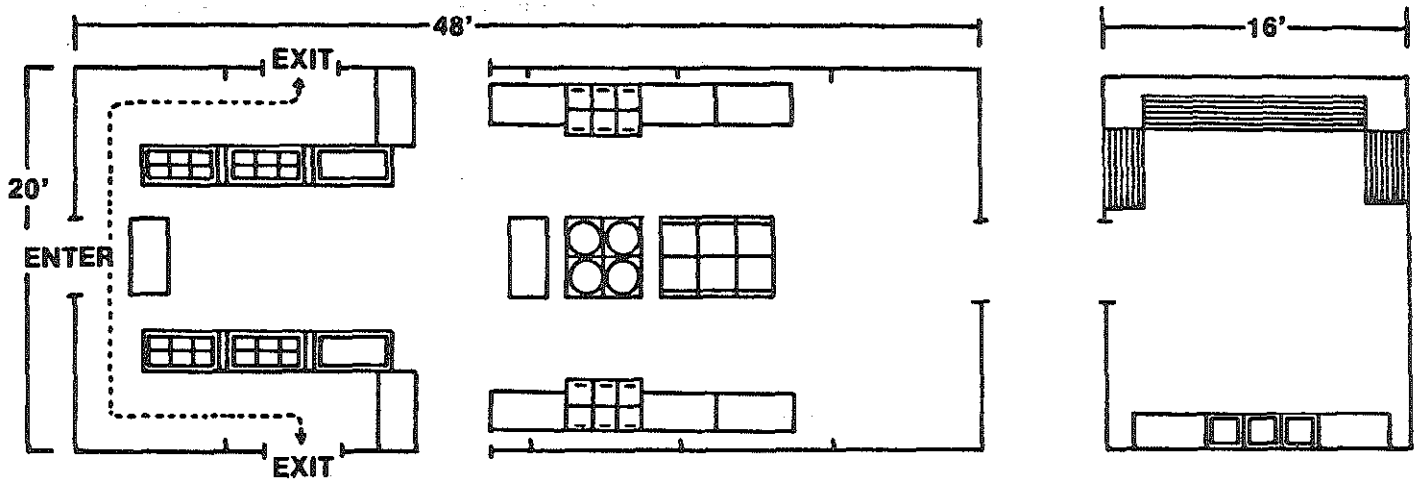

Figure 4. Large Modular Field Kitchen (451 to 1,100 troops) for A, B, or T Rations.

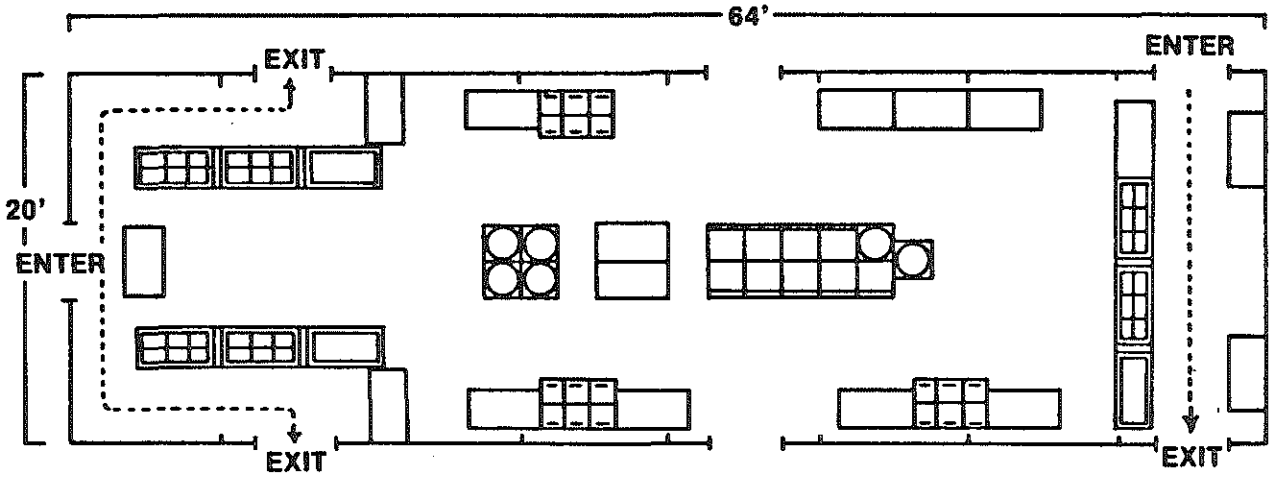

Figure 5. Complex of one Large and one Medium Modular Field Kitchen (1,361 to 1,550 troops) for A, B, or T Rations.

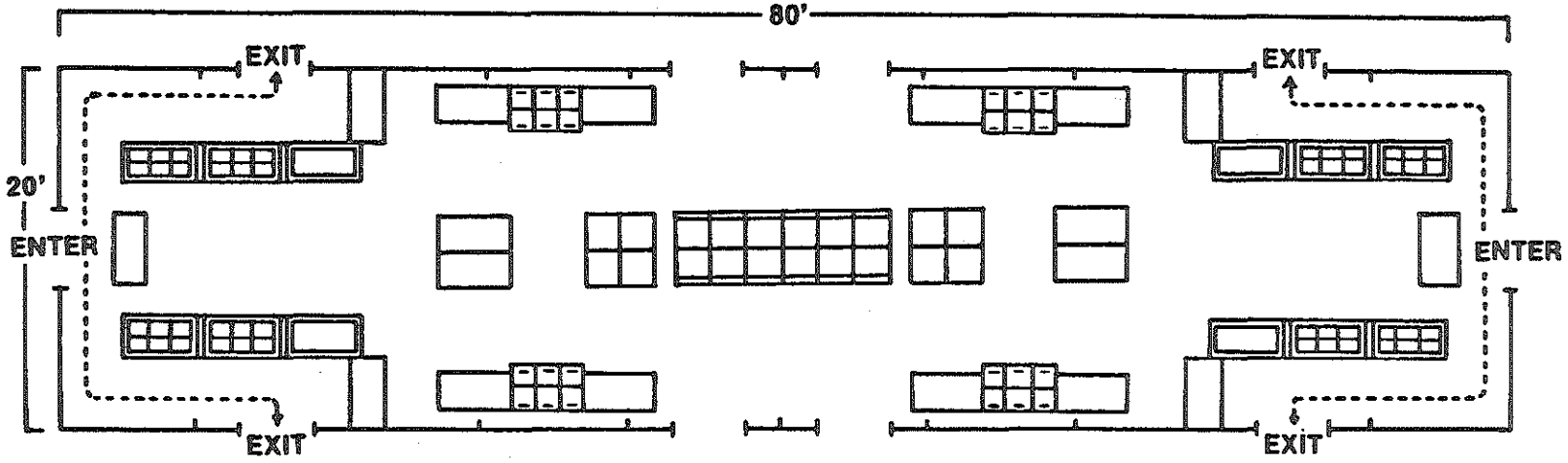

Figure 6. Complex of two Large Modular Field Kitchens (1,551 to 2,200 troops) for A, B, or T Rations.

sanitation of pots, pans and other kitchen items, and the insulated food container and beverage jugs for maintaining food and beverages hot or cold. Based on extensive field observations, the immersion heater and garbage can combination is considered inadequate for proper field sanitation due to the inability to submerse totally the larger pots and pans. In addition, current unit equipment authorizations provide for no serving or work tables, griddles, steamtables, or storage and drying racks. As a result, many units deploy to the field with additional nonauthorized items of equipment to permit them to perform better their field feeding function. These items typically represent either salvage from the garrison dining halls or unit-made equipment. By their nature, these items are not standard, variable between units, not designed for efficient packing. Furthermore, the items are often difficult or impossible to sanitize properly.

All new MFK items are designed to facilitate both easy and proper field sanitation. The items are made predominantly of stainless steel with the griddle top being made of an anodized aluminum. The items of equipment are made to facilitate easy and quick assembly and disassembly and to provide efficient (minimum volume) packing for mount-out purposes. In addition, the major parts of the various items are designed to be interchangeable. For example the legs of the serving and work tables, steamtables, and griddles, are identical. A brief description of each new major equipment item follows.

Serving and Work Tables

Serving and work tables, 2'W X 4'L, are the same dimension as the steamtables and griddles. For transport purposes, when disassembled, all three items can be efficiently packed in the same mount out box. Each table has two shelves. The top shelf is used as a serving or work table while the bottom shelf is intended for storage purposes.

Steamtables

The steamtable is designed to hold six Tray Packs or three full size steamtable pans. With an adaptor, the steamtable can hold two square-head pans instead. Each steamtable requires about two gallons of water which is heated by a single M-2 burner. The steamtable has a drain plug to facilitate rapid draining and cleaning after the meal period.

Griddles

The griddle top, which is made of anodized aluminum to facilitate easy cleaning, is reversible. A drain slot and chute permits easy removal of excess fat or food particles from the griddle top. For full use each griddle requires two M-2 burners. However, for reduced production levels, half of each griddle with only 1 M-2 burner only can be utilized.

Exhaust Vents

An exhaust vent is provided between each pair of griddles and steam tables. By natural convection, the excess heat and fumes coming off the

bottom of the griddles and steamtables is exhausted near the roof vents. As a result the heat and fumes are eliminated from the kitchen area and do not affect the food service personnel working the serving line or the troops going through the serving line.

Tray Pack Heater

For noncombat units, the MFK would be issued with Tray Pack heaters on the basis of one per serving line. This Tray Pack heater unit would be the same as that located on the MFSU with the exception that it would be skid mounted rather than trailer mounted.

Ovens

The ovens are designed for baking or roasting. Each oven can hold two square-heads or five standard field sheet pans. Unlike the current field range, the ovens provide the stable, uniform heat pattern required for successful field baking and roasting. However, other than for field baking and roasting, the current field range represents a proven and dependable item of equipment. Therefore, depending on specific menu items planned for future A or B Rations, it may be better to adopt some combination of ranges and ovens.

Pot Cradle

The pot cradle is designed to provide rapid heating or cooking of liquids or foods in the standard 15 gallon and 10 gallon pots. This item consists of a stand that holds the M-2 burner and supports the current standard pot cradle (a component of the field range). In addition an aluminum shroud is wrapped around the standard pot cradle stand. This shroud directs and holds the M-2 burner heat around the 15 or 10 gallon pot to facilitate rapid heating.

Sinks

The field sinks are sized to permit complete submersion of the largest cooking vessels (the 15 gallon pot and square head pan) for washing, rinsing and sanitizing purposes. The sinks are provided with drains and hoses to permit rapid drainage by gravity of waste water away from the sanitation area. Water within the sinks can be heated entirely by M-2 burners, or preheated by the M-80 hot water heating system and, as required, maintained hot by M-2 burners. The sanitation workload is a function of the number of troops supported. With the small and medium MFK, supporting 450 troops or less, the M-2 burner method of heating water is most likely sufficient. However due to increased sanitation workload, the M-80 hot water system is recommended with the large MFK.

M-80 Hot Water System (not shown)

This system (not shown in Figures 4, 5, or 6) consists primarily of the standard hot water heater associated with the shower and bath unit, a pump, and assorted hoses. The system provides a complete hot and cold water distribution system from the 400 gallon water trailer to the field

sinks. With the turning of a faucet the sinks can be filled with hot or cold water as desired. The hot water heater, on demand, provides five gallons of water, which is about 100°F above ambient. With this system the number of M-2 burners required in the sanitation center is reduced from three to one. Benefits of the system include the elimination of the labor-intensive need to hand-carry water in five gallon jugs from the water trailer to the sinks, and a significant reduction in the number of hours wasted by the KPs waiting for the M-2 burners to heat up the sanitation water to proper temperature.

Drain Tables

The drain tables are utilized both for stacking items requiring sanitation and as a place to scrape/scrub items as appropriate.

Storage/Drying Racks

These racks are provided for both drying and storing items following their sanitation.

CONCEPT OF OPERATIONS

The proposed new system provides a complete T, B, and A Ration preparation capability. Due to supply and resupply constraints, only the T and B Rations are feasible for the initial periods of a conflict. Compared to the B Ration, the benefits of the T Ration include increased frequency of hot meals, significantly reduced sanitation requirement, elimination of the need to assemble and mix several ingredients to make a single menu item, and consistent, uniform, highly acceptable quality products. In addition, the T Ration requires significantly less equipment and labor than the B Ration.

Because of the above, the proposed concept of operation is to deploy with only a T Ration capability and to then transition directly to an A Ration as the supply and combat situation permits. With this concept of operation, ground combat units would deploy with MFSUs only, and other units would deploy with reduced MFKs configured to provide T Rations only. For example, a unit supporting up to 1100 troops could deploy with the reduced (T Ration only) large MFK depicted in Fig. 7, rather than the large MFK shown in Fig. 4. This concept of operation permits units to deploy with a minimal amount of food service equipment. The remaining MFK equipment would then be deployed to the theater at a later time when the supply system permitted transitioning to an A Ration.

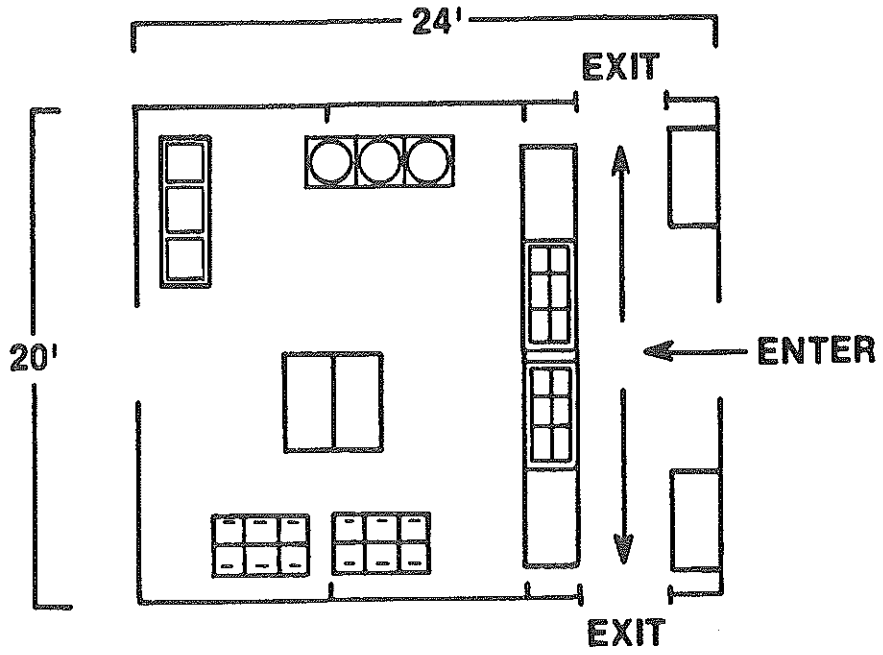

Figure 7. Large Modular Field Kitchen (451 to 1,100 troops) for T Rations

SYSTEM COST, RESOURCE, AND LOGISTICAL IMPACTS

The detailed evaluation of the USMC's current and proposed new field feeding systems relative to wartime cost, resource, and logistical impacts is presented in Appendices A through D. Both systems are evaluated based on the II MAF's (Marine Amphibious Force) field feeding requirements. The II MAF (which includes one division, one air wing, and one force service support group) represents a cross section of the USMC's field feeding requirements.

System cost, resource and logistics impacts are dependent on the type of bulk operational ration (A, B, or T Ration) and the mix of bulk and Meal Ready to Eat (MRE) rations, both of which vary as a function of the force component and time. Therefore, system impacts are projected based on expected or assumed ration mixes for three discrete time intervals in the evolution of a conflict. These ration mixes are presented in Table 2. The mixes for the current system with B or A Rations are from the USMC War Reserve Policy Manual, Chapter 3, Section 0303. For each time interval, the proportion of T Rations with the new system is assumed to be the same as the proportions of B Rations with the current system. However given the same tactical environment, the new system would permit a greater percentage of bulk T Rations than the current system would B Rations. Any shift to a larger proportion of bulk T Rations with the new system would increase the new systems' benefits by further reducing system cost and logistical impacts.

TABLE 2. System Ration Mixes[a]

System	Period	Marine Division	Force Service Support Group	Marine Air Wing
Baseline	1st 30 days	15 days B	15 days B	25 days B
	2nd 30 days	26 days B	26 days B	28 days B
	subsequent 30	26 days A	26 days A	28 days A
New	1st 30 days	15 days T	15 days T	25 days T
	2nd 30 days	26 days T	26 days T	28 days T
	subsequent 30	26 days A	26 days A	28 days A

[a] Average number and type bulk ration per person per first, second, and subsequent 30 day periods. Remaining rations are MREs.

STAFFING REQUIREMENTS

Baseline (current) and new system staffing requirements, to include food service personnel and Kitchen Police (KP), are summarized in Table 3. The development of these requirements is detailed in Appendix A.

TABLE 3. Baseline and New System Staffing Requirements[a]

	Baseline System	New System			
	B/A Rations	T Rations		A/T Rations	
Type Person	No. Req.	No. Req.	% Red.	No. Req.	% Red.
Food Service Personnel	961	618	36%	961	0%
Kitchen Police (KPs)	1,831	336	82%	627	66%
Total	2,792	954	66%	1,588	43%

[a] Based on II MAF's field feeding requirements.

The baseline system is staffed for a B or A Ration capability. Previous Natick R&D Center projects have shown that the workloads generated by (and therefore staffing requirements for) a B or A Ration are the same.[1,2] Baseline system food service personnel requirements reflect actual II MAF Table of Organization (T/Os) authorizations. In accordance with the "Personnel Requirements Criteria Manual, Chapter 4," baseline system KP requirements are established on the basis of one per 25 troops or major fraction supported.

Two separate staffing requirements are developed for the new system, one for a T Ration only capability and the other for an A or T Ration capability. The new system T Ration staffing level is designed to provide a three hot T Ration meal capability when feeding at the field kitchen level and a two hot T Ration meal capability when supporting troops at multiple remote sites with MFSUs. Work measurement data collected during the Cold Weather 83[3] field test confirm that the new system T Ration staffing levels are more than sufficient to satisfy the system design criteria.

As shown in Table 3, the new system with a T Ration only capability offers a 36%, 82%, and 66% reduction in food service personnel, KP, and total personnel requirements, respectively, relative to the baseline (current) system. These reductions are primarily attributable to the T Ration, which essentially eliminates the food preparation and sanitation workloads, and the use of disposable messgear. If the new system utilized permanent messkits rather than disposable messgear, the KP savings would be reduced by about 450 personnel. With an A or T Ration capability, the new system provides no reduction in food service personnel requirements but still offers a 66% and 43% reduction in KP and total personnel requirements, respectively. The reduction in KP requirements is primarily attributable to the improved sanitation equipment, new kitchen equipment and layouts, and the use of disposable messgear. With the new system, a task force could deploy with a T Ration capability only. However, to permit transition to an A Ration capability, the additional food service personnel would need to be maintained in the force structure.

Based on Table 3, an alternative staffing strategy would be to deploy with the number of food service personnel required for the A Ration capability. With this plan, during the initial stages of a

conflict with T Rations, food service personnel could perform all the workloads and no KPs would be necessary. The required number of KPs would then be drawn from the supported units only when the system transitioned to A Rations.

SYSTEM COSTS

The baseline and new system cost impacts are summarized in Table 4 for each of the three ration mixes. For detailed derivation of these impacts see Appendix C, System Cost/Resource Analysis. Relative to the information provided in Table 4, the following points are noted.

- Compared to the baseline system, the new system offers an annual cost savings of $15M, $9M, and $14M, respectively, as it transitions from a 62% T, to an 89% T, to an 89% A Ration mix. Note the remainder of the rations are provided as individual operational rations, i.e., the Meal Ready To Eat (MRE).

- Rations represent the major portion of each system's total cost. For the new system, rations represent a larger percent of total system cost due to both a higher T Ration cost and a lower total system cost.

- With T Rations, the new system offers a significant reduction in food service personnel and KP requirements. This reduction translates into a $28M annual cost savings. When the new system transitions to A Rations only, KP requirements are reduced with a $17M annual cost savings.

- Rations and personnel combined represent the most significant portion of each system's total cost. For the baseline system with B Rations, the two items account for 90-93% of total system cost, while for the new system with T Rations, they account for 87-91% of total system cost. From a system cost standpoint, all other cost factors combined (including transportation, equipment, fuel, water, and disposables) are insignificant.

- New system fuel and water requirements, and thus costs, are significantly less than the baseline system due to the use of disposable messgear, T Rations, and new sanitation equipment.

- The baseline system assumes permanent messkits and therefore incurs no cost for disposables. For the new system, the cost of disposables is more than offset by the cost savings attributable to reduced water, fuel, and KP requirements (see Appendix D, Cost Analysis of Permanent and Disposable Messgear Alternatives).

TABLE 4. Baseline and New System Annual Cost Summary
(Millions $ and % Total Annual System Cost)

Cost Component	Baseline System			New System		
	62% B[a]	89% B[a]	89% A[a]	62% T[a]	89% T[a]	89% A[a]
Food Service Personnel	18.86 12%	18.86 15%	18.86 13%	12.13 9%	12.13 10%	18.86 15%
KPs	26.58 17%	26.58 21%	26.58 19%	4.87 3%	4.87 4%	9.10 7%
Rations	100.06 64%	68.13 54%	74.66 53%	111.88 79%	85.56 73%	74.66 59%
Transportation	5.06 3%	4.10 3%	12.15 9%	5.39 4%	4.60 4%	12.15 10%
Equipment	1.21 1%	1.21 1%	1.21 1%	1.54 1%	1.54 1%	1.54 1%
Fuel	4.03 3%	5.92 5%	5.92 4%	0.24 0%	0.35 0%	2.09 2%
Water	0.92 1%	1.25 1%	1.25 1%	1.25 1%	0.29 0%	0.43 0%
Disposables	0.00 0%	0.00 0%	0.00 0%	5.40 4%	7.72 7%	7.77 6%
Total	156.72	126.05	140.63	141.70	117.06	126.60

[a] Remainder of rations are individual rations, i.e. MREs.

Baseline and new system annual costs, based on the B and T Ration, respectively, are depicted in Fig. 8 as a function of the percentage of bulk rations. Total cost for both systems declines as the percentage of bulk rations increases. This cost reduction is primarily attributable to the reduced consumption of the much more costly MRE individual rations. However, for a given percentage of bulk rations, the new system always results in a net cost reduction. The resulting new system cost savings, both in terms of millions of dollars per year and dollars per ration, is presented in Fig. 9. Cost savings attributable to the new system decline linearly from $29.14M per year ($1.748/ration) at 0% bulk rations to $6.55M per year ($0.392/ration) at 100% bulk rations. These cost savings, as a function of the percentage of bulk rations, are defined by the following equations:

$$\$M/Yr = 29.14 - 22.59\ X \qquad 0 \leq X \leq 1$$
$$\$/Ration = 1.748 - 1.356\ X \qquad 0 \leq X \leq 1$$

where X represents the fraction of bulk rations.

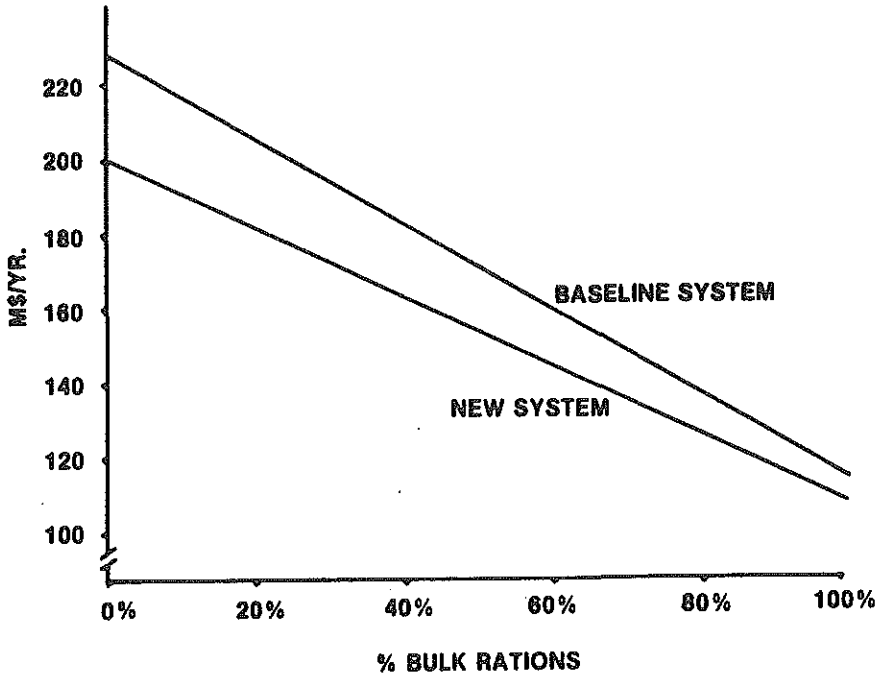

Figure 8. System annual cost (M$/yr) comparison as a function of percent bulk rations.

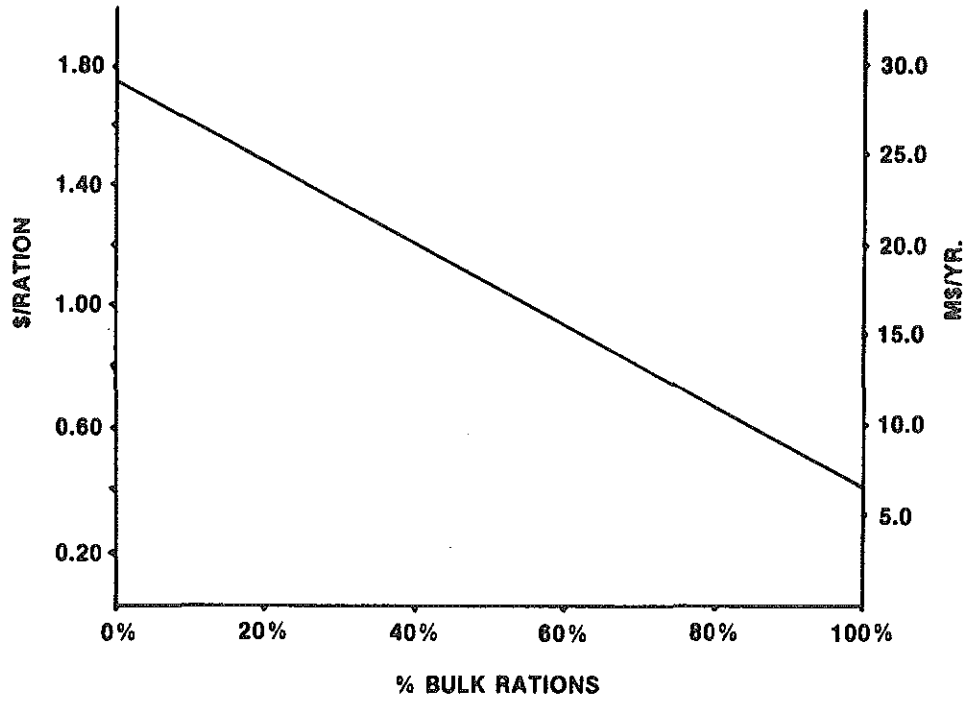

Figure 9. New system annual cost savings ($/ration and M$/yr) as a function of percent bulk rations.

The above cost savings (and equations) assume that both the baseline and new system provide the same fraction of bulk ration. However, given the performance characteristics of the new system, for a given tactical environment, the new system would permit a larger percentage of T Rations than the baseline system would B Rations. Referring to Figure 8, any shift to a larger percentage of T Rations would result in even a larger cost savings attributable to the new system. New system cost savings, incorporating a shift in the percentage of bulk rations, are defined by the following equations:

$$\$M/Yr = 29.14 - 22.59X + 92.47S$$
$$\$ \text{ Ration} = 1.748 - 1.356X + 5.544S$$

$$\text{where } 0 \leq X, S, X + S \leq 1$$

In the above equations X represents the proportion of bulk B Rations provided by the baseline system and S represents the increase in the proportion of bulk T rations provided by the new system. For example, if the baseline system provided only 40% B Rations while the new system would provide 50% T Rations, then

$$X = 0.40,$$
$$S = 0.10, \text{ and}$$
$$X + S = 0.50$$

The resulting cost savings attributable to the new system would then be \$29.35M per year or \$1.760 per ration. By referring back to the last two equations, it is easy to see that each 1% (S=0.01) increase in the proportion of T Rations results in an additional new system cost savings of \$0.92M per year or \$0.055 per ration.

FUEL REQUIREMENTS

As shown by Table 5, the new system offers significant reductions in fuel requirements compared to the baseline system. With T Rations the new system offers a 94% reduction in fuel requirement, of which 65% is attributable to the use of disposables. The remaining 29% reduction is attributable to the use of T Rations rather than B Rations. When the new system transitions to A Rations, the entire 65% reduction is due to the use of disposables.

TABLE 5. Baseline and New System Fuel Requirements

Baseline System		New System		
Ration Mix	Fuel Req't (Gal/Day)	Ration Mix	Fuel Req't (Gal/Day)	% Reduction
62% B	8,746	62% T	523	94%
87% B	12,880	87% T	751	94%
87% A	12,880	87% A	4,550	65%

WATER REQUIREMENTS

System water requirements are presented in Table 6. The new system reduces food service water requirements by 66% to 77%. With T Rations, about 12% of the reduction is attributable to the reduced sanitation requirement. The remainder of the reduction is due to the use of disposable messgear. With A Rations, the entire reduction is due to the use of disposable messgear.

TABLE 6. Baseline and New System Water Requirements

Baseline System		New System		
Ration Mix	Water Req't (Gal/Day)	Ration Mix	Water Req't (Gal/Day)	% Reduction
62% B	140,000	62% T	38,000	73%
87% B	190,000	87% T	44,000	77%
87% A	190,000	87% A	65,000	66%

LOGISTICAL IMPACTS

Because of their low density, the logistical or transportation impact of rations is a function of their volume rather than their weight. The average volume per B, T, and MRE Ration is 0.1054, 0.1225, and 0.2075 ft^3 respectively. Based on these volumes, the logistical impacts of T and MRE Rations are 16% and 97% larger than the B Rations. From a logistical impact standpoint (and a cost standpoint as well), the proportion of MRE rations utilized should be minimized to those situations where bulk rations are not possible. Compared to the baseline system, the use of T Rations with the new system would reduce the proportion of MRE rations required.

The relative transportation impacts of various baseline and new system ration mixes for the II MAF are presented in Table 7 in terms of 40 foot container loads per day. These impacts assume that the proportion of T Rations with the new system is the same as the proportion of B Rations with the baseline system. As shown, the new system results in a small 1% to 6% increase in transportation requirements when the percent bulk rations is between 20% and 60%, as during the initial periods of conflict. Only when the proportion of bulk ration reaches the 80% to 100% range does the new system result in a 10% to 16% increase in transportation.

TABLE 7. Relative Transportation Impact of Baseline and New System Ration Mixes (40' Container Loads/Day)

% Bulk Rations	Baseline System (B Ration/MRE)	New System (T Ration/MRE)	Increase %
100	2.05	2.37	16
80	2.45	2.70	10
60	2.85	3.05	6
40	3.25	3.36	3
20	3.65	3.69	1
0	4.04	4.01	-1

However, the new system reduces the proportion of MRE rations required. Table 8 presents baseline and new system ration mixes, which result in the same logistical impact. As shown, a 40% B/60% MRE mix and a 48% T/52% MRE mix result in the same total logistical impact. That is, the increased volume of T Rations compared to B Rations is offset by the reduced transportation requirement for MRE rations. Referring to the other entries in Table 8, it is easy to see that both systems result in the same logistical impact if the percentage of T Rations with the new system is 1.2 times the percentage of B Rations with the old system. For larger increases in the percentage of T Rations (i.e. more that 1.2 times the percent B Rations) the total logistical impact of the new system would be less than the baseline system.

TABLE 8. Equivalent Ration Mix Logistical Impacts

Avg. Volume (Ft^3) Per Ration	Baseline System		New System	
	B Ration %	MRE %	T Ration %	MRE %
0.1258	80	20	96	4
0.1462	60	40	72	28
0.1667	40	60	48	52
0.1871	20	80	24	76
0.2075	0	100	0	100

PERMANENT VERSUS DISPOSABLE MESSGEAR

The detailed cost analysis of three messgear alternatives, including the current USMC permanent messkit system, a disposable system, and a disposable system with a permanent messkit backup is presented in Appendix D. The results of this analysis are summarized in Table 9. As shown, both the disposable system and a disposable system with a permanent messkit backup are less expensive than the current permanent messkit system. In addition, the costs savings attributable to these two systems increases as a function of the number of hot meals per day.

TABLE 9. Annual Messgear Cost and Cost Savings Per Individual

System	Bulk Ration Meals per Day		
	1 Meal	2 Meals	3 Meals
Permanent Messkit System	$103.44	$193.97	$284.49
Disposable System	62.54	125.07	187.61
Disposable System with Permanent Messkit Backup	75.46	137.99	200.53
Cost Savings: Disposable System	$ 40.90	$ 68.90	$ 96.88
Cost Savings: Disposable System with Permanent Messkit Backup	27.98	55.98	83.96

Other benefits of a disposable system include reduced KP, fuel, and water requirements due to the elimination of the messkit washline; elimination of potential messkit sanitation problems, and improved customer satisfaction. Disadvantages of a disposable system include the need to deliver the disposables to the theater and the need to dispose of them after use.

RECOMMENDATIONS

The proposed new field feeding system has the responsiveness, mobility, and flexibility characteristics required to support the USMC's combat role of the future and to ensure that combat troops receive frequent and highly acceptable hot meals. In addition the system offers significant reductions in total costs, manpower, fuel, and water requirements. Specific recommendations include:

- The T Ration be adopted as the USMC's standard bulk operational ration,
- MFSUs be allocated on the basis of 2 per combat battalion,
- MFKs be allocated on the basis of assigned field kitchen feeding strengths, and
- disposable messgear be adopted, and, if necessary, permanent messgear be maintained as a backup.

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APPENDIX A

Baseline and New System Staffing Requirements and Field Kitchen Feeding Strengths for II Marine Amphibious Force (MAF)

The USMC's current (baseline) and proposed new field feeding systems are both evaluated based on the II MAF's field feeding requirements. The II MAF (which includes one division, one air wing, and one force service support group) represents a cross section of the USMC's field feeding requirements.

Tables A1 through A3 present the detailed staffing requirements of the 2nd Marine Division, 2nd Marine Air Wing, and 2nd Force Service Support Group (which make up the II MAF) for both the baseline and proposed new system. Two separate staffing levels are provided for the new system, one for a T Ration only capability and one for an A, B, or T Ration capability.

A brief explanation of Tables A1 through A3 follows. In the column titled, "Unit Designation," indented units are provided field food service support by the nonindented unit immediately above. Referring to Table A1, the 2nd Division has 10 Infantry Battalions. In turn, each battalion consists of 1 Headquarters and Support Company, 3 Rifle Companies, and 1 Weapons Company. The column titled, "Unit Str," lists the number of non-food-service personnel per company. As listed, the Headquarters and Support Company Infantry Battalion has 254 assigned non-food-service personnel. In addition, each Headquarters and Support Company, Infantry Battalion provides food service support to the other units of the same battalion, to include three Rifle Companies and 1 Weapons Company. Therefore, each Headquarters and Support Company Infantry Battalion provides field food service support to a total of 940 non-food-service personnel.

Food service personnel staffings for the baseline system represent the actual II MAF Table of Organization (T/O's) authorizations. Based on the "Personnel Requirements Criteria Manual, Chapter 4," baseline system KP requirements are established on the basis of 1 per 25 non-food-service troops, or major fraction thereof supported. As shown in Table A1, with the baseline system, each infantry battalion is authorized 26 food service personnel and 38 KPs. For the division's 10 infantry battalions, this multiplies into a total authorization of 260 food service personnel and 380 KPs.

The staffing criteria for the new system are presented in Table A4. With the new system two separate staffing levels are developed for nonmedical units. The first level is for a T Ration capability only while the second is for an A/B or T Ration capability. As shown in Table A4, T Ration staffing levels are a function of the type equipment authorized and the number of troops supported. The new system T Ration staffing criteria are designed to provide a three hot T Ration meal capability when feeding at the Modular Field Kitchen (MFK) level, and a

two hot T Ration meal capability when supporting troops at multiple sites with Mobile Food Service Units (MFSUs).

With the exception of the Headquarters Battalion, divisional units are authorized both MFSUs and MFKs. The division headquarters battalion, and all MAW and FSSG units are authorized MFKs only. With the new system, all food service personnel and equipment are assigned to the same units, which currently provide field food service support. For example, the Headquarters and Support Company Infantry Battalion is authorized one large MFK and two MFSUs to support 940 troops. For divisional units authorized both MFSUs and MFKs, the staffing authorization is the larger of that based on the one large MFK and MFSU staffing criteria. For example, based on the one large MFK, an infantry battalion would be authorized only 9 food service personnel and 6 KPs. However, based on the larger MFSU criteria, the battalion is authorized a total of 16 food service personnel and 6 KPs. As a result, with the new system's MFSUs, MFKs, and T Rations, an infantry battalion is authorized 16 food service personnel and 6 KPs. All of the food service personnel are assigned and organic to the Headquarters and Support Company, Infantry Battalion while the KPs are drawn from the supported units on an as-required basis.

Due to patient feeding requirements, medical units are staffed with a T or A Ration capability initially and do not transition from a T Ration to an A Ration capability as nonmedical units do. Therefore, new system medical unit food service personnel staffings are the same as the baseline system's T/O food service personnel authorization. However, due to improved sanitation equipment and the use of disposable messgear, new system medical unit KP requirements are greatly reduced.

Table A5 represents a consolidation of Tables A1 through A3 and summarizes the number and sizes of the II MAF's field kitchen feeding strengths. The number and the sizes of MFKs required with the new system is based upon these feeding strengths.

Table A6 summarizes the total II MAF feeding strengths with the baseline and proposed new system. Total feeding strengths are determined by adding the number of food service personnel required with each system to the number of non-food-service personnel authorized in the II MAF. System KP requirements are drawn from the non-food-service personnel and therefore not added in to determine total feeding strengths. These total feeding strengths are utilized in Appendix C to establish the cost and resource impact of both the baseline and proposed new field feeding systems.

TABLE A1. 2nd Marine Division - Baseline and New System Staffing Levels

Unit Designation	Unit Str[a]	No.	Feeding Strength[a] Per Unit	Feeding Strength[a] Total	System/Staffing Levels: Baseline (A/B) Per Unit FSP	Baseline (A/B) Per Unit KP	Baseline (A/B) Total FSP	Baseline (A/B) Total KP	New (T) Per Unit FSP	New (T) Per Unit KP	New (T) Total FSP	New (T) Total KP	New (A/B/T) Per Unit FSP	New (A/B/T) Per Unit KP	New (A/B/T) Total FSP	New (A/B/T) Total KP
Serv Co, Hq Bn	110	1	1,393	1,393	24	56	24	56	14	9	14	9	24	19	24	19
Div Hq, Hq Bn	371	1														
Hq Co, Hq Bn	227	1														
MP Co, Hq Bn	127	1														
Comm Co, Hq Bn	322	1														
Truck Co, Hq Bn	236	1														
Hq Co, Inf Regt	223	3	223	669	5	9	15	27	4	2	12	6	5	3	15	9
H&S Co, Inf Bn	254	10	940	9,400	26	38	260	380	4	2	40	20	26	13	260	130
Rifle Co, Inf Bn	180	30							3	1	90	30				
Weapons Co, Inf Bn	146	10							3	1	30	10				
Hq Btry, Arty Regt	288	1	288	288	9	12	9	12	5	3	5	3	9	4	9	4
Hq Btry, D/S Bn	190	3	682	2,046	16	27	48	81	3	1	9	3	16	9	48	27
105 How Btry, D/S Bn	123	9							2	1	18	9				
155 How Btry (T), D/S Bn	123	3							2	1	6	3				
Hq Btry, G/S Bn	194	1	400	400	13	16	13	16	3	1	3	1	13	5	13	5
155 How Btry, G/S Bn	103	2							2	1	4	2				
Hq Btry, G/S Bn	221	1	548	548	16	22	16	22	3	1	3	1	16	7	16	7
8" How Btry, G/S Bn	109	2							2	1	4	2				
175 Btry, G/S Bn	109	1							2	1	2	1				
H&S Co, Recon Bn	123	1	372	372	12	15	12	15	2	1	2	1	12	5	12	5
Recon Co, Recon Bn	83	3							2	1	6	3				

TABLE A1 cont. 2nd Marine Division - Baseline and New System Staffing Levels

Unit Designation	Unit Str[a]	No.	Feeding Strength[a] Per Unit	Feeding Strength[a] Total	System/Staffing Levels: Baseline (A/B) Per Unit FSP	Baseline (A/B) Per Unit KP	Baseline (A/B) Total FSP	Baseline (A/B) Total KP	New (T) Per Unit FSP	New (T) Per Unit KP	New (T) Total FSP	New (T) Total KP	New (A/B/T) Per Unit FSP	New (A/B/T) Per Unit KP	New (A/B/T) Total FSP	New (A/B/T) Total KP
H&S, Co, Eng Bn	144	1	794	794	25	32	25	32	3	1	3	1	25	11	25	11
Cmbt Eng Co, Eng Bn	119	3							2	1	6	3				
Eng Supt Co, Eng Bn	293	1							4	2	4	2				
H&S Co, Tank Bn	321	1	321	321	13	13	13	13	5	3	5	3	13	4	13	4
Tank Co, Tank Bn	102	4	102	408	5	4	20	16	3[b]	1	12	4	5	1	20	4
AT(TOW) Co, Tank Bn	246	1	246	246	8	10	8	10	4	2	4	2	8	3	8	3
H&S Co, AAV Bn	253	1	253	253	8	10	8	10	4	2	4	2	8	3	8	3
AAV Co, AAV Bn	221	4	221	884	5	9	20	36	4	2	16	8	5	3	20	12
Total	-	-	-	18,022	-	-	491	726	-	-	302	129	-	-	491	243

[a] Strength excludes food service personnel.
[b] Due to small size, T Ration staffing set at 3 FSP and 1 KP, not staffing guides 4 FSP and 2 KPs.

TABLE A2. 2nd Marine Air Wing (MAW) - Baseline and New System Staffing Levels

Unit Designation	Unit Str[a]	No.	Feeding Strength[a]		System/Staffing Levels											
					Baseline (A/B)				New (T)				New (A/B/T)			
			Per Unit	Total	Per Unit		Total		Per Unit		Total		Per Unit		Total	
					FSP	KP	FSP	KP	FSP	KP	FSP	KP	FSP	KP	FSP	KP
HQ, MAW	279	1	279	279	9	11	9	11	5	3	5	3	9	4	9	4
MWHS-2	340	1	951	951	42	38	42	38	9	6	9	6	42	13	42	13
AWTU 2/3, MWHS	45	1														
MWHS ADP Aug Unit	4	1														
TMU, MWHS	1	1														
TME (Fixed Wing), MWHS	9	1														
H&HS, MACG	192	1														
MWCS	360	1														
Hq Sqdrn,MWSG	95	1	1,305	1,305	32	52	32	52	13	8	13	8	32	17	32	17
MWWU	49	1														
WES	414	1														
WTS	250	1														
Det A, MWSG	293	1														
Det B, MWSG	204	1														
H&S Btry, LAAM Bn	305	1	305	305	8	12	8	12	5	3	5	3	8	4	8	4
Missile Btry, LAAM Bn	126	3	378	378	4	5	12	15	4	2	12	6	4	2	12	6
FAAD Btry, MACG	229	1	229	229	9	9	9	9	4	2	4	2	9	3	9	3
MACS/MTDS, MACG	259	1	259	259	7	10	7	10	4	2	4	2	7	3	7	3
MASS, MACG	237	1	237	237	6	9	6	9	4	2	4	2	6	3	6	3

TABLE A2 cont. 2nd Marine Air Wing (MAW) - Baseline and New System Staffing Levels

Unit Designation	Unit Str[a]	No.	Feeding Strength[a] Per Unit	Feeding Strength[a] Total	System/Staffing Levels: Baseline (A/B) Per Unit FSP	Baseline (A/B) Per Unit KP	Baseline (A/B) Total FSP	Baseline (A/B) Total KP	New (T) Per Unit FSP	New (T) Per Unit KP	New (T) Total FSP	New (T) Total KP	New (A/B/T) Per Unit FSP	New (A/B/T) Per Unit KP	New (A/B/T) Total FSP	New (A/B/T) Total KP
MABS-14, MAG-14	264	1	3,076	3,076	34	123	34	123	27	18	27	18	34	41	34	41
H&MS-14	474	1														
H&MS Supplement	11	1														
MABS Supplement	7	1														
VMA(AW) 10 A6E	297	3														
VMGR-252/18 KC-130	605	1														
VMAQ 7EA-6A/B	360	1														
VMAT(AW) 13A6/3TC4C	364	1														
Airb. Rad. Oper. Sch.	4	1														
MATCS, MACG (33%)	96	1/3														
Det VMAQ 4EA6B, MAG-14	218	2	436	436	6	9	12	18	4	2	8	4	6	3	12	6
MABS-31, MAG-31	264	1	2,686	2,686	34	107	34	107	27	18	27	18	34	36	34	36
H&MS-31	474	1														
H&MS Supplement	48	1														
VMFA 12 F4J	299	6														
TME (Fixed Wing)	9	1														
MATCS, MACG (33%)	97	1/3														
MACS/MTDS, MAG-31	259	1	259	259	7	10	7	10	4	2	4	2	7	3	7	3
MABS-32, MAG-32	264	1	2,195	2,195	34	88	34	88	18	12	18	12	34	29	34	29
H&MS-32	474	1														
H&MS Supplement	62	1														
VMAT 8AV-8A/7AV-8A	242	1														
VMA 15AV-8A	276	2														
VMA 19A4	252	2														
MATCS, MACG (33%)	97	1/3														

TABLE A2 cont. 2nd Marine Air Wing (MAW) - Baseline and New System Staffing Levels

Unit Designation	Unit Str[a]	No.	Feeding Strength[a] Per Unit	Feeding Strength[a] Total	System/Staffing Levels: Baseline (A/B) Per Unit FSP	Baseline (A/B) Per Unit KP	Baseline (A/B) Total FSP	Baseline (A/B) Total KP	New (T) Per Unit FSP	New (T) Per Unit KP	New (T) Total FSP	New (T) Total KP	New (A/B/T) Per Unit FSP	New (A/B/T) Per Unit KP	New (A/B/T) Total FSP	New (A/B/T) Total KP
MABS-26, MAG-26	208	1	2,744	2,744	36	110	36	110	27	18	27	18	36	37	36	37
H&MS-26	354	1														
H&MS Supplement	37	1														
H&MS Augmentation	10	1														
MABS Supplement	7	1														
HMM 18CH46F	247	2														
HMM 12CH46F	191	3														
HMH 16CH53D	258	2														
HMH 15CH53E	297	1														
HMT 10CH46/9CH53	248	1														
MABS-29, MAG-29	208	1	1,699	1,699	36	68	36	68	18	12	18	12	36	23	36	23
H&MS-29	427	1														
HMA 24AH1J/T	374	1														
HML 24UH1N	312	1														
VMO 18 OV-10A	244	1														
HMLTE 6UHIN	46	1														
HMA (TE) 6AH-1J	73	1														
Nav. Av. Obs. School	6	1														
TME (HELO)	9	1														
Total	-	-	-	17,038	-	-	318	680	-	-	185	116	-	-	318	228

[a] Strength excludes food service personnel.

TABLE A3. 2nd Force Service Support Group (FSSG) Baseline and New System Staffing Levels

Unit Designation	Unit Str[a]	No.	Feeding Strength[a]		System/Staffing Levels											
					Baseline (A/B)				New (T)				New (A/B/T)			
			Per Unit		Per Unit		Total		Per Unit		Total		Per Unit		Total	
				Total	FSP	KP	FSP	KP	FSP	KP	FSP	KP	FSP	KP	FSP	KP
H&S Co, H&S Bn	750	1	6,175	6,175	58	247	58	247	54	36	54	36	58	81	58	81
Serv Co, H&S Bn	548	1														
Commo Co, H&S Bn	367	1														
MP Co, H&S Bn	204	1														
H&S Co, Supply Bn	432	1														
Ammo Co, Supply Bn	398	1														
Ration Co, Supply Bn	185	1														
Supply Co, Supply Bn	465	1														
Med Log Co, Supply Bn	46	1														
H&S Co, Mnt Bn	156	1														
Elec Mnt Co, Mnt Bn	211	1														
Eng Mnt Co, Mnt Bn	239	1														
Ord Mnt Co, Mnt Bn	279	1														
MT Mnt Co, Mnt Bn	419	1														
GS Mnt Co, Mnt Bn	374	1														
H&S Co, MT Bn	183	1														
Transport Co, MT Bn	228	1														
Truck Co, MT Bn	321	1														
MTV Co, MT Bn	115	1														
H&S Co, Dental Bn	16	1														
Dental Co, Dental Bn	62	3														
Topo Platoon	53	1														
H&S Co, Eng Supt Bn	150	1	1,670	1,670	23	67	23	67	18	12	18	12	23	22	23	22
Eng Spt Co, Eng Spt Bn	388	1														
Bridge Co, Eng Spt Bn	137	1														
Bulk Fuel Co,Eng Spt Bn	304	2														
Eng Co, Eng Spt Bn	129	3														
H&S Co, Med Bn	280	1	780[b]	780	22	31	22	31	22	20	22	20	22	20	22	20
Med Co, Med Bn	100	5														

TABLE A3 cont. 2nd Force Service Support Group (FSSG) Baseline and New System Staffing Levels

Unit Designation	Unit Str[a]	No.	Feeding Strength[a] Per Unit	Feeding Strength[a] Total	System/Staffing Levels: Baseline (A/B) Per Unit FSP	Baseline (A/B) Per Unit KP	Baseline (A/B) Total FSP	Baseline (A/B) Total KP	New (T) Per Unit FSP	New (T) Per Unit KP	New (T) Total FSP	New (T) Total KP	New (A/B/T) Per Unit FSP	New (A/B/T) Per Unit KP	New (A/B/T) Total FSP	New (A/B/T) Total KP
Hosp Co, Med Bn	216	1	216[c]	262	16	9	16	9	16	9	16	9	16	9	16	9
H&S Co, L&S Bn	295	1	881	881	13	35	13	35	9	6	9	6	13	12	13	12
Landing Spt Co, L&S Bn	68	3														
B&P Co, L&S Bn	382	1														
Hq Co, Comm Bn	199	1	759	759	17	30	17	30	9	6	9	6	17	10	17	10
Comm Co, Comm Bn	203	1														
Long Line Co, Comm Bn	208	1														
Comm Spt Co, Comm Bn	149	1														
Force Recon Co	151	1	151	151	3	6	3	6	3[d]	2	3	2	3	2	3	2
ANGLICO	271	1	0[e]	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	-	-	-	10,632	-	-	152	425	-	-	131	91	-	-	152	156

[a] Strength excludes food service personnel.
[b] Plus 360 patients, maximum.
[c] Plus 200 patients, maximum.
[d] New system T Ration FSP staffing maintained at 3, not 4 as authorized by new system staffing criteria.
[e] Supported by non USMC units.

TABLE A4. New System Staffing Criteria

Type Unit (Rations)	Type Equipment Authorized	Authorization Criteria			
Nonmedical (T)	Mobile Food Service Units (MFSUs)	Per Company	Company Size	Authorization FSP	KP
			0-125	2	1
			126-225	3	1
			226-325	4	2
	Modular Field Kitchens (MFKs)	Per MFK	Type Kitchen (Size)	Authorization FSP	KP
			Small (1-260)	4	2
			Medium (261-450)	5	3
			Large (451-1100)	9	6
	MFSUs and MFKs	At the MFK feeding level, the larger of the combined company MFSU authorization, or the MFK authorization.			
Nonmedical (A/T)	MFKs	At the MFK feeding level FSP - current T/O authorization. KPs - 1 per 75 unit personnel, or major fraction.			
Medical (A/T)	MFKs	FSP - current T/O authorization. KPs - 1 per 75 unit personnel, or major fraction. 1 per 35 patients, or major fraction.			

TABLE A5. Summary of MAF Field Kitchen Feeding Strengths

Division		MAW		FSSG	
No.	Fed/Kitchen	No.	Fed/Kitchen	No.	Fed/Kitchen
4	102	3	126	1	151
4	221	2	218	1	216
3	223	1	229	1	759
1	246	1	237	1	780
1	253	2	259	1	881
1	288	1	279	1	1,670
1	321	1	305	3	2,058(6,175)
1	372	1	951		
1	400	1	1,305		
1	548	1	1,699		
3	682	1	2,195		
1	794	1	2,686		
10	940	1	2,744		
1	1,393	1	3,076		

TABLE A6. Baseline and New System Feeding Strengths

Force Component	Non-Food-Service Personnel	System					
		Baseline		New			
		B/A Rations		T Rations		T/B/A Rations	
		FSP	Total	FSP	Total	FSP	Total
Division	18,022	491	18,513	302	18,324	491	18,513
MAW	17,038	318	17,356	185	17,223	318	17,356
FSSG	10,632	152	10,784	131	10,763	152	10,784
MAF	45,692	961	46,653	618	46,310	961	46,653

APPENDIX B

Cost and Logistical Parameters of Ration Alternatives

This appendix details the development of the cost and logistical parameters of the A, B, T, and MRE Rations. From a ration standpoint, the difference between the USMC's current and proposed new field feeding system is the replacement of B Ration by the T Ration. Both systems utilize the Meal-Ready-To-Eat (MRE) for individual, nongroup feeding, and transition to the A Ration for group feeding when the tactical situation and supply system permit. The primary difference between B and T Rations is in the entree, starch, vegetable, and dessert components. For these meal components, the labor intensive B Ration menu items are replaced with low labor, high response, heat and serve T Ration Tray Pack items. Other meal components, for example, breakfast fruits and juices, condiments, hot and cold beverages, etc., remain unchanged. To insure that the B and T Rations were comparable, the following methodology was utilized to define the T Ration. First the entire 10-day Standard B Ration for the Armed Forces was reviewed, and each menu item was categorized by meal component; for example, entree, starch, juice/fruit, etc. Lunch and dinner menu items were categorized into one set of meal components while breakfast items were categorized into a separate set of meal components. The meal component categories were:

Breakfast	Lunch/Dinner
Entree/Starch	Entree
Juice/Fruit	Starch
Jam/Jelly/Butter	Vegetables
Cereal	Dessert
Beverages	Soups
	Jam/Jelly/Butter
	Beverages

For the T Ration, B Ration menu items classified as entree/starch for breakfast; or entree, starch, vegetable, or dessert for lunch and dinner were replaced by Tray Pack items. The remaining B Ration items, categorized as juice/fruit, jam/jelly/butter, cereal, or beverages for breakfast; or soup, jam/jelly/butter, or beverages for lunch or dinner, were then added back to complete the 10-day T Ration menu. The end result was a 10-day T Ration menu comparable in composition to the 10-day B Ration menu.

The B Ration includes many wet-packed items for which an alternate dehydrated item is also listed. Since the USMC normally utilizes the wet pack items, the B Ration cost and logistical parameters are based on the wet pack rather than the dehydrated alternate items. The B Ration logistical parameters are based on those provided in the publication, Standard B Ration for the Armed Forces (MCO P10110.25B). However, the 10-day B Ration menu, as defined in MCO P10110.25B includes fresh bread ingredients. To facilitate direct comparison of A, B, and T Ration

parameters (without bread) the cost, weight, and cube impacts of B Ration bread ingredients were calculated and excluded from the B Ration cost and logistical parameters. The B Ration costs are based on the 1 April 82 Federal Supply Catalog Price List (C8900-PL).

Cost and logistical impacts for the T Ration's non-Tray Pack meal components were calculated based on the food items and quantities authorized by "Standard B Ration for the Armed Forces", the "Federal Supply Catalog (C8900-PL, 1 April 82)" price list, and item logistical impact date (weight and cube per case) as listed in "Federal Supply Catalog (C8900-SL)".

The cost and logistical impact contribution of the Tray Pack portion of the T Ration is a function of the cost per tray, portions per tray, and gross weight and cube parameters per case of Tray Packs. Table B1 lists the costs of commercially available Tray Pack items and the average price per Tray Pack by meal component as of 1 April 82. With large scale military procurements these average prices are expected to be discounted by about 12%. The projected average cost per Tray Pack, given a 12% discount, is presented in Table B2. Instead of developing a specific menu, the cost and logistical impact of lunch and dinner entree, starch, vegetable, and dessert items are based on the average projected cost per Tray Pack by meal component (Table B2) and average portions per Tray as defined in Table B3.

At the time of the analysis there were no commercially available Tray Pack breakfast items. Due to their nature, breakfast entrees (i.e., eggs, waffles, pancakes) would tend to be less expensive than lunch or dinner entrees. Cost impacts of Tray Pack entree and starch breakfast meal components for the T Ration were established as follows. The 10-Day B Ration menu was reviewed relative to the breakfast entree and starch menu items offered. These items were then replaced by similar potential Tray Pack items. Both the B Ration and replacement T Ration items are listed in Table B4. Cost per Tray Pack for these items were projected based on commercially available items of comparable composition.

The detailed analysis to establish the cost, weight, and cube parameters of the T Ration is presented in Table B5 and summarized in Table B6 by meal component.

The A Ration food cost is based on the Basic Daily Food Allowance as of 1 April 82. Weight and cube parameters for an A Ration are based on prior detailed analysis as summarized in NRDC Technical Report TR/80-027, "A Proposed Combat Food Service System Concept for the Army in 1990". The ration cost for the Meal Ready To Eat (MRE) is based upon the projected 1 April 82 cost of $41.00 per case (12 meals or 4 rations). Weight and cube parameters for the MRE are from the Federal Supply Catalog (C8900-SL).

Cost and logistical parameters for the A, B, T, and MRE Rations are summarized in Table B7. This information represents the basis for projecting the baseline and new system ration costs and intertheater transportation impacts and costs in Appendix C.

TABLE B1. Commercially Available Tray Pack Item Costs
(1 April 82)

Items	$/Tray Pack[a]
Entrees	
Beef Stew	9.11
BBQ Beef	14.09
Sliced Roast Beef/Gravy	16.23
Beef Tips/Gravy	14.23
Beef Stroganoff	14.23
Sliced Roast Pork/Gravy	15.60
Salisbury Steak	10.16
Stuffed Peppers	8.58
Stuffed Cabbage	8.04
Chicken Stew	7.79
Chicken Breasts	16.43
Chicken Cacciatore	9.11
Sloppy Joe	9.01
Lasagna	7.29
Chili Con Carne	6.10
Chicken A La King	7.95
Chicken with Noodles	6.08
Entree Average	$10.59
Starches	
Baked Beans	4.66
Macaroni and Cheese	5.04
Macaroni and Beef	5.61
Scalloped Potatoes	7.55
German Potato Salad	9.43
Stew Cut Potatoes	5.80
Starch Average	$6.35
Vegetables	
Green Beans	6.05
Lima Beans	5.80
Corn	5.80
Stewed Tomatoes	6.80
Peas	5.80
Vegetable Average	$6.05
Desserts	
Cherry Compote	7.68
Apple Compote	5.74
Blueberry Compote	7.68
Peach Compote	5.74
Dessert Average	$6.71

[a] Price includes type-CF, Style-RSC, Grade-V3c shipping container.

TABLE B2. Projected Average Tray Pack Costs By Meal Component
(1 April 82)

Meal Component	Current Average Cost Per Tray $	Quantity Discount (12%)	Projected Average Cost Per Tray $
Entree	10.59	1.27	9.32
Starch	6.35	0.76	5.59
Vegetable	6.05	0.73	5.32
Dessert	6.71	0.81	5.90

TABLE B3. Servings Per Tray Pack

Meal Component	No. Portions
Breakfast	
Breakfast Meat	30
Creamed Beef	12
Egg Product	20
Breakfast Bake/Pancakes	20
Potatoes	18
Lunch/Dinner	
Entrees	14
Starches	15
Vegetables	25
Desserts	25

TABLE B4. T Ration Tray Pack Breakfast Items

Day	B Ration	T Ration Tray Pack Item
1	French Toast w/Syrup Bacon	Breakfast Bake/Pancakes Breakfast Meat
2	Scrambled Eggs Corned Beef Hash	Egg Product Creamed Beef
3	Griddle Cakes w/Syrup Bacon	Breakfast Bake/Pancakes Breakfast Meat
4	Scrambled Eggs Bacon	Egg Product Breakfast Meat
5	Scrambled Eggs, Western Hashed Browns	Egg Product Potatoes
6	Griddle Cakes w/Syrup Bacon	Breakfast Bake/Pancakes Breakfast Meat
7	Scrambled Eggs Luncheon Meat	Egg Product Breakfast Meat
8	French Toast w/Syrup Bacon	Breakfast Bake/Pancakes Breakfast Meat
9	Griddle Cakes Bacon	Breakfast Bake/Pancakes Breakfast Meat
10	Scrambled Eggs, Western Hashed Browns	Egg Product Potatoes

TABLE B5. T Ration Cost, Weight, and Cube Analysis

Ration Items	No. Days	Qnty	Unit Price[a]	Total Price	Units /Case	Case Wt.	Case Cube	Total Wt.	Total Cube
Entree/Starch(Brkft)									
Breakfast Meat (T)	7	23.33	14.00	326.62	4	32.25	0.73	188.10	4.26
Creamed Beef (T)	1	8.33	7.93	66.06	4	32.25	0.73	67.16	1.52
Egg Product (T)	5	25.00	7.69	192.25	4	28.25	0.73	176.56	4.56
Breakfast Bake/Pancakes (T)	5	25.00	5.13	128.25	4	28.25	0.73	176.56	4.56
Potatoes (T)	2	11.11	5.00	55.55	4	32.25	0.73	89.57	2.03
Syrup, Im. Maple	5	7.50	2.02	15.15	4	32.25	0.73	60.47	1.37
Total				783.88				758.42	18.30
Juice/Fruit(Brkft)									
Grapefruit #303	2	40.00	0.48	19.20	24	30.00	0.73	50.00	1.22
Juice, Grapefruit #15½	1	5.00	3.77	18.85	24	32.00	1.44	6.67	0.30
Juice, Orange #15½	4	20.00	3.77	75.40	24	32.00	1.44	26.67	1.20
Juice, Pineapple #3	1	12.00	0.57	6.84	12	44.00	1.04	44.00	1.04
Juice, Tomato (3+1) 36 Oz	2	10.00	0.88	8.80	12	35.00	0.77	29.17	0.64
Total				129.09				156.51	4.40
Jam/Jelly/Butter(Brkft)									
Jelly, BlackBerry #2½	2	8.00	2.06	16.48	24	61.00	1.16	20.33	0.39
Jelly, Grape #2½	3	12.00	1.49	17.88	24	61.00	1.16	30.50	0.58
Jam, Peach #2½	2	8.00	1.51	12.08	24	64.00	1.16	21.33	0.39
Jam, Strawberry #2½	3	12.00	2.49	29.88	24	64.00	1.16	32.00	0.58
Margarine (lb)	10	10.00	0.214	2.14	39	44.00	1.10	11.73	0.29
Total				78.46				115.89	2.23
Cereal(Brkft)									
Oatmeal, 20 Oz Cu	4	20.00	0.60	12.00	24	37.00	1.01	30.83	0.84
Wheat, Farina, 28 Oz Bx	1	3.57	0.58	2.07	24	47.00	1.16	6.99	0.17
Milk, NF, Dry (lb)	5	15.00	1.064	15.96	30	37.00	1.35	18.50	0.68
Sugar (lb)	5	30.00	0.281	8.43	60	61.00	1.16	30.50	0.58
Total				38.46				86.82	2.27

TABLE B5 cont. T Ration Cost, Weight, and Cube Analysis

Ration Items	No. Days	Qnty	Unit Price[a]	Total Price	Units /Case	Case Wt.	Case Cube	Total Wt.	Total Cube
Hot Beverage(Brkft)									
Coffee (lb)	10	40.00	2.24	89.60	40	47.00	1.51	47.00	1.51
Cream Sub. Dry (bx)	10	5.00	0.97	4.85	20	23.00	1.70	5.75	0.43
Sugar (lb)	10	40.00	0.281	11.24	60	61.00	1.16	40.67	0.77
Total				105.69				93.42	2.71
Entrees (L/D)									
Assorted Tray Pack Items	10	142.86	9.32	1,331.46	4	32.25	0.73	1,151.81	26.07
Starches (L/D)									
Assorted Tray Pack Items	10	133.33	5.59	745.31	4	32.25	0.73	1,074.97	24.33
Vegetables (L/D)									
Assorted Tray pack Items	10	80.00	5.32	425.60	4	32.25	0.73	645.00	14.60
Desserts (L/D)									
Assorted Tray Pack Items	10	80.00	5.90	472.00	4	32.25	0.73	645.00	14.60
Soups (L/D)									
Tomato Veg. #2½ cn	2	8.00	1.46	11.68	24	32.00	1.16	8.00	0.29
Pea, Green #3 cyl cn	1	4.00	1.20	4.80	12	30.00	1.04	10.00	0.35
Onion, #2½ cn	2	5.00	1.32	6.60	24	37.00	1.16	7.71	0.24
Chicken Noodle #2½ cn	2	8.00	1.16	9.28	24	37.00	1.16	12.33	0.39
Between Meal Sppt (bx)	10	2.50	6.70	16.75	8	35.00	1.41	10.94	0.44
Crackers, Soda (lb)	7	35.00	0.74	25.90	48	60.00	5.81	43.75	4.24
Total				75.01				92.73	5.95

TABLE B5 cont. T Ration Cost, Weight, and Cube Analysis

Ration Items	No. Days	Qnty	Unit Price[a]	Total Price	Units /Case	Case Wt.	Case Cube	Total Wt.	Total Cube
Jam/Jelly/Butter (L/D)									
Margarine #10 cn (1 lb)	10	19.00	0.214	4.07	39	44.00	1.10	22.26	0.56
Peanut Butter #2½ cn	4	14.00	1.69	23.66	24	56.00	1.16	32.67	0.68
Jam, Peach, #2½ cn	1	4.00	1.51	6.04	24	64.00	1.16	10.67	0.19
Jam, Strawberry, #2½ cn	1	4.00	2.49	9.96	24	64.00	1.16	10.67	0.19
Jelly, Grape, #2½ cn	1	4.00	1.49	5.96	24	61.00	1.16	10.17	0.19
Jelly, Blackberry, #2½ cn	1	4.00	2.06	8.24	24	61.00	1.16	10.17	0.19
				57.93				96.61	2.00
Beverages (L/D)									
Coffee (1b)	10	70.00	2.24	156.80	40	47.00	1.51	82.25	2.64
Tea (bx)	3	1.50	1.03	1.55	24	18.00	1.50	1.13	0.09
Cream, Sub. Dry (bx)	10	9.50	0.97	9.22	20	23.00	1.70	10.93	0.81
Sugar (1b)	10	76.00	0.281	21.36	60	61.00	1.16	77.27	1.47
Total				188.93				171.58	5.01

[a] Non Tray Pack item prices are from the Federal Suppply Catalog (C8900-PL, 1 April 1982) price list. Cost of Tray Pack breakfast items, not commercially available, are estimates. Price per lunch and dinner Tray Pack items are based on Table B2.

TABLE B6. T Ration Summary
(10-Days - 100 Men - 1000 Rations)

Meal/Component	Total Cost ($)	Total Weight (Lbs)	Total Cube (Ft^3)
Breakfast			
Entree/Starches (T)	$ 783.88	758.42	18.30
Juice/Fruit	129.09	156.51	4.40
Jam/Jelly/Butter	78.46	115.89	2.23
Cereals	38.46	86.82	2.27
Hot Beverages	105.69	93.42	2.71
	1,135.58	1,211.06	29.91
Lunch and Dinner			
Entrees (T)	1,331.46	1,151.81	26.07
Starches (T)	745.31	1,074.97	24.33
Vegetables (T)	425.60	645.00	14.60
Desserts (T)	472.00	645.00	14.60
Soup/Crackers	75.01	92.73	5.95
Jam/Jelly/Butter	57.93	96.61	2.00
Beverages	188.93	171.58	5.01
	3,296.24	3,877.70	92.56
Total (1000 Rations)	$4,431.82	5,088.76	122.47
Per/Ration	$ 4.43	5.09	0.1225

TABLE B7. Ration Summary[a]

Parameter		Ration A	Ration B[b]	Ration T	Ration MRE
Weight (Lbs)	NP	2.19	3.75	5.09	4.25
	P	3.80	-	-	-
	Total	5.99	3.75	5.09	4.25
Cube (Ft^3)	NP	0.0697	0.1054	0.1225	0.2075
	P	0.1007	-	-	-
	Total	0.1704	0.1054	0.1225	0.2075
Cost ($)		3.67	3.24	4.43	10.25

[a] A, B, and T Ration statistics exclude the cost, weight, and cube contribution of fresh bread.

[b] B Ration statistics are based on the use of the wet pack items rather that the dehydrated items.

APPENDIX C

System Cost/Resource Analysis

In this appendix the cost and resource impacts generated by the baseline and proposed new system concepts are developed. The major system cost elements include rations, labor, intertheater transportation, equipment, fuel, water, and disposables (new system only). System cost and resource impacts are projected based on the field feeding requirements of the II MAF (Marine Amphibious Force). These impacts are a function of the II MAF feeding strengths (developed in Appendix A) summarized in Table C1 by system and type ration provided. Total MAF feeding strength by system is established by adding the systems food service personnel requirement to the II MAF's Table of Organization (T/O) authorized non-food-service personnel strength.

System cost and resource impacts are dependent on the types and proportion of bulk and individual rations consumed, which vary as a function of the force component and time. Annual cost and resource impacts per system are therefore projected based on expected ration mixes at three discrete time intervals in the evolution of a conflict. These ration mixes are summarized in Table C2, and are based on the USMC War Reserve Policy Manual, Chapter 3, Section 0303. As shown in Table C2 the proportion of bulk rations increases as a function of time and eventually both the baseline and new system transition from a bulk operational ration (B or T) to a bulk garrison A Ration.

The baseline and new system cost summaries are presented in Tables C3 and C4 by ration mix. A description of the methodology and assumptions used to establish these costs follows.

LABOR COSTS

Labor costs for the baseline and new system are separated into food service personnel and Kitchen Police (KP) cost components. The food service personnel requirement per system, as summarized in Table C1, includes only those food service personnel directly involved with the supervision and operation of the field feeding system. Food service personnel responsible for higher level management functions are not included and therefore not charged off against system cost. However, the number of food service personnel involved with these functions is expected to remain unchanged between systems.

Table C5 presents the annual food service personnel cost for the baseline system. For the baseline system, the distribution of food service personnel by grade is based on actual II MAF Table of Organization authorizations. The cost per worker year by grade is developed in Table C6. These costs exclude subsistence which varies as a function of the type and mix of rations. With the baseline system, the food service personnel requirement and resulting annual cost impact is the same for both B or A type rations.

Annual KP costs for the baseline system are developed in Table C7. These figures are based on the baseline systems KP requirement (see Appendix A) and an estimated cost of $14,517 per KP worker year. The cost per KP worker year represents a weighted average of the E1, E2, and E3 grade personnel costs, based on a projected 45% E1, 45% E2, and 10% E3 KP staffing. Annual food service personnel and KP labor costs for the new system are developed in Table C8 for both a T and A Ration capability. As shown in Table C8, the number of food service personnel and KPs required with the new system for T Ration preparation is significantly less than that required for an A (or B) Ration preparation capability. Food service personnel costs for the new system are projected based on the baseline systems average cost per food service personnel, $19,621. As with the baseline system, KP costs were projected based on $14,517 per worker year.

RATION COSTS

Ration costs are a function of the feeding strengths, cost per ration, and the ration mix (which represents the relative proportion of each type ration being consumed). Table C9 summarizes the cost of each type ration, which were developed in Appendix B. The bulk ration (A, B, T) cost statistics exclude the cost of bread which is assumed to be provided from a field bakery or other source and is the same for each case.

The baseline and new system ration costs are presented in Tables C10 and C11 by ration mix. As shown in Table C11, when the new system transitions from T to A Rations, additional rations are needed due to the increased food service personnel requirement.

INTERTHEATER TRANSPORTATION COSTS

The cost of intertheater transportation of rations is estimated based on rations being transported via commercial container transport from Chicago to Northern Europe ports. Commercial container charges are established and expressed per MTON (measurement ton, defined as 40 cubic feet of interior container volume). Based on commercial container rates ($ per MTON container volume) and average container utilization rates (load volume divided by container volume), the average cost per MTON of product is developed in Table C12. The intertheater transportation cost per ration is developed in Table C13 based on the rations cube and the cost per MTON of product developed in Table C12.

The resulting annual transportation cost for the baseline and new system are presented in Tables C10 and C11 by ration mix. In addition, these tables detail the intertheater transportation impact of each system with each ration mix in terms of the number of 40-foot container loads required per day.

EQUIPMENT COSTS

Baseline system field food service equipment requirements and associated cost impacts are presented in Table C14. Requirements for items that are used exclusively for field food service, for example, range outfits, accessory outfits, immersion heaters, insulated food containers, and vacuum jugs, are based on actual unit Table of Equipment (T/E) authorizations. Baseline system requirements for items that are not unique to food service were established based on the equipment authorization criteria detailed in Table C15. The baseline system authorization criteria for water trailers is based on a food service system requirement of four gallons per person per day and four water trailer fillups per day.

The new system comprises five major components, to include:

Modular Field Kitchen (Small),
Modular Field Kitchen (Medium),
Modular Field Kitchen (Large),
Mobile Food Service Unit, and,
T Ration Equipment Augmentation.

Modular field kitchens are authorized to all MAF units. These field kitchens have all the necessary equipment (except refrigeration) to provide A, B, or T Ration meals. The small kitchen is designed to feed up to 260 troops, the medium kitchen 261-450 troops, and the large kitchen 451-1100 troops. Each kitchen contains exactly the same equipment items with the only difference being the quantity of each item. These kitchens are modular and can be complexed together to support more than 1100 troops. For example, a large and medium modular field kitchen could be combined to support up to 1550 troops as shown in Figure 5. Mobile Food Service Units are issued to combat elements of the division only on the basis of two per battalion. The MFSU has the high response, heat on the move capability necessary to provide combat troops hot T Ration meals. Other units, which do not require a heat on the move T Ration capability, are issued T Ration equipment augmentations on the basis of one per serving line. This equipment is set up and operated in the Modular Field Kitchens to provide a T Ration capability.

The new system equipment requirements and resulting cost impacts are presented in Table C16. Modular Field Kitchen requirements were established based upon the baseline system feeding strengths per field kitchen which are summarized in Table A5. That is, they are to be set up and operated at the same level as the baseline system. The only division unit not authorized MFSUs is the Headquarters Battalion. Therefore the Headquarters Battalion is authorized three T Ration equipment augmentations to complement its Modular Field Kitchen authorization. The investment and uniform annual cost impacts per Modular Field Kitchen, MFSU, and T Ration equipment augmentation are developed in Table C17 thru C21. Water trailer requirements with the new system are projected on the basis of 1 per 750 troops or fraction thereof. As will be shown later the new system water requirement, with

the use of disposable messgear, is about one third of the baseline system's water requirement. Therefore, with the new system each water trailer is capable of supporting 750 troops or three times as many troops as with the baseline system.

FUEL COSTS

The only equipment items in the baseline system that burn fuel (gasoline) are the range outfit (M-2 burner) and immersion heaters. These equipment items are operated, and therefore only burn fuel, when B or A Ration type meals are provided. When providing three B or A Ration meals per day these items are estimated to operate 12 hours per day, and consume fuel at 0.5 gallons per hour. Based on the number of authorized range outfits and immersion heaters (see Table C14), the baseline system's daily fuel requirement and annual cost impact is developed in Table C22 for the three different ration mixes.

The new system's fuel requirement and associated cost impact depend on the type of bulk ration being provided; that is T or A/B. The quantity of fuel consumed per MFSU or Modular Field Kitchen T Ration equipment augmentation to provide three hot T Ration meals per day is estimated at 7.2 gallons (see Table C23). Based on the number of these items required with the new system (see Table C16), the daily fuel requirement and associated annual cost impact to provide three hot T Ration meals per day to the entire II MAF is developed in Table C24. Likewise, the quantity of fuel consumed per Modular Field Kitchen to provide three hot A or B Ration meals is developed in Table C25 thru C27. Based on the number of each size Modular Field Kitchen required with the new system (from Table C16), the daily fuel requirement and associated annual cost impact to provide three hot A or B Ration meals to the entire II MAF is developed in Table C28. The resulting daily fuel requirement and annual cost impact for the three different ration mixes are developed in Table C29.

WATER COSTS

No annual recurring cost figures for USMC field water production units were available and therefore water costs are projected based on the annual recurring cost figures associated with the Army Water Supply Company. However, the USMC and Army utilize similar types of water production equipment and therefore their costs should be about the same. As shown in Table C30, the production cost per gallon of water is estimated at $0.018. The water requirements by type ration is presented in Table C31. The large reduction in water requirement with the new system is due to the replacement of permanent messkit with disposable messgear. As shown in Table C31, the new system with A Rations requires only 1.5 gallons or 1/3 of the 4.5 gallon baseline system A Ration requirement. This difference in water requirement is due to the use of disposables with the new system. The baseline and new system daily water requirements and annual cost impacts by ration mix are developed in Table C32 and C33 respectively.

DISPOSABLE MESSGEAR

The new system utilizes disposable messgear rather than permanent messkits, which require sanitation after each use. For the new system, the purchase cost, transportation impact, and transportation cost of disposables for each ration mix is developed in Table C34. Disposable messgear is utilized with the bulk rations (T or A) only. As always individual rations (MRE) are consumed directly from their package. These cost and transportation impact figures for disposables include a 10% loss factor, that is, 1,000 sets of disposables need to be procured and transported to provide 900 sets of disposables in the field. Detailed cost and cube figures for disposable messgear are provided in Appendix D.

TABLE C1. Baseline and New System MAF Strengths

Force Component	Non Food Service Strength	Baseline System A/B Rations FSP	Baseline System A/B Rations Total	New System T Rations FSP	New System T Rations Total	New System A Rations FSP	New System A Rations Total
Division	18,022	491	18,513	302	18,324	491	18,513
Force Service Support Group(FSSG)	10,632	152	10,784	131	10,763	152	10,784
Marrine Air Wing(MAW)	17,038	318	17,356	185	17,223	318	17,356
Marine Amphibious Force(MAF)	45,692	961	46,653	618	46,310	961	46,653

TABLE C2. System Ration Mixes[a]

System	Mix	Division	FSSG	MAW
Baseline	1	15B	15B	25B
	2	26B	26B	28B
	3	26A	26A	28A
New	1	15T	15T	25T
	2	26T	26T	28T
	3	26A	26A	28A

[a] Average number and type bulk ration per person per 30-day period. Remaining rations are all MREs.

TABLE C3. Baseline System Annual Cost Summary (M$)

Force Component	Ration Mix	FSP	KP	Rations	Transp	Equip	Fuel	Water	Total Cost	Cost($)/ Ration[b]
Division[a] (18,022)	50% B	9.58	10.54	45.58	2.19	0.55	1.59	0.30	70.33	$10.69
	87% B	9.58	10.54	28.21	1.66	0.55	2.75	0.48	53.77	8.17
	87% A	9.58	10.54	30.73	4.77	0.55	2.75	0.48	59.40	9.03
FSSG (10,632)	50% B	2.99	6.17	26.55	1.27	0.26	0.73	0.18	38.15	9.83
	87% B	2.99	6.17	16.43	0.97	0.26	1.26	0.28	28.36	7.31
	87% A	2.99	6.17	17.90	2.78	0.26	1.26	0.28	31.64	8.15
MAW (17,038)	83% B	6.29	9.87	27.93	1.60	0.40	1.71	0.44	48.24	7.76
	93% B	6.29	9.87	23.49	1.47	0.40	1.91	0.48	43.91	7.06
	93% A	6.29	9.87	26.03	4.60	0.40	1.91	0.48	49.58	7.97
MAF (45,692)	62% B	18.86	26.58	100.06	5.06	1.21	4.03	0.92	156.72	9.40
	89% B	18.86	26.58	68.13	4.10	1.21	5.92	1.25	126.05	7.56
	89% A	18.86	26.58	74.66	12.15	1.21	5.92	1.25	140.63	8.43

[a] Figures in parenthesis indicate non food-service-personnel strength.
[b] Per ration cost is determined by dividing annual cost by 365 times the number of non-food-service personnel.

TABLE C4. New System Annual Cost Summary (M$)

Force Component	Ration Mix	FSP	KP	Rations	Transp	Equip	Fuel	Water	Disp	Total Cost	Cost($)/ Ration[b]
Division[a] (18,022)	50% T	5.93	1.87	49.09	2.28	0.73	0.08	0.09	1.71	61.78	$9.39
	87% T	5.93	1.87	34.82	1.85	0.73	0.15	0.11	2.97	48.43	7.36
	87% A	9.58	3.53	30.73	4.77	0.73	0.86	0.17	2.99	53.36	8.11
FSSG (10,632)	50% T	2.57	1.32	28.84	1.34	0.31	0.04	0.05	1.01	35.48	9.14
	87% T	2.57	1.32	20.45	1.09	0.31	0.07	0.07	1.74	27.62	7.12
	87% A	2.99	2.26	17.90	2.78	0.31	0.45	0.10	1.75	28.54	7.35
MAW (17,038)	83% T	3.63	1.68	33.95	1.77	0.51	0.12	0.10	2.68	44.44	7.15
	93% T	3.63	1.68	30.29	1.66	0.51	0.13	0.11	3.01	41.02	6.60
	93% A	6.29	3.31	26.03	4.60	0.51	0.78	0.16	3.03	44.71	7.19
MAF (45,692)	62% T	12.13	4.87	111.88	5.39	1.54	0.24	0.25	5.40	141.70	8.50
	89% T	12.13	4.87	85.56	4.60	1.54	0.35	0.29	7.72	117.06	7.02
	89% A	18.86	9.10	74.66	12.15	1.54	2.09	0.43	7.77	126.60	7.59

[a] Figures in parenthesis indicate non-food-service personnel strength.
[b] Per ration cost is determined by dividing annual cost by 365 times the number of non-food service-personnel.

TABLE C5. Baseline System Food Service Personnel Labor Costs ($)

Type Person	Grade	Annual Cost	Division		FSSG		MAW		MAF	
			No	Total Cost	No	Total Cost	No	Total Cost	No	Total Cost
Cooks (3381)	E8	40,053	1	40,053	1	40,053	7	280,371	9	360,477
	E7	32,982	18	593,676	7	230,874	11	362,802	36	1,187,352
	E6	27,843	52	1,447,836	7	194,901	27	751,761	86	2,394,498
	E5	23,671	45	1,065,195	23	544,433	30	710,130	98	2,319,758
	E4	20,549	72	1,479,528	34	698,666	46	945,254	152	3,123,448
	E3	16,592	161	2,671,312	45	746,640	70	1,161,440	276	4,579,392
	E2/1	14,286	79	1,128,594	26	371,436	89	1,271,454	194	2,771,484
	All	-	428	8,426,194	143	2,827,003	280	5,483,212	851	16,736,409
Bakers (3311)	E6	27,843	0	0	0	0	5	139,215	5	139,215
	E5	23,671	13	307,723	0	0	9	213,039	22	520,762
	E4	20,549	5	102,745	4	82,196	13	267,137	22	452,078
	E3	16,592	43	713,456	5	82,960	11	182,512	59	1,978,928
	E2/1	14,286	2	28,572	0	0	0	0	2	28,572
	All	-	63	1,152,496	9	165,156	38	801,903	110	2,119,555
Total		-	491	9,578,690	152	2,992,159	318	6,285,115	961	18,855,964

TABLE C6. FY82 Annual Cost Per Man-Year

Grade	CA Composite Rate[a]	Other Costs[b]	PCS[c]	Total	Total-Less Subsistence[d]
E8	27,022	13,376	967	41,365	40,053
E7	22,292	11,035	967	34,294	32,982
E6	18,855	9,333	967	29,155	27,843
E5	16,064	7,952	967	24,983	23,671
E4	13,976	6,918	967	21,861	20,549
E3	11,329	5,608	967	17,904	16,592
E2	10,268	5,083	967	16,318	15,006
E1	9,305	4,606	967	14,878	13,566

[a] Includes basic pay, basic allowance for quarters, miscellaneous expenses, incentive pay, and special pay.
[b] Other costs equal 49.5% of CA Composite Rate to include 23.0% for operating appropriation support (medical, quarters, food subsistence, and commissary support), plus 26.5% for military retirement.
[c] PCS - Permanent Change Station costs on per worker year basis.
[d] Estimated annual average subsistence costs per enlisted Marine, $1312.

TABLE C7. Baseline System Annual KP Labor Costs

Component	No. KPs	Annual Cost (M$)[a]
Division	726	10.54
FSSG	425	6.17
MAW	680	9.87
MAF	1,831	26.58

[a] Annual cost per worker is $14,517.

TABLE C8. New System Annual Food Service Labor Costs (M$)

Type Ration	Type Personnel	Division		FSSG		MAW		MAF	
		No.	M$	No.	M$	No.	M$	No.	M$
T	FSP	302	5.93	131	2.57	185	3.63	618	12.13
	KP	129	1.87	91	1.32	116	1.68	336	4.87
A	FSP	491	9.58	152	2.99	318	6.29	961	18.86
	KP	243	3.53	156	2.26	228	3.31	627	9.10

TABLE C9. Ration Costs

Type Ration	Cost ($)
B	$ 3.24
T	4.43
A	3.67
MRE	10.25

TABLE C10. Baseline System Annual Ration and Transportation Cost and Daily Container Requirement

Force Component (Strength)	Rations/Day			Annual Costs (M$)		Containers/Day[a] (40 Ft)		
	A	B	MRE	Rations	Transp	P	NP	Total
Division (18,513)	0	9,256	9,257	45.58	2.19	-	1.21	1.21
	0	16,045	2,468	28.21	1.66	-	0.92	0.92
	16,045	0	2,468	30.73	4.77	0.82	0.68	1.50
FSSG (10,784)	0	5,392	5,392	26.55	1.27	-	0.70	0.70
	0	9,346	1,438	16.43	0.97	-	0.54	0.54
	9,346	0	1,438	17.90	2.78	0.48	0.40	0.88
MAW (17,356)	0	14,463	2,893	27.93	1.60	-	0.89	0.89
	0	16,199	1,157	23.49	1.47	-	0.81	0.81
	16,199	0	1,157	26.03	4.60	0.83	0.57	1.40
MAF (46,653	0	29,111	17,542	100.06	5.06	-	2.80	2.80
	0	41,590	5,063	68.13	4.10	-	2.27	2.27
	41,590	0	5,063	74.66	12.15	2.13	1.65	3.78

[a] Average product cube per refrigerated container (P) is 1962 ft^3, and per dry container (NP) is 2394 ft^3.

TABLE C11. New System Annual Ration and Transportation Cost and Daily Container Requirement

Force Component	No FSP	Ration Mix	Rations/Day				Annual Cost (M$)		Containers/Day[a] (40 ft)		
			Total	A	T	MRE	Rations	Transp	P	NP	Total
Division	302	15T/30	18,324	0	9,162	9,162	49.09	2.28	-	1.26	1.26
	302	26T/30	18,324	0	15,881	2,443	34.82	1.85	-	1.02	1.02
	491	26A/30	18,513	16,045	0	2,468	30.73	4.77	0.82	0.68	1.50
FSSG	131	15T/30	10,763	0	5,381	5,382	28.84	1.34	-	0.74	0.74
	131	26T/30	10,763	0	9,328	1,435	20.45	1.09	-	0.60	0.60
	152	26A/30	10,784	9,346	0	1,438	17.90	2.78	0.48	0.40	0.88
MAW	185	25T/30	17,223	0	14,352	2,871	33.95	1.77	-	0.98	0.98
	185	28T/30	17,223	0	16,075	1,148	30.29	1.66	-	0.92	0.92
	318	28A/30	17,356	16,199	0	1,157	26.03	4.60	0.83	0.57	1.40
MAF	618	19T/30	46,310	0	28,895	17,415	111.88	5.39	-	2.98	2.98
	618	27T/30	46,310	0	41,284	5,026	85.56	4.60	-	2.54	2.54
	961	27A/30	46,653	41,590	0	5,063	74.66	12.15	2.13	1.65	3.78

[a] Average product cube per refrigerated container (P) is 1962 ft^3, and per dry container (NP) is 2,394 ft^3.

TABLE C12. Intertheater Transportation Rates

Route	Rate ($/MTON of Container Space)	
	Nonperishable Cargo	Perishable Cargo
Chicago to East Coast	$11.45	$ 16.02
East Coast to Continental Europe	48.90	135.14
Chicago to Continental Europe	$60.35	$151.16
Utilization Rate	73%	63%
Total Cost ($)/MTON of Product	$82.67	$239.94

TABLE C13. Intertheater Transportation Costs For Various Types of Rations

Type Ration	Ration Component	Volume/ Ration(Ft^3)	Cost($)/ Component	Cost($)/ Ration
A	P	0.1007	$0.604	
	NP	0.0697	0.144	0.748
B	NP	0.1054	0.218	0.218
T	NP	0.1225	0.253	0.253
MRE	NP	0.2075	0.429	0.429

TABLE C14. Baseline System Annual Equipment Costs ($)

Equipment Data			Force Component											
			Division			FSSG			MAW			MAF		
Item	Unit Cost	Economic Life (Yrs)	No	Invest. Cost	UAC[1]	No	Invest. Cost	UAC	No	Invest. Cost	UAC	No	Invest. Cost	UAC
G.P. Medium Tent	$1,158.54	1	101	$117,013	$117,013	48	$ 55,610	$55,610	82	$ 95,000	$95,000	231	$267,623	$267,623
Range Outfit	757.18	4	396	299,843	94,451	162	122,663	38,639	254	192,324	60,582	812	614,830	193,672
Accessory Outfit	368.08	3	209	76,929	30,925	88	32,391	13,021	138	50,795	20,420	435	160,115	64,366
Immersion Heater	87.78	4	754	66,186	20,849	365	32,040	10,093	489	42,924	13,521	1,608	141,150	44,463
Insul. Food Cont.	89.05	2	1,036	92,256	53,139	322	28,674	16,516	382	34,017	19,594	1,740	154,947	89,249
Jug, Vacuum	154.00	2	793	122,122	70,342	376	57,904	33,353	488	75,152	43,288	1,657	255,178	146,983
Water Trailer	6,921.00	6	84	581,364	133,714	48	332,208	76,408	76	525,996	120,979	208	1,439,568	331,101
Garbage Can	18.40	2/3	1,113	20,479	30,719	629	11,574	17,361	982	18,069	27,103	2,724	50,122	75,184
Total	-	-	-	$1,376,192	$551,152	-	$673,064	$261,001	-	$1,034,277	$400,487	-	$3,083,533	$1,212,641

[1] UAC - Uniform Annual Cost.

TABLE C15. Baseline System Equipment Authorization Criteria

Equipment Item	Feeding Strength	Authorization
G.P. Medium Tents	0 - 350	2
	351 - 600	3
	601 - 1,000	4
	1,001 - 1,500	6
	1,501 - 2,500	8
	over 2,500	4 per 1,000 or major fraction
Water Trailers (400 gallon)	-	1 per 250 or fraction
G.I. Cans (32 gallon)	-	1 per immersion heater plus 5 per 500 or major fraction

TABLE C16. New System Annual Equipment Cost ($)

Equipment Item	Force Component											
	Division			FSSG			MAW			MAF		
	No	Invest.	UAC	No	Invest.	UAC	No	Invest.	UAC	No	Invest.	UAC
Modular Field Kitchen (Small)	13	187,785	81,081	2	28,890	12,474	10	144,450	62,370	25	361,125	155,925
Modular Field Kitchen(Medium)	5	101,255	43,740	1	20,251	8,748	2	40,502	17,496	8	162,008	69,984
Modular Field Kitchen (Large)	16	573,104	260,016	11	394,009	178,761	15	537,285	243,765	42	1,504,398	682,542
Mobile Food Service Unit	48	1,265,952	259,872	-	-	-	-	-	-	48	1,265,952	259,872
T Ration Augmentation	3	48,591	9,195	24	388,728	73,560	42	680,274	128,730	69	1,117,593	211,485
Water Trailer	45	311,445	71,640	20	138,420	31,840	35	242,235	55,720	100	692,100	159,200
Totals	-	2,488,132	725,544	58	970,298	305,383	104	1,644,746	508,081	292	5,103,176	1,539,008

TABLE C17. Small Modular Field Kitchen Equipment Cost
(Feeding Strength 1-260)

Item	Cost/ Item ($)	Number Units	Economic Life (Years)	Investment Cost ($)	Uniform Annual Cost ($)
Tent Sections (8 ft.)	1,624[a]	3	-	4,872	3,561[b]
Griddle w/Stand	600	1	10	600	98
Steamtable w/Stand	600	2	8	1,200	224
Tables, Serving & Work	280	5	4	1,400	441
Exhaust Assembly	160	2	10	320	52
Ovens	640	1	4	640	202
Pot Cradle	96	1	8	96	18
Kits, Cooking & Serving Utensils	1,804	1	6	1,804	415
Burners	143	8	3	1,144	460
Tool Box & Tools	135	1	10	135	22
Beverage Jug, Insulated, 5 Gal.	75	4	2	300	173
Sanitation Center					
G.I. Cans	18	3	2/3	54	81
Sinks	400	3	8	1,200	224
Draintables	240	2	4	480	151
Storage Racks	200	1	2	200	115
Total	-	-	-	14,445	6,237

[a] Fabric cost is estimated at $1,102; frame cost is estimated at $522.
[b] Fabric, 1 year economic life; frame, 10 years economic life.

TABLE C18. Medium Modular Field Kitchen Equipment Cost
(Feeding Strength 261-450)

Item	Cost/ Item ($)	Number Units	Economic Life (Years)	Investment Cost ($)	Uniform Annual Cost ($)
Tent Sections (8 ft.)	1,624[a]	4	-	6,496	4,748[b]
Griddle w/Stand	600	1	10	600	98
Steamtable w/Stand	600	2	8	1,200	224
Tables, Serving & Work	280	6	4	1,680	529
Exhaust Assembly	160	2	10	320	52
Ovens	640	3	4	1,920	605
Pot Cradle	96	2	8	192	36
Kits, Cooking & Serving Utensils	1,804	2	6	3,608	830
Burners	143	10	3	1,430	575
Tool Box & Tools	135	1	10	135	22
Beverage Jug, Insulated, 5 Gal.	75	4	2	300	173
Sanitation Center					
G.I. Cans	18	5	2/3	90	135
Sinks	400	3	8	1,200	224
Draintables	240	2	4	480	151
Storage Racks	200	3	2	600	346
Total	-	-	-	20,251	8,748

[a] Fabric cost is estimated at $1,102; frame cost is estimated at $522.
[b] Fabric, 1 year economic life; frame, 10 years economic life.

TABLE C19. Large Modular Field Kitchen Equipment Cost
(Feeding Strength 451-1100)

Item	Cost Item ($)	Number Units	Economic Life (Years)	Investment Cost ($)	Uniform Annual Cost ($)
Tent Sections (8 ft.)	1,624[a]	8	-	12,992	9,496[b]
Griddle w/Stand	600	2	10	1,200	196
Steamtable w/Stand	600	4	8	2,400	449
Tables, Serving & Work	280	10	4	2,800	882
Exhaust Assembly	160	4	10	640	104
Ovens	640	6	4	3,840	1,210
Pot Cradle	96	4	8	384	72
Kits, Cooking & Serving Utensils	1,804	3	6	5,412	1,245
Burners	143	18	3	2,574	1,035
Tool Box & Tools	135	1	10	135	22
Beverage Jug, Insulated, 5 Gal.	75	8	2	600	346
Sanitation Center					
G.I. Cans	18	9	2/3	162	243
Sinks	400	3	8	1,200	224
Draintables	240	2	4	480	151
Storage Racks	200	5	2	1,000	576
Total	-	-	-	35,819	16,251

[a] Fabric cost is estimated at $1,102; frame cost is estimated at $522.
[b] Fabric, 1 year economic life; frame, 10 years economic life.

TABLE C20. Mobile Food Service Unit Equipment Cost (1982)

Item	Economic Life (Years)	Investment Cost ($)	Uniform Annual Cost ($)
Tray Pack Heater Assembly	8	10,842	2,027
Generator	6	2,471	568
Holding Cabinet Assembly	10	1,791	292
Potable Water Assembly (40 gal)	8	2,038	381
Tables (3)	4	1,544	486
Can Opener	2	50	29
Platform (Skid) Assembly	10	2,884	470
Steps	10	248	40
Tool Box & Tools	10	100	16
Cover	5	432	114
Fire Extinguisher (2)	1	100	100
Trailer, 1½ Ton, M105A	6	3,874	891
Total	-	26,374	5,414

TABLE C21. T Ration Augmentation Equipment Cost (1982)

Item	Economic Life (Years)	Investment Cost ($)	Uniform Annual Cost ($)
Tray Pack Heater Assembly	8	10,842	2,027
Generator	6	2,471	568
Platform (Skid) Assembly	10	2,884	470
Total	-	16,197	3,065

TABLE C22. Baseline System Annual Fuel Costs Summary ($)

Division			FSSG			MAW			MAF	
Ration Mix[a]	Daily Req't (Gals)	Annual Cost($)[b]	Ration Mix	Daily Req't (Gals)	Annual Cost($)	Ration Mix	Daily Req't (Gals)	Annual Cost($)	Daily Req't (Gals)	Annual Cost($)
30/30	6,900	$3,173,310	30/30	3,162	$1,454,204	30/30	4,458	$2,050,234	14,520	$6,677,748
15/30	3,450	1,586,655	15/30	1,581	727,102	25/30	3,715	1,708,529	8,746	4,022,286
26/30	5,980	2,750,202	26/30	2,740	1,260,310	28/30	4,160	1,913,552	12,880	5,924,064

[a] Fraction of bulk A or B ration meals per person per 30 day period.

[b] Based on worldwide average cost of $1.26/gal. (Reference: Defense Fuel Supply Center, Budget Office, Pentagon, Wash., DC)

TABLE C23. Fuel Requirement per New System Equipment Item For Three T Ration Meals Per Day

Type T Ration Equipment	Fuel Burning Items	No	Consumption (Gals/Hr)	Usage (Hrs/Day)	Fuel Req't (Gals/Day)
Mobile Food Service Unit or Modular Field Kitchen T Ration Augmentation	Tray Pack Heater Assembly	1	0.6	9	5.4
	Generator(2.2 KW)	1	0.2	9	1.8
Total	-	-	-	-	7.2

TABLE C24. New System Fuel Cost To Provide 100% T Rations ($)

Type Equipment	Gals/ Unit	Force Component											
		Division			FSSG			MAW			MAF		
		No	Gals/ Day	Annual Cost($)	No	Gals/ Day	Annual Cost($)	No	Gals/ Day	Annual Cost($)	No	Gals/ Day	Annual Cost($)
Mobile Food Service Unit	7.2	48	346	159,125	-	-	-	-	-	-	48	346	159,125
T Ration Augmentation	7.2	3	22	10,118	24	173	79,563	42	302	138,890	69	497	228,571
Total	-	51	368	169,243	24	173	79,563	42	302	138,890	117	843	387,696

TABLE C25. Fuel Requirement Per Small Modular Field Kitchen To Provide A/B Rations

Items	Consumption Rate (Gals/Hr)	Usage Rate (Hrs/Day)	Daily Fuel Requirement (Gals)
Kitchen			
2 Burners (Griddle)	1.0	4	4.0
2 Burners(Steamtables)	1.0	9	9.0
1 Burner (Ovens)	0.5	9	4.5
1 Burner (Pot Cradles)	0.5	9	4.5
Sanitation			
3 Burners (Sinks)	1.8	6	10.8
Total	-	-	32.8

TABLE C26. Fuel Requirement Per Medium Modular Field Kitchen To Provide A/B Rations

Items	Consumption Rate (Gals/Hr)	Usage Rate (Hrs/Day)	Daily Fuel Requirement (Gals)
Kitchen			
2 Burners (Griddle)	1.0	4	4.0
2 Burners (Steamtables)	1.0	9	9.0
3 Burners (Ovens)	1.5	9	13.5
2 Burners (Pot Cradles)	1.0	9	9.0
Sanitation			
3 Burners (Sinks)	1.8	8	14.4
Total	-	-	49.9

TABLE C27. Fuel Requirement Per Large Modular Field Kitchen To Provide A/B Rations

Items	Consumption Rate (Gals/Hr)	Usage Rate (Hrs/Day)	Daily Fuel Requirement (Gals)
Kitchen			
4 Burners (Griddles)	2.0	4	8.0
4 Burners (Steamtables)	2.0	9	18.0
6 Burners (Ovens)	3.0	9	27.0
4 Burners (Pot Cradles)	2.0	9	18.0
Sanitation			
3 Burners (Sinks)	1.8	12	21.6
Total	-	-	92.6

TABLE C28. New System Fuel Cost To Provide 100% A/B Rations

Type Kitchen	Fuel Req't (Gals/Day)	Force Component											
		Division			FSSG			MAW			MAF		
		No	Gals/ Day	Annual Cost($)	No	Gals/ Day	Annual Cost($)	No	Gals/ Day	Annual Cost($)	No	Gals/ Day	Annual Cost($)
Modular Field Kitchen (Small)	32.8	13	426	195,917	2	66	30,353	10	328	150,847	25	820	377,117
Modular Field Kitchen (Med)	49.9	5	250	114,975	1	50	22,995	2	100	45,990	8	400	183,960
Modular Field Kitchen (Large)	92.6	16	1,482	681,572	11	1,019	468,638	15	1,389	638,801	42	3,890	1,789,011
Totals	-	-	2,158	992,464	-	1,135	521,986	-	1,817	835,638	-	5,110	2,350,088

TABLE C29. New System Annual Fuel Costs To Provide T-MRE and A-MRE Mixed Rations ($)

Division			FSSG			MAW			MAF	
Ration Mix	Gals/ Day	Annual Cost	Ration Mix	Gals/ Day	Annual Cost	Ration Mix	Gals/ Day	Annual Cost	Gals/ Day	Annual Cost
30T/30	368	$169,243	30T/30	173	$ 79,563	30T/30	302	$138,890	843	$ 387,696
15T/30	184	84,622	15T/30	87	39,782	25T/30	252	115,742	523	240,146
26T/30	319	146,677	26T/30	150	68,955	28T/30	282	129,631	751	345,263
30A/30	2,158	992,464	30A/30	1,135	521,986	30A/30	1,817	835,638	5,110	2,350,088
26A/30	1,870	860,135	26A/30	984	452,388	28A/30	1,696	779,929	4,550	2,092,452

TABLE C30. Water Production Costs

Unit	SRC 05-067H Engineer Water Supply Company
Annual Recurring Cost	$3,166,800 (FY82)
Production Rate	27,000 Gal/Hour, 18 Hours/Day
Yearly Production	177,390,000 Gallons
Cost Per Gallon ($)	$0.018/Gal

TABLE C31. Water Requirements by Type Ration (Gal/Ration)

Water Use	Type Ration				
	A(Baseline System)	A (New System)	B	T	MRE
Beverages, Ration Preparation/Heating	0.5	0.5	0.5	1.0	0.5
Pot/Pan Sanitation	1.0	1.0	1.0	0.0	0.0
Messkit Sanitation	3.0	0.0	3.0	0.0	0.0
Total	4.5	1.5	4.5	1.0	0.5

TABLE C32. Baseline System Water Requirement and Annual Cost

Force Component	Ration Mix			Water Req't (Gal/Day)	Annual Cost (M$)
	A	B	MRE		
Division	0	9,256	9,257	46,281	0.30
(18,513)	0	16,045	2,468	73,437	0.48
	16,045	0	2,468	73,437	0.48
FSSG	0	5,392	5,392	26,960	0.18
(10,784)	0	9,346	1,438	42,776	0.28
	9,346	0	1,438	42,776	0.28
MAW	0	14,463	2,893	66,530	0.44
(17,356)	0	16,199	1,157	73,474	0.48
	16,199	0	1,157	73,474	0.48
MAF	0	29,111	17,542	139,771	0.92
(46,653)	0	41,590	5,063	189,687	1.25
	41,590	0	5,063	189,687	1.25

TABLE C33. New System Water Requirements and Annual Cost

Force Component	No FSP	Ration Mix	Number of Rations				Req't (Gal/Day)	Cost (M$)
			Total	A	T	MRE		
Division	302	15T/30	18,324	0	9,162	9,162	13,743	0.09
	302	26T/30	18,324	0	15,881	2,443	17,103	0.11
	491	26A/30	18,513	16,045	0	2,468	25,302	0.17
FSSG	131	15T/30	10,763	0	5,381	5,382	8,072	0.05
	131	26T/30	10,763	0	9,328	1,435	10,046	0.07
	152	26A/30	10,784	9,346	0	1,438	14,738	0.10
MAW	185	25T/30	17,223	0	14,352	2,871	15,788	0.10
	185	28T/30	17,223	0	16,075	1,148	16,649	0.11
	318	28A/30	17,356	16,199	0	1,157	24,877	0.16
MAF	618	19T/30	46,310	0	28,895	17,415	37,603	0.25
	618	27T/30	46,310	0	41,284	5,026	43,797	0.29
	961	27A/30	46,653	41,590	0	5,063	64,917	0.43

Table C34. New System Annual Cost of Disposables

Force Component	%Bulk	Bulk Meals /Day	Disp. Cost /Yr (M$)[a]	Cont/ Day[b]	Trans Cost /Yr (M$)	Total Cost /Yr (M$)
Division	50T	27,486	1.38	0.18	0.33	1.71
	87T	47,643	2.39	0.32	0.58	2.97
	87A	48,135	2.41	0.32	0.58	2.99
FSSG	50T	16,143	0.81	0.11	0.20	1.01
	87T	27,984	1.40	0.19	0.34	1.74
	87A	28,038	1.41	0.19	0.34	1.75
MAW	83T	43,056	2.16	0.29	0.52	2.68
	93T	48,225	2.42	0.32	0.59	3.01
	93A	48,597	2.44	0.33	0.59	3.03
MAF	62T	86,865	4.35	0.58	1.05	5.40
	89T	123,852	6.21	0.83	1.51	7.72
	89A	124,770	6.25	0.84	1.52	7.77

[a] Cost - $137.33/1,000 sets (including 10% loss factor)
[b] Cube per 1,000 sets of disposables - 16.11 ft^3. Average product cube per 40ft container - 2,394 ft^3.

APPENDIX D

Cost Analysis of Permanent and Disposable Messgear Alternatives

This appendix presents an economic analysis of two messgear alternatives, including the US Marine Corps current nondisposable messgear system and a disposable messgear alternative, which has no sanitation requirement.

The current nondisposable messgear system consists of a messpan, canteen cup, knife, fork, and spoon, which are issued to and maintained by the individual Marine. For every 80 troops or fraction thereof, a messkit washline is assembled for messgear sanitation, as required by MIL Handbook 740. The washline consists of four 32-gallon G.I. cans with immersion heaters. Prior to using the messkit, a Marine sterilizes the messkit in the first G.I. can with boiling water. After eating the meal, the Marine scrapes any remaining food waste from the messgear and then washes, rinses, and sanitizes the messgear in the three remaining G.I. cans, which are filled with water heated by immersion heaters. Kitchen police (KP) are normally assigned the duties of preparing, maintaining, and cleaning the required messkit washlines.

The disposable messgear alternative consists of a five-compartment fiberboard tray, a paper cup, and a plastic knife, fork, and spoon. Since all used messgear is discarded after each meal, no sanitation is required.

COST ANALYSIS

NONDISPOSABLE MESSGEAR SYSTEM

The five individual cost elements of the current nondisposable messgear system include messkits, washline equipment, washline consumables/expendables, water transportion, and washline labor.

Messkits

Individual messkits are exposed to normal wear, enemy action, pilferage, abandonment, and destruction and must be replaced over a period of time. The annual cost of replacing the nondisposable messkit is calculated based on the initial cost and economic life of each messkit component, as shown in Table D1. The total annual cost of providing a Marine with nondisposable messgear is $10.16.

Messkit Washline Equipment

The sanitation of the nondisposable messkits requires a messkit washline consisting of four 32-gallon G.I. cans and four attached immersion heaters. Based on equipment purchase cost and estimated economic life, the uniform annual cost is $221.00 per washline, or $2.76 per Marine per year as calculated in Table D2.

Messkit Washline Consumables/Expendables

The operation of the washline equipment and sanitation of the messgear requires dishwashing compound, water, fuel, scrapers, and brushes. The annual cost of these items is a function of the number of meals prepared daily during the year. As shown in Table D3, the total annual cost of these items for three meals per day is $13,240.44 per washline or $165.51 per Marine.

Water Transportation

Water required by the messkit washline is transported from the water supply point to the kitchen site in a 400-gallon water trailer hauled by a 2½-ton truck. The trailer and truck are required for other food service functions, their maintenance and replacement costs are charged off against the food service system. However, the variable cost to transport water for washline use is considered part of the cost of messgear sanitation. Based on an estimated operational cost (fuel, oil) of $0.27 per mile for a 2½-ton truck, and an average round-trip distance of 20 miles to refill the water trailer, the cost of transporting water is estimated at $0.014 per gallon. The messkit sanitation water requirement is one gallon per person per meal. Therefore, for three meals per day the total annual water transportation cost is $15.33 per person.

Messkit Washline Labor

The KP labor requirement to prepare, maintain, and clean a washline for one meal is about two work hours (based on extensive field observations) or one-sixth of a work day. Based on an annual KP labor cost per of $14,517 per worker year, the annual labor cost per messkit washline for three prepared meals per day is $7,259, or equivalently $90.73 per individual.

The total annual cost of the nondisposable messgear alternative is summarized in Table D4. As shown, for three prepared meals per day, the total cost is $284.49 per individual.

DISPOSABLE MESSGEAR SYSTEM

The disposable messgear alternative consists of a five-compartment fiberboard tray, a 10-oz. paper cup, and a plastic knife, fork, and spoon. One set of disposable messgear is issued to each man for each prepared meal.

The total cost of this alternative consists of three components, purchase cost, intertheater transportation, and intratheater transportation.

Purchase Cost

Table D5 lists the purchase cost per case and per worker year for each of the five items of disposable messgear. It is estimated that 10%

of the disposables are lost or destroyed in transit or in the field. Incorporating the 10% loss factor, the total annual purchase cost per person for three meals per day is $150.38.

Intertheater Transportation

The cost of intertheater transportation of disposable messgear is estimated based on commercial container rates from Chicago to Northern Europe. As developed in Appendix C, the commercial transport charge rate is equivalent to $82.67 per 40 ft^3 of product. A year's supply of disposables for one individual has a cube of 17.64 ft^3 (after incorporating a 10% loss factor). Based on this cube, the cost for intertheater transportation is $36.46 per person.

Intratheater Transportation

In-theater, the disposable messgear is assumed to be transported by 2½-ton truck from the port over an estimated mean distance of 25 miles. Based on an estimated truck operational cost of $0.27 per mile, a round-trip distance of 50 miles, an estimated average truck load of 310 ft^3 of actual product, and 17.64 ft^3 of product per person per year, the annual cost of intratheater transportation is estimated to be only $0.77 per man.

The resulting total annual cost per individual for disposable messgear for three meals per day is $187.61.

COMPARISON AND SUMMARY OF MESSGEAR ALTERNATIVES

In this section the total annual cost of three messgear alternatives, including the current nondisposable and the disposable alternative discussed previously, and a disposable messgear alternative which includes a nondisposable backup capability, are compared as a function of the number of hot meals provided daily. In the analysis, the variable X represents the fraction of the meals that require messgear. (For instance, if the ration mix for a force component is 87% A, 13% MRE, then 87% of the daily meals require messgear, and $\underline{X} = 0.87$.) The variable Y equals the total annual cost per person for the given messgear system, corresponding to the ration mix described by X. Finally, the variable S equals the annual cost savings per person when either disposable system replaces the current permanent messgear system.

NONDISPOSABLE MESSGEAR SYSTEM

The current systems cost has both a fixed and variable cost component. The fixed annual cost per person for messgear and washline equipment is $12.92, while the variable annual cost per person (consumables/expendables, water transportation, and labor) based on three hot meals daily, is $271.57. The total annual cost per person corresponding to ration mix $\underline{X}$ is therefore given by the equation $Y = 12.92 + (271.57)\ X$.

DISPOSABLE MESSGEAR SYSTEM

The disposable system has no permanent messgear and no washline equipment, and therefore no fixed cost. For this alternative the variable annual cost per person for three meals per day is $187.61. The total annual cost per person corresponding to ration mix $\underline{X}$ is given by the equation $Y = (187.61)X$. Compared to the current system, the total annual cost savings per person provided by this system is defined by the equation $S = 12.92 + (83.96)X$.

DISPOSABLE MESSGEAR SYSTEM WITH NONDISPOSABLE BACKUP

This system assumes that nondisposable messgear and washline equipment is maintained with the disposable system so as to facilitate a quick transition to a nondisposable system if the supply of disposables is disrupted. Maintaining a nondisposable backup incurs the same fixed cost as the current system, but the variable cost remains that of the disposable system alone. For this alternative, the total annual cost per person corresponding to ration mix X is given by the equation $Y = 12.92 + (187.61)X$, and the annual cost savings per person is given by the equation $S = (83.96)X$.

Table D6 summarizes the annual cost for each system for one, two, and three hot meals per day and the cost savings enjoyed when either disposable system replaces the current system. Clearly, it is always less expensive to use disposable messgear, and this cost benefit increases with the number of prepared daily meals.

TABLE D1. Annual Cost Per Person of Current Messkit

Item	Initial Cost($)	Economic Life(Yrs)	Annual Cost($)
Pan, Mess Kit	5.61	1.00	5.61
Cup, Canteen	2.93	1.00	2.93
Knife, Metal	0.83	0.75	1.11
Fork, Metal	0.20	0.75	0.27
Spoon, Metal	0.18	0.75	0.24
Total	-	-	10.16

TABLE D2. Uniform Annual Cost of Messkit Washline Equipment

Item	Cost/ Unit	Units/ Washline	Economic Life	U.A.C.[a]
Heater, Immersion	$87.78	4	4	$110.60
Can, 32-Gallon	18.40	4	2/3	110.40
Cost per washline	-	-	-	221.00
Cost per individual	-	-	-	2.76

[a] Uniform Annual Cost

TABLE D3. Annual Cost of Consumables/Expendables per Messkit Washline (One Prepared Meal per Day)

Item	Usage Rate	Cost($)/ Year	Cost($)/ Year
Dishwashing Compound	0.75 lb/meal[a]	0.39/lb	$ 106.76
Water	80 gal/meal[b]	0.018/gal[c]	525.60
Fuel	8 gal/meal[d]	1.26/gal[e]	3,679.20
Scraper	1/week[f]	0.56	29.12
Brush	1/week[f]	1.40	72.80
Total annual cost per washline (1 meal/day).....			$4,413.48
Total annual cost per washline (3 meals/day.....			$13,240.44
Total cost per individual (3 meals/day).....			$165.51

[a] Per MIL HDBK 740.
[b] 20 gallons per G.I. can, 4 cans per washline, water changed after every meal.
[c] Annual water production cost rate of Engineer Water Supply Company (SRC 05067H)(see Table C30).
[d] Based on 4 immersion heaters per washline, operating 4 hours per meal, fuel consumption rate, 0.5 gal/hr.
[e] DoD worldwide average gasoline cost.
[f] Estimated usage rate based on field observations for 1 hot meal/day.

TABLE D4. Total Annual Cost of Nondisposable Messgear per Individual (Three Prepared Meals Per Day)

Cost Element	Annual Cost ($)
Messkit Annual Replacement	10.16
Washline Annual Replacement	2.76
Consumables/Expendables	165.51
Water Transportation	15.33
Labor	90.73
Total	284.49

TABLE D5. Disposable Messgear System Cost and Cube Data (Three Prepared Meals Per Day)

Item	Units/ Case[a]	Purchase Cost ($)	Cube(Ft^3)/ Case[a]	Annual Cost per Man	Annual Cube per Man (Ft^3)
Tray	500	22.00/500	4.71	$48.18	10.31
Hot Cup	1000	22.60/1000	2.62	24.75	2.87
Knife	1000	1.95/500	0.82	21.35	0.90
Fork	1000	1.95/100	0.82	21.35	0.90
Spoon	1000	1.80/100	0.82	19.71	0.90
Total without Loss Factor				$ 135.34	15.88
Total with 10% Loss Factor[b]				$ 150.38	17.64

[a] Source - GSA
[b] Source of 10% Loss Factor - Comptroller's Office, Cost Analysis Group, Marine Corps, Washington, DC.

TABLE D6. Comparison of Annual Cost Per Individual for Three Messgear Alternatives

System Costs and Savings	Number of Meals Served Daily		
	1 Meal	2 Meals	3 Meals
A. Curent System	$103.44	$193.97	$284.49
B. Disposable System	62.54	125.07	187.61
C. Disposable System with Nondisposable Backup	75.46	137.99	200.53
D. Cost Savings of B	40.90	68.90	96.88
E. Cost Savings of C	27.98	55.98	83.96