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A COST AND SYSTEMS EFFECTIVENESS ANALYSIS OF THE XM-75 AND XM-76 FIELD FEEDING SYSTEMS FOR MARINE CORPS DIVISIONS

July 1976

UNITED STATES ARMY
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A cost and systems effectiveness analysis was performed for Marine Corps Divisions comparing two new consolidated feeding systems (designated XM-75 and XM-76). The results demonstrated that both of the new systems were superior to the conventional Marine Corps system. The XM-75 and XM-76 yielded annual savings of $50,764 and $50,070 respectively for a Marine Corps infantry battalion while requiring investments of $30,753 and $42,479, respectively. Of the two new systems, the XM-75 is preferred providing a relative worth of 39% more than the conventional system and 5% more than the XM-76.

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PREFACE

This report documents the results of a cost and system effectiveness analysis of alternative battalion level Marine Corps field feeding systems. These consisted of the standard Marine Corps system housed in three General Purpose Medium Tents and two new systems. The new systems are quite different in design with one being housed in an expandable frame type shelter while the second is mounted on three 1-1/2 ton trailers. Both of the new systems were designed to provide significant reductions in personnel requirements through the use of new equipment and electrically powered labor saving devices. Data used in the analysis were obtained from a recent experiment conducted at Camp Pendleton, CA as well as from observations of field training exercises.

This analysis was conducted under the DOD Food Research Development Test and Engineering Program, Project No. 1Y762724AH99A and is jointly sponsored by the Marine Corps and Army.

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CHAPTER I

INTRODUCTION AND SUMMARY REPORT

Much of the equipment in the existing Marine Corps field feeding system dates back to World War II. Most of this equipment is, therefore, badly in need of modernization. This, plus the fact that there is a critical need for increased efficiency in the combat service support operations, was the major driving force in establishing the requirement for a comprehensive evaluation of Army and Marine Corps field feeding.

In 1974, a systems analysis was undertaken with the prime objective of achieving significant reductions in the number of personnel required to operate Army and Marine Corps field feeding systems. A two phase approach was undertaken whereby Phase I would result in "quick fix" recommendations to each service for short term improvements which could be adopted without any major R&D effort and which could be implemented within a 12 month timeframe. Phase II was intended to provide a totally new state-of-the-art concept which would be available for implementation in the 1985-1990 timeframe. The Phase II system, however, would most likely require substantial R&D effort as well as extensive testing.

During the Phase I effort, a systems analysis was performed for the Army which showed the potential for significant personnel savings through consolidation of its field feeding system. Such a plan for consolidation, if implemented, would create an Army requirement to feed its maneuver battalions from a single kitchen. This new requirement would, therefore, result in a common problem for the Army and Marine Corps, namely how to efficiently provide hot meals to 800 - 900 troops from a single kitchen in a tactical environment. Since the analysis of Marine Corps field feeding had already uncovered a number of equipment problem areas which required immediate attention, work was initiated on the design of two new "quick fix" systems for battalion level feeding. The first was based on the use of an expandable frame type soft shelter with several new labor saving devices including new sanitation equipment while the second was based on the use of three Mobile Kitchen Trailers centrally connected to operate as a homogeneous facility. In order to evaluate these new systems and to gain operational data and information, a field feeding experiment[1] was conducted during March 1976 with Marine Corps units at Camp Pendleton, CA. The primary purpose of this experiment was to evaluate the relative performance of all three systems and to verify any potential for personnel savings which could be achieved with the new system. The three systems evaluated, and shown in Appendix D, include:

(1) A conventional Marine Corps battalion size system consisting of standard authorized equipment.

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[1]Baritz, S., _et al_, "The Camp Pendleton Experiment in Battalion Level Field Feeding", Tech Report 7T-4 OR/SA, US Army Natick R&D Command, Natick, MA 01760, July 1976

(2) A new product improvement system designated XM-75 and housed in expandable frame type shelters.

(3) A second product improvement system designated XM-76 and based on the use of multiple Mobile Kitchen Trailers.

One point which should be noted concerning the XM-76 system is that the experiment demonstrated a serious problem with the three trailer concept. This problem concerned human factors and workspace design deficiencies which would require additional development and testing prior to implementation. This was not the case with the XM-75. The additional development costs of the XM-76 system were not included in the analysis.

This report then documents the results of a cost and systems effectiveness analysis which was performed based on the data from the Camp Pendleton experiment as well as previously available information and data. The analysis provides the necessary information required by the Marine Corps to make a decision regarding the adoption of a new field feeding system to replace their conventional system.

Objectives

The objectives of this analysis are to:

(1) Establish cost data which represents an accurate assessment of equipment and operational costs associated with each system.

(2) Develop a system effectiveness model to evaluate the ability of each system to perform the intended mission.

(3) Use the cost and systems effectiveness data to develop a set of quantitative relationships which can be used without further work as a basis for comparison between the alternatives.

(4) Develop the quantitative relationships among the alternative systems and present the results, conclusions, and recommendations.

Results and Conclusions

Based on the results of the cost and systems effectiveness analysis, the following results and conclusions are offered:

(1) The XM-75 and XM-76 reduce operating costs by $50,764 and $50,070 per system annually compared to the conventional system when supporting a typical Marine Corps infantry battalion. Across the three Marine Divisions, the expected reduction in annual labor costs ıld be $2.526 million with either the XM-75 or XM-76 systems.

(2) The XM-75 and XM-76 systems require investments of $30,753 and $42,479 per system, respectively. Total implementation costs for three Marine Divisions are estimated at $1.770 million for the XM-75 and $2.338 million for the XM-76.

(3) The XM-75 and XM-76 would recover their new equipment investments (payback period) in 0.60 years and 0.85 years, respectively, at the battalion level.

(4) Both the XM-75 and XM-76 systems reduce labor costs sufficiently that the breakeven point is $177,726 per system. This amount could be invested before the labor savings are offset and the systems operating cost become equivalent to the conventional system.

(5) On the basis of systems effectiveness, the XM-75 is superior to the XM-76 and the conventional system.

(6) In terms of cost and systems effectiveness, the XM-75 is the preferred candidate for a battalion level field feeding system. Based on relative worth ratings, the XM-75 is worth 39 percent more than the conventional system and 5 percent more than the XM-76.

Recommendation

It is recommended, on the basis of the Camp Pendleton Field Feeding Experiment and this analysis, that the Marine Corps adopt the XM-75 as their standard field feeding system. The combination of a significantly lower capital investment cost and higher relative worth of the XM-75 as compared to the XM-76 plus the fact that the XM-76 has serious human factors and workspace layout problems which require additional development and evaluation make the XM-75 the preferred system.

CHAPTER II

COST BENEFIT ANALYSIS

Cost benefit analysis has been defined as the process of comparing alternative solutions to mission requirements in terms of value received for the resources expended. This type of analysis should be very helpful in assessing the relative benefits of the new XM-75 and XM-76 systems tested during the Camp Pendleton Field Feeding Experiment as compared to the conventional Marine Corps battalion size system.

The enhanced designs of both the XM-75 and XM-76 systems allow them an increased efficiency, which in turn effects a labor savings when compared to the conventional system. Therefore, the intent of this analysis is to compare, on a basis for economic decision, the labor saving attributes of the alternative systems as opposed to the capital investment requirements of these systems and in so doing provide a basis for economic decision.

Annual cost comparisons will be used as the basis for the economic decisions. Annual costs have the advantage of incorporating into a single figure, the investment and recurring annual costs associated with each alternative. In this analysis, only those costs which vary with the alternatives will be considered.

Assumptions

The following assumptions were made in performing this analysis:

(1) The discount rate is 10%.

(2) Salaries, benefits, and all other costs remain constant over the period of analysis.

(3) The analysis includes only those costs which are subject to variation within the alternatives.

(4) The menu selected is assumed to remain the same for all alternatives. Thus, food costs remain constant and do not affect the outcome of the analysis.

(5) Troop strengths remain constant over the period of analysis.

(6) The age of the equipment presently being used in the control system is homogeneous (i.e., some items are new, while others approaching wearout are about to be replaced with the remainder equally distributed between these extremes). Thus, the annual investment expenditure for replacement equipment in the control system is given by the ratio C/L where C is the cost of the equipment in dollars and L is its economic life in years.

(7) The alternative systems will replace the control systems on a one for one basis at the battalion level.

(8) Non-disposable mess gear is used by each system.

The following elements have been identified as major cost areas in the field feeding system studies[2]:

(1) Labor

(2) Food

(3) Equipment

(4) Transportation

(5) Mess gear equipment and cleaning

(6) Kitchen trucks

(7) Fuel

For purposes of this analysis, labor and equipment were the only cost areas which were subject to variation within the systems. All systems served the same menu, therefore, food cost and the cost to transport the rations are the same. As stated above, one of the assumptions was that all systems used non-disposable mess gear. Therefore, mess gear equipment and cleaning costs would be the same for each system since each system utilized the same mess kit wash lines. Based on the volume of equipment, number of personnel, and the cube of the rations to be transported, each system would require five 2-1/2 ton kitchen trucks for operational use. Data taken at the Camp Pendleton Experiment also indicates that fuel costs are approximately the same for each system.

Labor Costs

The following elements were used to calculate labor costs:

(1) Salary and Benefits

(2) Support Costs

(3) Training Costs

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[2] Smith, R. S., et al, "A System Evaluation of Consolidated Field Feeding for the Army", Technical Report 75-83, OR/SA, US Army Natick Development Center, Natick, MA 01760, February 1975.

(4) Rotation Costs

(5) Initial Clothing and Accession Costs

These elements were combined to obtain a uniform annual labor cost for each MOS and pay grade that is used in staffing a kitchen system[3].

One of the objectives of the Camp Pendleton Experiment was to determine the feasibility of feeding 800-1000 Marines more efficiently by utilizing experimental systems. Therefore, the staffing levels of the XM-75 and XM-76 systems, as determined from this experiment, together with the Marine Corps personnel requirements will be used to calculate labor costs. Staffing by grade and MOS along with labor costs for the conventional (Standard Marine Corps) system is included in Table 1 of Appendix A.

Benefits

The work sampling analysis of the Camp Pendleton Experiment indicates that both the XM-75 and XM-76 systems effect a labor savings of 2 cooks[4] and 5 messmen over the control system[5]. Based on a weighted average of E-2, E-3, E-4, and E-5 cooks, the annual savings would be $8,670 per cook and $7,745 per messman. Therefore, both the XM-75 and XM-76 systems would result in labor savings of $56,065 per year for a battalion size kitchen.

Capital Investment

Equipment costs for the conventional, XM-75 and XM-76 systems are exhibited in Appendix A. The equipment was analyzed in two categories, equipment which is presently being used in the conventional system and that which is being introduced in the XM-75 and XM-76 systems. The annual costs for the equipment in the conventional system were calculated by dividing the cost of the equipment in dollars by its economic life in years[6]. The annual costs for new equipment were calculated by taking into account the purchase price, economic life, and the discount rate of the investment dollars. The discount rate and the economic life were used to calculate the capital recovery factors. The capital recovery factors can be obtained from tables or computed from the formula[7]:

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[3] Labor Cost Information, Commandant of the Marine Corps, LFS-4-rbs, 29 October 1975.

[4] This is a conservative estimate based on the difference between current staffing levels and the experimental systems. The data from the experiment demonstrated that the control system was understaffed by 2 cooks thus making a net savings of 4 cooks.

[5] Op. Cit. 1

[6] SB 10-496, Supply Control - Replacement Factors, Headquarters, Department of the Army, November 1972.

[7] Barish, Norman N., Economic Analysis, McGraw-Hill Book Company, New York, 1962.

$$\text{Capital Recovery Factor} = \frac{i\,(1 + i)^n}{(1 + i)^n - 1}$$

where i is the discount rate

and n is the economic life in years

The annual costs were then obtained by multiplying the capital recovery factor times the purchase price of the equipment item. The annual cost comparison provides a common denominator for economic decisions and a tool for budget planning and control.

The initial investment requirements of an alternative system can be a prime consideration in any cost benefits study. Assuming that the Marine Corps will require sixty three systems to equip three divisions, the initial investment for new equipment required by the XM-75 and XM-76 systems is as follows (Appendix B):

	XM-75	XM-76
Cost of new equipment and provisioning	$30,753	$42,479
Investment required for 3 Divisions (63 systems)	$1,769,895	$2,635,680

Payback Period

When the funds available for capital investment are limited, the speed with which invested funds are returned to the organization becomes a criterion of some importance in capital investment decision making. The labor saving attributes of the XM-75 and XM-76 generate gross annual savings of $56,065 for an infantry battalion. However, this figure must be adjusted to account for the recurring expense of equipment replacement as it wears out. Thus, the net annual savings of the XM-75 and XM-76 systems are $50,764 and $50,070, respectively, as shown in Table 1. By comparison, required investments in new equipment are $30,753 and $42,479, respectively (see Tables 3 and 4 and Appendix A for calculations). The payback period for these two systems is calculated as follows:

$$\text{Payback Period XM-75} = \frac{\$30,753}{\$50,764} = .60 \text{ years}$$

$$\text{Payback Period XM-76} = \frac{\$42,479}{\$50,070} = .85 \text{ years}$$

Therefore, both the XM-75 and XM-76 would recover their new equipment investments in less than one year.

TABLE 1. Annual Costs for Battalion Level Field Feeding Systems

	Conventional	XM-75	XM-76
Labor Cost	$302,587	$246,522	$246,522
Equipment Capitalization Cost (See Appendix A)	14,095	19,392	20,090
Total Cost Per System	$316,682	$265,918	$266,612
Annual Savings Compared to Conventional		$ 50,764	$ 50,070

Breakeven Analysis

Costs may be subject to variation as a system goes through its life cycle and as the military and economic environments change. It is therefore necessary to establish a cost ceiling for each system. Breakeven analysis is an analytical technique which is often applied to establish these cost limits. For purposes of this analysis, we shall define the breakeven point as that maximum amount which can be invested in a new system given that it is not necessary to effect a cost savings when compared to the conventional system. To make this calculation, we will assume a discount rate of 10 percent and an average system life of 4 years. Both the XM-75 and XM-76 effect labor savings of $56,065 annually per system. These savings can be anticipated for the life of the system. By taking the present worth of this uniform series of savings (USPW), we can compute the breakeven point[8]:

$$\text{Breakeven Point} = \$56{,}065 \begin{pmatrix} \text{USPW} \\ i = 10 \\ n = 4 \end{pmatrix}$$

$$\text{where USPW} = \frac{(1+i)^n - 1}{i\,(1+i)^n}$$

n = average years of life

i = discount rate

$$\text{Breakeven Point} = \$56{,}065\ (3.170)$$

$$= \$177{,}726$$

Therefore, $177,726 can be invested in the new system before the labor savings are offset and the system costs are equivalent to the conventional system.

[8] Op. Cit. 7

Division Operating Costs

The reduced operating costs expected with the XM-75 and XM-76 systems have previously been computed based on a typical Marine Corps infantry battalion. Of primary interest to decision makers is the extension of these savings across an entire Division.

A Marine Corps Division currently is provided its hot meals by 21 field kitchens varying in size from 1377 to 183 customers. The use of the XM-75 and XM-76 systems would be expected to reduce annual operating costs by $1.838 and $1.637 million, respectively (see Appendix B) for the three active Marine Divisions. It should be noted that these savings reflect the capitalization of the new equipment and replacement due to wearout.

Conclusions

The following conclusions can be drawn from this analysis.

(1) The XM-75 and XM-76 yield respective savings of $50,764 and $50,070 per system annually compared to the conventional system at the battalion level

(2) The XM-75 requires a new equipment investment of $30,753 per system. The payback period for this investment is approximately seven months.

(3) The XM-76 requires a new equipment investment of $42,479 per system. The payback period for this investment is approximately ten months.

(4) Considering the potential for personnel savings achieved with the XM-75 and XM-76 systems, the breakeven point for investment in a system is $177,726 at the battalion level.

(5) The XM-75 and XM-76 systems would be expected to reduce food service labor costs by $2.526 million annually for the three active Marine Divisions. Discounting this savings for equipment replacement would reduce this figure to $1.838 million annually for the XM-75 and $1.637 million annually for the XM-76.

CHAPTER III

SYSTEMS EFFECTIVENESS ANALYSIS

The Army and Marine Corps, while striving to determine more efficient approaches to the employment of their resources, are constrained by financial, personnel, and other limitations. When alternate approaches to meeting a requirement are proposed, it is frequently very helpful to decision makers if a methodology is available to evaluate the comparative effectiveness and cost benefits of these alternatives. The factors to be considered generally concern the impact of new concepts on overall performance, trends in effectiveness as related to the conventional approach, as well as cost and performance limits. The desired result is to rank the alternative systems in order of preference based on cost and systems effectiveness. The overall evaluation must include consideration of non-quantifiable factors as well as analysis of quantitative data.

Since a cost analysis of the alternative systems is presented in a prior chapter, this chapter will present the systems effectiveness analysis and the integration of the two elements into a relative worth determination. The effectiveness of a system is the degree to which the ability of a force to perform its mission is improved or degraded by the introduction of the system[9]. A model of systems effectiveness has been determined for the conventional, XM-75 and XM-76 systems and is presented in Figure 1. The three main parameters of this model are performance, human factors, and maintainability/reliability. A measure of effectiveness was determined for each of these parameters. Each of these parameters were subdivided into a series of effectiveness factors. These individual factors were weighted with a point score between .05 and .20 in terms of their importance in the effective operation of a field feeding system. The measure of effectiveness for each parameter and the total system were determined by the weighted summation of these effectiveness factors. It is noted that the weightings given to the various system effectiveness factors are based upon the experience and best judgment of the authors. The reader is encouraged to use his own best judgment, establish his own weightings and recalculate the effectiveness ratings. A sample calculation of effectiveness for one factor is shown in Appendix C. The effectiveness factors of this model are described as follows:

(1) Productivity is the measured output in number of meals per man hour of effort (weighted as .20).

(2) Sanitation is evaluated as the effort required to accomplish all sanitation tasks, excluding individual mess gear; effectiveness of sanitation equipment; and microbiological assessment (weighted as .15).

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[9]Cost and Operational Effectiveness Analysis Handbook, United States Army Training and Doctrine Command, Pamphlet 11-8, Fort Monroe, Virginia 23651.

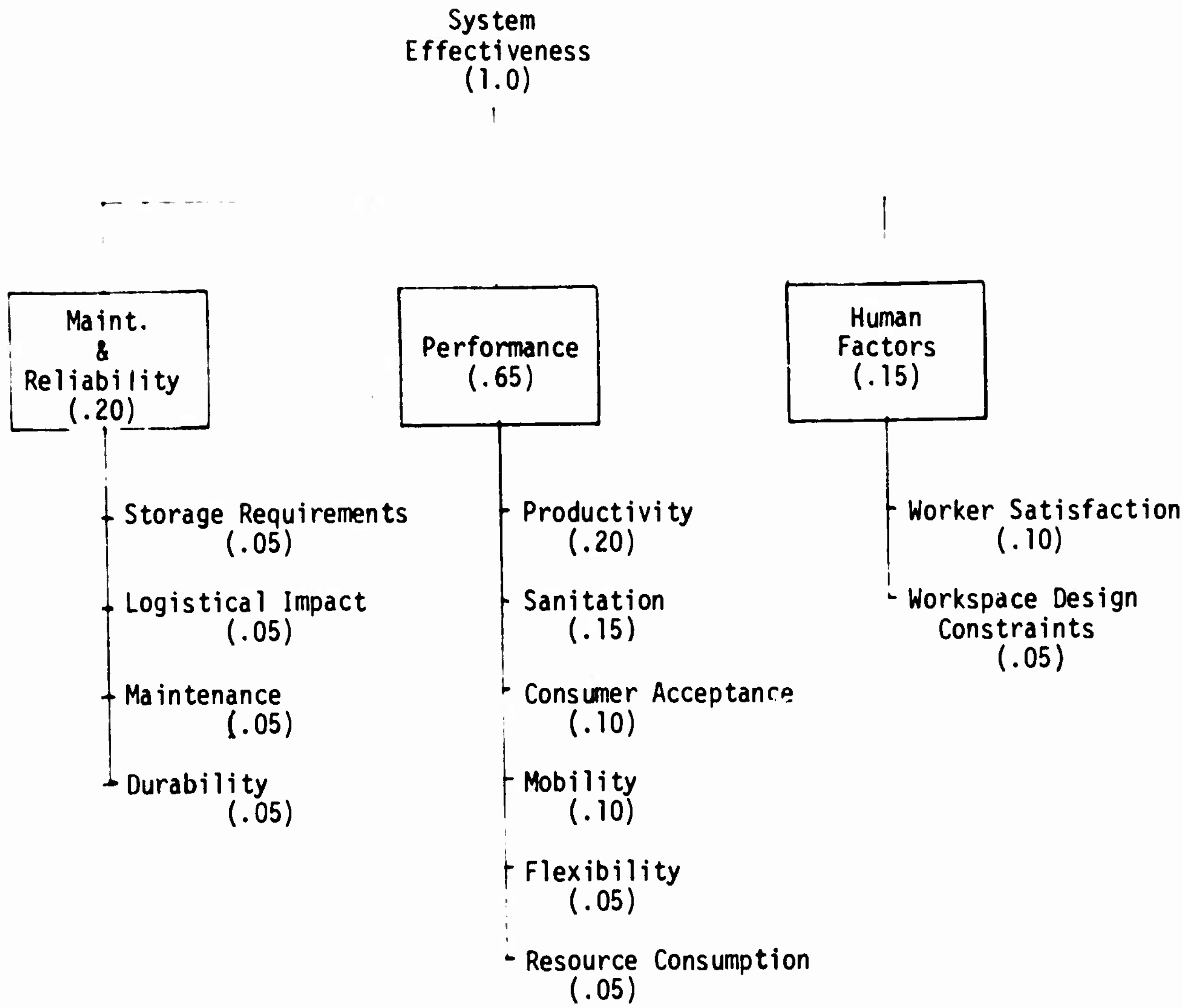

Figure 1. Field Feeding Systems Effectiveness Model

(3) The consumer acceptance is the quality of the food as evaluated by consumers at remote sites (weighted as .10).

(4) Mobility is the total amount of time required to displace a kitchen system, including tear down, on-loading, off-loading, and set-up (weighted as .10).

(5) Worker satisfaction is the overall worker assessment of the work environment of each system (weighted as .10).

(6) Indicate workspace design constraints the adequacy of achieving human factors criteria as specified in MIL-STD-1472B (weighted as .05).

(7) Resource consumption is the amount of fuel and water required daily (2 meals) for cooking and kitchen sanitation (weighted as .05).

(8) Storage requirement is the cube of the systems (weighted as .05).

(9) Logistical impact is the provisioning, spare parts and transportation requirements of each system (weighted as .05).

(10) Maintenance is a measure of the level of effort required to maintain a field feeding system (weighted as .05).

(11) Durability is a measure of the systems ability to withstand repeated performance of the mission (weighted as .05).

(12) Flexibility is the capability to tailor the system to meet various work loads and the capability to operate as two widely separated locations with each increment properly tailored to support assigned workload (weighted as .05).

The prime source of data for input into the operational effectiveness model is the Camp Pendleton Field Feeding Experiment[10]. This type of field experiment produces data which are very valuable in performing a systems analysis. The following numerical values for the operational model of the systems under study were obtained from the experimental data:

(1) The conventional, XM-75 and XM-76 systems yield productivity of 4.4, 6.3, and 6.4 meals per man-hour, respectively[11]. This productivity and the corresponding weight factors translate into system ratings of .138, .197, and .200 for the conventional, XM-75 and XM-76 systems.

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[10] Op. Cit 1

[11] Op. Cit 1

(2) The sanitation ratings are based on the evaluation of surfaces of work tables, pots, pans, and utensils by Rodac plates[12]. The conventional and new systems yielded 38% and 56% satisfactory tests on the total surfaces tested System ratings for the conventional, XM-75 and XM-76 were .098, .150, and 150, respectively.

(3) Consumer acceptance of food items is determined from data taken from remote sites[13]. Based on a 9-point hedonic scale the values for the conventional, XM-75 and XM-76 were 7.2, 7.1, and 7.5. The weighting factors given the conventional, XM-75 and XM-76 system ratings of .096, .095, and .100, respectively.

(4) The mobility characteristics of each system were based on estimated total displacement time. The XM-76 was rated superior primarily due to the fact that much of the equipment is already in place and does not require on or off loading. Total displacement time for the XM-76 is therefore estimated to be 30% less than for either the conventional or XM-75 systems.

(5) No significant difference was observed in the resource consumption of the three systems, therefore, they are all assigned the same ratings in these categories.

(6) The cubes of the systems were calculated and shown in the following table (the cubes include mount out boxes for overseas shipment):

	Conventional	XM-75	XM-76
Cube (ft^3)	1,420	1,373	3,005

Based on these values, the systems would receive effectiveness ratings as follows:

	Conventional	XM-75	XM-76
Cube	.048	.050	.023

(7) The overall worker ratings of the conventional, XM-75 and XM-76 are 4.80, 6.50, and 4.00, respectively[14]. These ratings were based on a seven point Likert scale. Applying the weighting factor gives these three systems ratings of .074, .100, and .062.

(8) The design constraint rating is evaluated based upon the number of serious defects which present potential safety hazards in the systems[15]. The XM-76 contained the greatest number of potential safety hazards followed by the conventional and the XM-75 in that order.

(9) The logistical impact, maintenance, durability, mobility, and flexibility are factors which are non-quantifiable from the experimental data. Judgmental decisions based upon observations of the experiment were applied in establishing these rankings.

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[12] Op. Cit. 1

[13] Op. Cit. 1

[14] Op. Cit. 1

[15] Op. Cit. 1

Results

Table 2 presents a comparison of the ratings of all three systems. The XM-75 exhibits the greatest operational effectiveness with a rating of .912 of a possible 1.00, followed by the XM-76 and the conventional systems with ratings of .880 and .779, respectively. Although the XM-76 maintains a high level of productivity, the effectiveness of this system is limited by a low level of worker satisfaction, high cube, and the existence of work space design constraints. Therefore, on the basis of systems effectiveness, the XM-76 scored lower than the XM-75 system.

Up to this point, the cost analysis and the systems effectiveness have been treated separately. The ideal relationship is to integrate both measures and produce a relationship indicating the cost of achieving a certain level of effectiveness. This relationship is usually expressed as a ratio[16] and is valuable in providing guidance for decision makers.

The main purpose of this analysis is to determine the extent to which new candidate field feeding systems improve the Marine Corps when compared to their present capability. Relative worth of a system is a means frequently employed in developing cost and systems effectiveness analysis to be used by decision makers for making comparisons between competing systems[17]. This technique is used as part of the analysis for the field feeding systems. Relative worth is a combination of the relative cost and effectiveness of each system. Relative cost is the ratio of the cost of the alternative system divided by the cost of the conventional system. Relative effectiveness is the same type of ratio using the measures of systems effectiveness. The relationships are as follows:

$$\text{Relative Cost} = \frac{\text{Annual Cost of Alternative System}}{\text{Annual Cost of Conventional System}}$$

$$\text{Relative Effectiveness} = \frac{\text{Effectiveness of Alternative System}}{\text{Effectiveness of Conventional System}}$$

$$\text{Relative Worth} = \frac{\text{Relative Effectiveness}}{\text{Relative Cost}}$$

Relative worth normalizes the cost and operational effectiveness relationships with the conventional system assigned the unit value. A new system is considered preferable to the old when the relative worth is greater than one. The calculation of these ratios is shown in Table 3. Annual costs were obtained from the previous chapter.

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[16] Op. Cit. 9

[17] Op. Cit. 9

TABLE 2. SUMMARY OF SYSTEMS EFFECTIVENESS FOR FIELD FEEDING SYSTEMS

	Conventional	XM-75	XM-76
1. Productivity	.138	.197	.200
2. Sanitation	.098	.150	.150
3. Consumer Acceptance	.096	.095	.100
4. Mobility	.070	.070	.100
5. Worker Satisfaction	.074	.100	.062
6. Resource Consumption	.050	.050	.050
7. Storage Requirement	.048	.050	.023
8. Design Constraints	.030	.050	.030
9. Logistical Impact	.050	.030	.040
10. Maintenance	.050	.040	.035
11. Durability	.040	.040	.040
12. Flexibility	.035	.040	.050
Total Systems Effectiveness	.779	.912	.880

TABLE 3

COST AND SYSTEM EFFECTIVENESS COMPARISON OF
CONVENTIONAL, XM-75, AND XM-76 SYSTEMS

	Conventional	XM-75	XM-76
Annual Cost for one System*	$316,682	$265,768	$266,612
Operational Effectiveness	.779	.912	.880
Relative Cost	1.0	.840	.840
Relative Effectiveness	1.0	1.170	1.130
Relative Worth	1.0	1.39	1.34
% Increase in Relative Worth Compared to Conventional System	-	39%	34%

*Labor and equipment

Conclusions

Table 3 summarizes the results of this analysis. The following conclusions can be drawn from this presentation:

(1) On the basis of cost and systems effectiveness, both the XM-75 and XM-76 are superior to the conventional field feeding system.

(2) The XM-75 is the preferred candidate for a battalion level field feeding system. In terms of relative worth, the XM-75 is worth 39 percent more than the conventional system and 5 percent more than the XM-76.

(3) The XM-76 represents a 34 percent relative worth improvement when compared to the conventional system.

APPENDIX A

Personnel and Equipment Costs

TABLE A-1

Staffing Level for Conventional System Authorized
TOE Strength of 1000 Personnel

1	E-7	Supervisor	MOS	3381	@	$14,224/annum	14,224
1	E-6	Supervisor	MOS	3371	@	$12,197/annum	12,197
1	E-5	Cooks	MOS	3371	@	$10,463/annum	10,463
3	E-4	Cooks	MOS	3371	@	$ 9,334/annum	28,002
1	E-4	Baker	MOS	3311	@	$ 9,145/annum	9,145
1	E-3	Baker	MOS	3311	@	$ 8,084/annum	8,084
6	E-3	Cooks	MOS	3371	@	$ 8,273/annum	49,638
2	E-2	Cooks	MOS	3371	@	$ 7,967/annum	15,934
20	Mess Attendants				@	$ 7,745/annum	154,900
	Total Annual Labor Cost						$302,587

TABLE A-2

Equipment Cost for Conventional System

Quantity	Item	Unit Cost	System Cost	Years Life	Annual Cost
3	Tent; G.P. Medium	$812	$ 2,436	1	$ 2,436
14	Range Outfits Complete	772	10,808	4	2,702
4	Accessory Outfits	83	332	3	110
35	Immersion Heaters	92	3,220	4	805
8	Tableware, Field	210	1,680	1	1,680
59	Food Containers, Ins	71	4,187	2	2,094
36	Jug, Val 3 Gal	93	3,348	1	3,348
40	G. I. Cans	23	920	1	920
	Total Costs		$26,931		$14,095

TABLE A-3

Equipment Cost for XM-75 System

Quantity		Unit Cost	System Cost	Years Life	Annual Cost
1	Tent, Kitchen, Frame	$2,844	$2,844	8	$ 533
	Fabric	2,300	2,300	2	1,325
	Fly	856	856	1	942
2	Pot Shack & Dry Storage, Frame	1,091	2,182	8	409
	Fabric	869	1,738	2	1,001
	Fly	240	480	1	528
4	Griddle & Food Warmer Components	1,800	6,800	8	1,275
	Griddle	400	1,600	1	1,760
10	Work Table Tops	50	500	4	158
	Legs	75	750	8	141
4	Sanitizing Sinks, Complete	550	2,200	8	412
4	Shelving	90	360	2	207
1	Hot Water Heater	3,500	3,500	8	656
20	Duck Boards	40	800	1	880
1	Meat Slicer, Electric	500	500	8	94
1	Veg. Cutter, Electric	1,000	1,000	8	169
1	Opener Can, Electric	95	95	2	55
1	Serving Utensils	300	300	8	56
8	Pan B & R w/o Cover	56	448	4	112
20	Jugs, Ins. Bev Disp	50	1,000	1	1,100
	Total New Equipment		$30,253		$11,813
*12	Range Outfits Complete	772	9,264	4	2,316
*10	Burner Units, M-2A	135	1,350	4	338
* 4	Accessory Outfits	83	332	3	111
*50	Food Containers, Ins.	71	3,550	2	1,775
* 8	Tableware, Field	210	1,680	1	1,680
*30	G. I. Cans, Field	23	690	1	690
*25	Immersion Heaters	92	2,300	4	575
	Total Conventional Equipment		$19,166		$ 7,485
	Manuals nd Operating Instructions		500		94
	Total System Cost		$49,919		$19,392

*Items currently in system and obtainable from Conventional System.

TABLE A-4

Equipment Cost for XM-76 System

Quantity	Item	Unit Cost	System Cost	Years Life	Annual Cost
3	Government Furnished Property for Kitchen, Field, Trailer Mounted (Ref. Mil Spec MIL-K-43911 (GL))	$ 2,480	$ 7,440	Variable	$ 2,706
3	Contractor Cost Kitchen, Field, Trailer Mount Total Procurement Cost $10,952	6,388	19,164	4	6,046
1	Connecting Platform	2,500	2,500	4	789
2	Pot Shack & Dry Storage, Frame	1,091	2,182	8	409
	Fabric	869	1,738	2	1,001
	Fly	240	480	1	528
4	Sanitizing Sinks, Complete	550	2,200	8	412
4	Shelving	90	360	2	207
1	Hot Water Heater	3,500	3,500	8	656
8	Duck Boards	40	320	1	352
1	Meat Slicer, Electric	500	500	8	94
1	Veg. Cutter, Electric	1,000	1,000	8	169
1	Can Opener, Electric	95	95	2	55
20	Jugs, Ins Bev Disp	50	1,000	1	1,100
	Total New Equipment		$42,479		$14,524
* 6	Range Outfits, Complete	772	4,632	4	1,158
*16	Burner Units M-2A	135	2,160	4	540
* 8	Tableware, Field	210	1,680	1	1,680
*30	G.I. Cans, Field	23	690	1	690
*25	Immersion Heaters	92	2,300	4	575
*26	Food Containers, Ins.	71	1,846	2	923
	Total Conventional Equipment		$13,308		$ 5,566
	Total System Cost		$55,787		$20,090

*Items currently in system and obtainable from Conventional System.
It is assumed that the Government Furnished Range Cabinets and Burner Units could be supplied from already existing stock.

Appendix B

Cost Reduction in Marine Corps Divisions

The information and data provided in this appendix extends the results of the economic analysis across the three active Marine Corps Divisions. Since the XM-75 is a modular system, two variants have been defined for use by smaller units. The intermediate version, designated XM-75A with less equipment and shelters, would support between 300 and 600 Marines and cost an estimated $21,039. The smallest version designated XM-75B, would support between 100 and 300 Marines and would cost an estimated $14,013.

Implementation of the XM-76 system would also require several versions. For this analysis it was assumed that two MKT's (XM-76A) would handle those units requiring a capacity of between 300 and 600 Marines and would cost $29,817. A single MKT (XM-76B) was used for all units with troop strengths below 300 and would cost $13,231. Both the XM-76 A and B were provided with the same sanitation equipment and shelter as the XM-75 A and B. Anticipated personnel savings are shown in Table B-1 and are identical for the XM-75 and XM-76.

TABLE B-1

Personnel Savings in Divisional Units

Divisional/Units	No. Systems Required	Personnel Requirements: Cooks Conv**	Cooks XM-75	Messmen Conv**	Messmen XM-75	Savings Cooks	Savings Messmen
HQ Bn	1	23	20	31	26	3	5
Infantry Bn	9	171	153	243	197	18	45
Artillery (DS) Bn	3	42	36	39	27	6	12
Artillery (GS) Bn	1	14	12	13	9	2	4
HQ, Art. Bty*	1	6	6	6	5	0	1
Engineer Bn	1	13	11	17	13	2	4
Reconnaissance Bn	1	9	9	11	9	0	2
Motor Transport Bn	1	7	7	7	6	0	1
HQ CO*	3	15	15	15	15	0	0
Total	21	300	269	382	308	31	74

* Regiment
** Conventional System

TABLE B-2. CAPITAL INVESTMENT AND CAPITALIZED COSTS FOR XM-75 FIELD FEEDING SYSTEMS

EQUIPMENT	NUMBER REQUIRED PER DIVISION	ACTUAL COST ($)	CAPITALIZED COST ($)
XM-75	10	302,530	118,130
XM-75A	6	126,234	50,494
XM-75B	5	70,065	27,235
Spare	-	80,136	31,399
Total Equipment Cost Per Division		578,965	227,258
Total Equipment Cost For 3 Divisions		1,736,895	681,774
Manuals and Operating Instructions		33,000	6,204
Total Cost For 3 Divisions		1,769,895	687,978

TABLE B-3. ANNUAL COST SAVINGS FOR 3 MARINE DIVISIONS (XM-75)

Category	No. of Personnel	Annual Salary & Benefits	Annual Labor Savings ($)
Cooks	93	8670	806,310
Messmen	222	7745	1,719,390
Total Labor Savings			2,525,700
Capitalized Equipment Costs			687,980
Net Annual Savings			1,837,720

TABLE B-4. CAPITAL INVESTMENT AND CAPITALIZED COSTS FOR XM-76 FIELD FEEDING SYSTEMS

EQUIPMENT	NUMBER REQUIRED PER DIVISION	ACTUAL COST ($)	CAPITALIZED COST ($)
XM-76	10	424,790	145,240
XM-76A	6	178,902	58,458
XM-76B	5	66,155	53,000
Spare	-	109,464	39,664
Total Equipment Cost Per Division		779,311	296,362
Total Cost for 3 Divisions		2,337,933	889,086

TABLE B-5. ANNUAL COST SAVINGS FOR 3 MARINE DIVISIONS (XM-76)

Category	No. of Personnel	Annual Salary & Benefits	Annual Labor Savings ($)
Cooks	93	8670	806,310
Messmen	222	7745	1,719,390
Total Labor Savings			2,525,700
Capitalized Equipment Costs			889,086
Net Annual Savings			1,636,614

Appendix C

Effectiveness Calculations

In terms of operational effectiveness, the maximum score using the system model would be 1.0. This score is obtained by summing the weights for each effectiveness factor. The following is a sample calculation for the productivity of each system:

(1) Data from the Camp Pendleton Experiment indicates that the conventional XM-75 and XM-76 systems produce 4.4, 6.3, and 6.4 meals per man-hour, respectively.

(2) The weight of the effectiveness factor is .20.

(3) The XM-76 has the highest productivity and is, therefore, scored .20, the highest value for this factor and the base rating for this criteria.

(4) The scores for the conventional and XM-75 are calculated based on the following relationship:

$$\text{System Rating} = \frac{(\text{Weight Factor}) \times (\text{Measure of Effectiveness})}{(\text{Effectiveness Measure of Best System})}$$

$$\text{XM-75 Productivity Score} = \frac{(.20) \times (6.3)}{(6.4)} = .197$$

$$\text{Conventional Productivity Score} = \frac{(.20)\ (4.4)}{(6.4)} = .138$$

(5) Therefore, the conventional XM-75 and XM-76 systems were given productivity scores of .138, .197, and .200.

The calculations for the other effectiveness factors are performed in a similar fashion.

APPENDIX D

Exterior Views and Layouts of Conventional, XM-75, and XM-76 Systems

Figure D-1. Conventional Kitchen: Exterior View

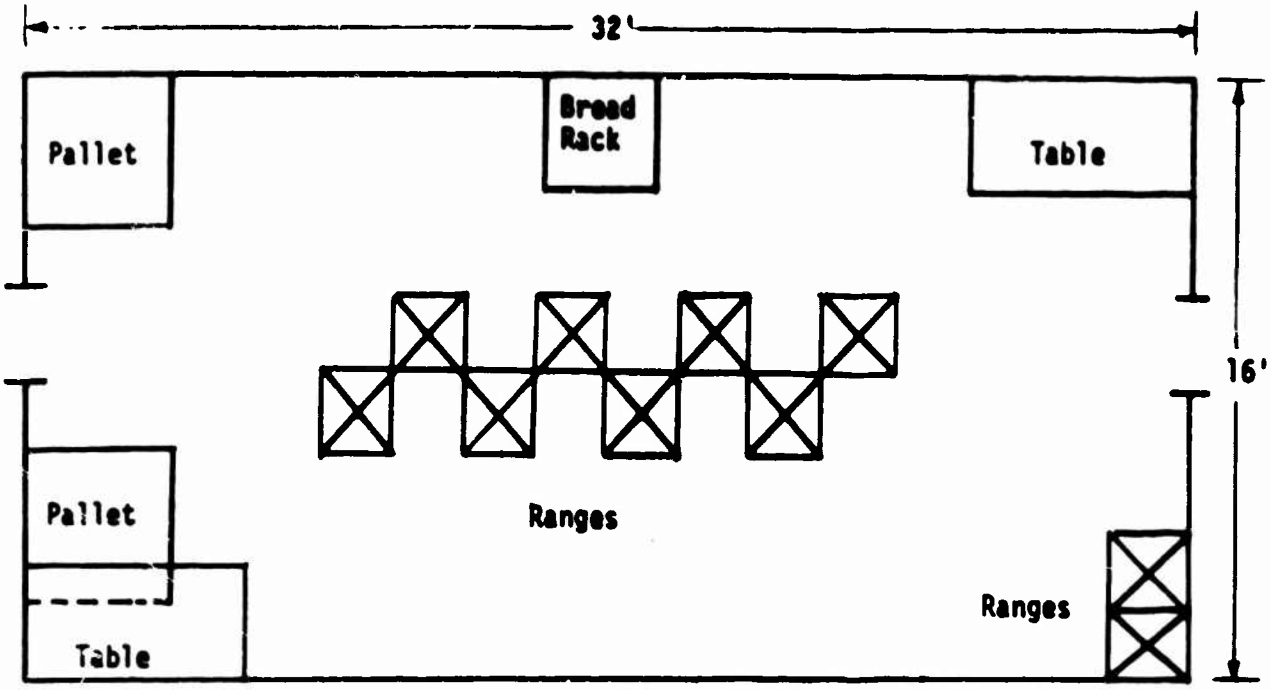

Figure D-2 Layout of Control Kitchen (above) and Serving Line (below)

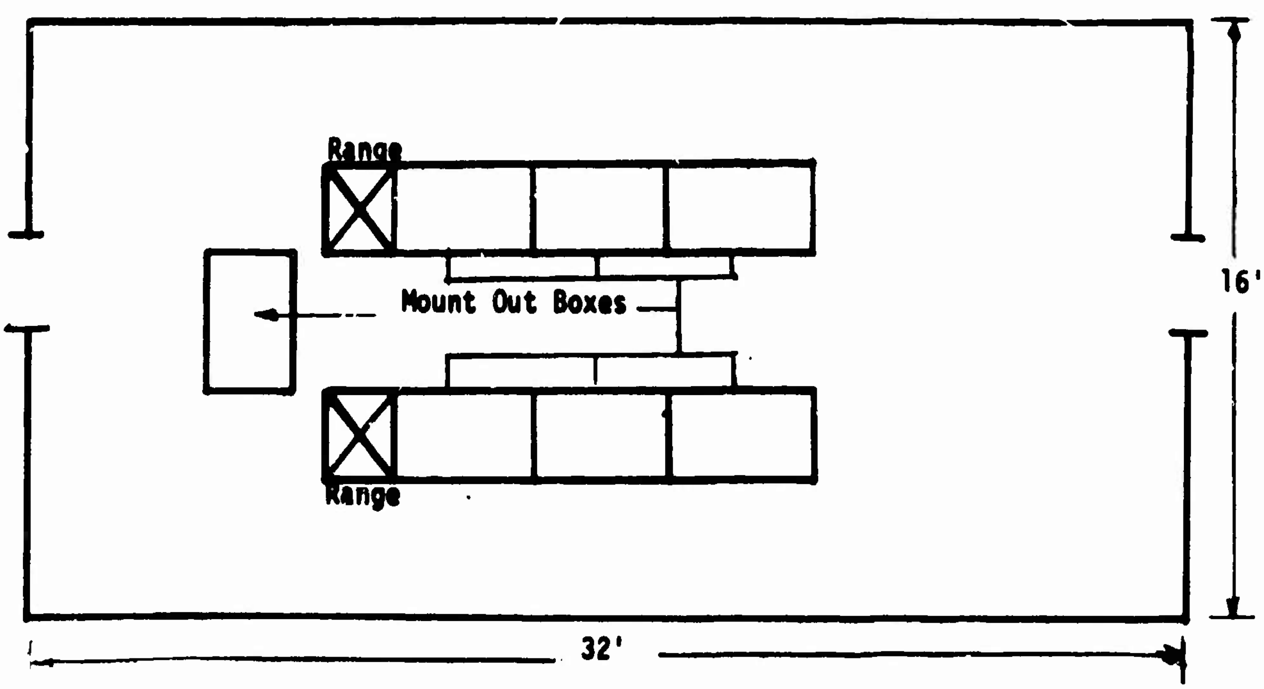

Figure D-3. XM-75 Kitchen: Exterior View

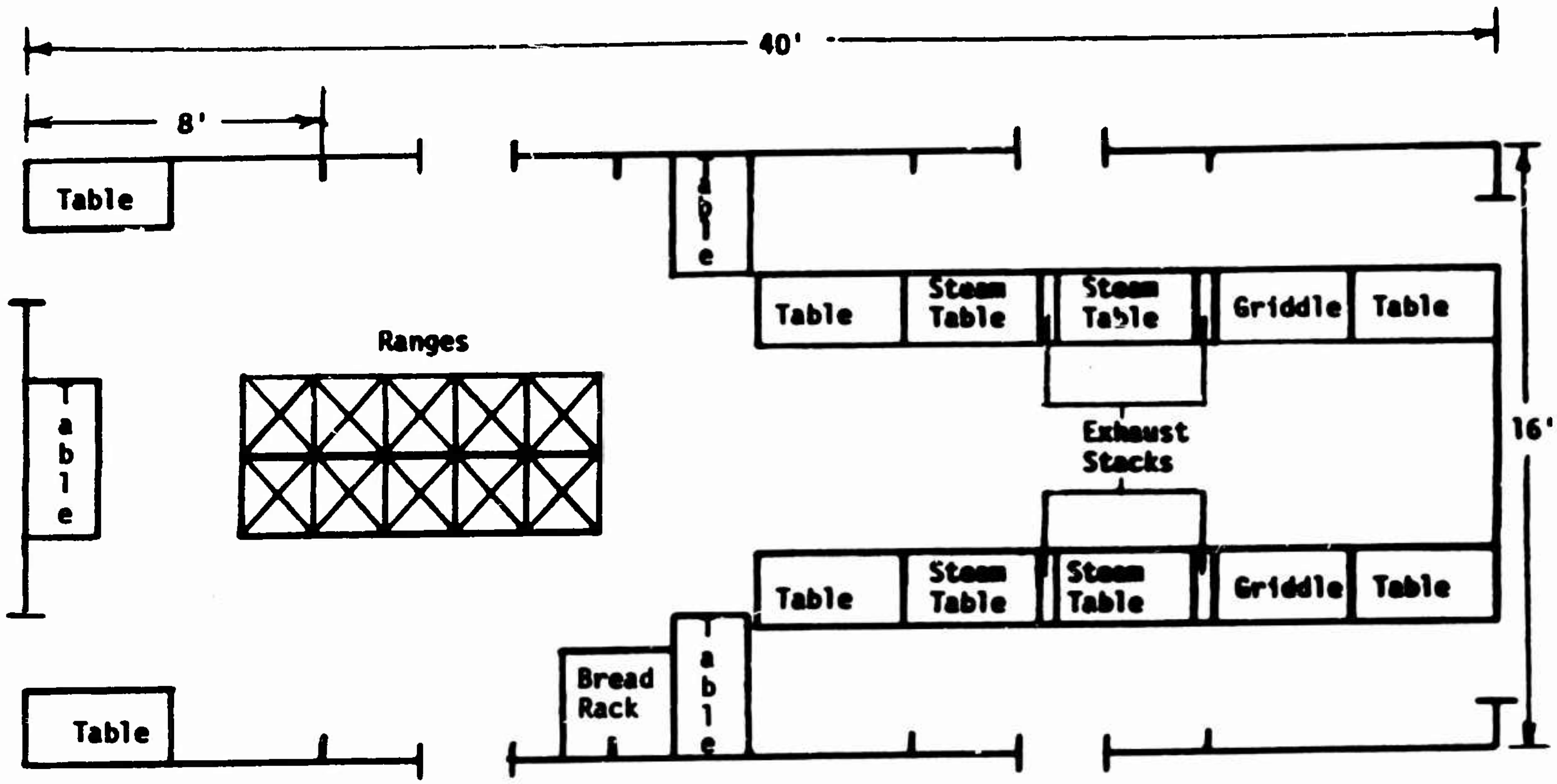

Figure D-4 Layout of XM-75 Kitchen

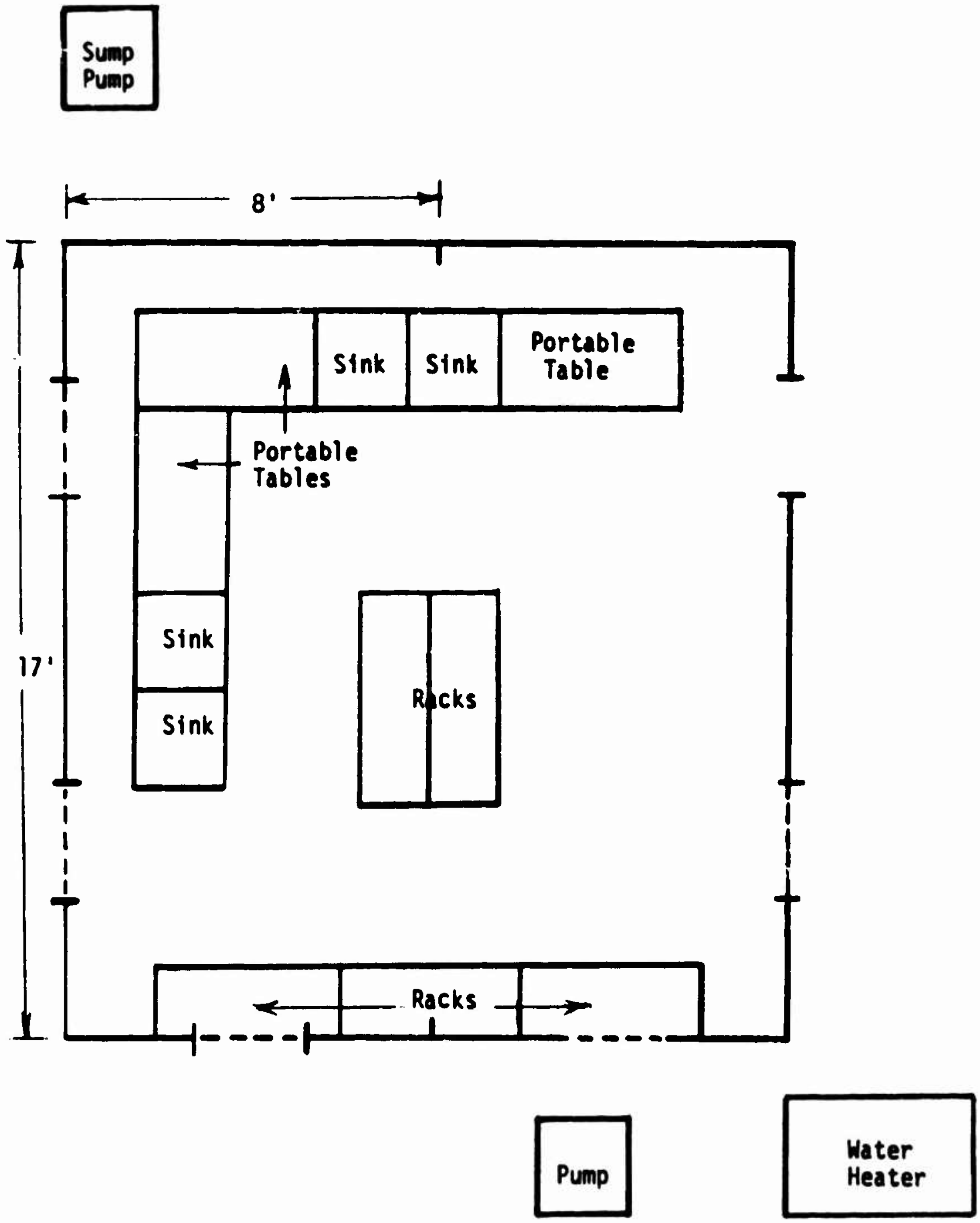

Figure D-5. Layout of Sanitation Center

Figure D-6. XM-76 Kitchen: Exterior View

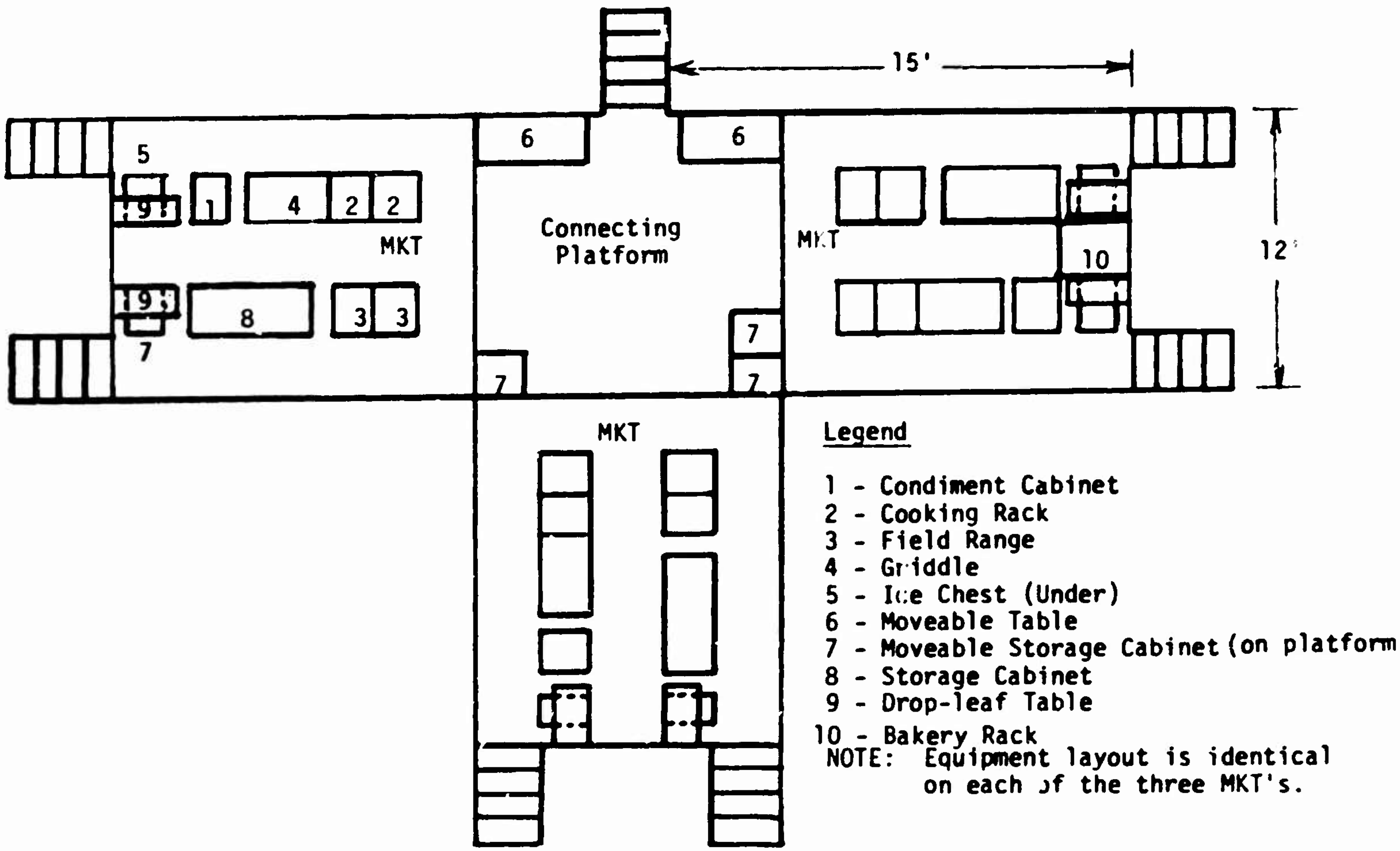

Figure D-7. Layout of XM-76 Kitchen