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EVALUATION OF AN ADVANCED PREPARATION HOSPITAL FOOD SERVICE SYSTEM

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) An experiment was conducted at Moncriel Army Hospital, which was operating at 250 beds, at Fort Jackson, SC, to test the effectiveness of an Advanced Preparation Food Service System that employs a combination of cook-freeze, cook-chill, and cook-serve production methods along with rethermalization carts for patient tray delivery. The Advanced Preparation System is projected to be more cost effective and has equal or better food acceptance for both dining room patrons and patients than the original conventional system, which employs cook-serve production techniques. The test results support a recommendation that the Army		

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SUMMARY

An Advanced Preparation Food Service System that utilizes a rethermalization cart for patient tray delivery is a feasible and effective approach to integrate into future Army hospital construction. The most prominent advantages are: 1.) cost effectiveness through labor reduction; 2.) equal or better patient and dining room patron food acceptance; and 3.) increased military mobilization capability as compared to a conventional system. Equally important, the Advanced Preparation system can be operated within existing food cost budgets and with microbiological safety. It is expected that future testing will achieve similar results in a medical center-size facility.

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PREFACE

The Directorate for Systems Analysis and Concept Development (DSACD) of the US Army Natick Research and Development Center was tasked by the Office of the Surgeon General (OTSG) to conduct a systems analysis of Army hospital food service operations. The project has been conducted in two phases.

Phase I defined and evaluated conventional Army hospital food service operations and recommended a Frozen-Ready Food Service System concept for Army hospitals. That effort is documented by Technical Report NATICK TR-78/031 entitled "A Systems Analysis of Army Hospital Food Service Operations," dated March 1978.

The objective of Phase II was to develop a new food service system based on the Frozen-Ready concept that could be incorporated into existing Army hospitals. An Advanced Preparation System, a version of the Frozen-Ready concept, was installed for testing at Moncrief Army Hospital, Ft. Jackson, SC. The following report documents the results of the test with specific recommendations for improving food service in both new and existing Army hospitals.

The work reported in this Technical Report was completed under Military Service Requirement US Army 78-4 (MSR A78-4), of the DoD Food Research, Development, Testing, and Engineering Program; Project Number 1L162724AH99A, entitled "Analysis and Design of Military Feeding Systems."

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EVALUATION OF AN ADVANCED PREPARATION HOSPITAL FOOD SERVICE SYSTEM

I. INTRODUCTION

Objectives

In response to a requirement generated by the US Army Office of The Surgeon General (OTSG), the Directorate for Systems Analysis and Concept Development (DSACD) of the US Army Natick R&D Center conducted a systems analysis of Army hospital food service operations. The Frozen-Ready food service concept was determined to be the most cost effective food production system for new Army hospitals.¹ The Office of the Surgeon General requested that this system be tested in an existing facility. In September 1978 Moncrief Army Hospital, Fort Jackson, SC, which was operating at 250 beds, was designated by the US Army Health Services Command as the testing and evaluation facility for the Frozen-Ready concept.

The objectives of the project presented in the following report were to test the feasibility and effectiveness of the new concept and to determine if implementing the system in an existing facility was practical.

The goals of the project were to achieve reductions in overall operating costs and labor requirements, increase productivity, maintain meal acceptance, and assure energy cost effectiveness. Operational modifications included conversion to cook-freeze and cook-chill production and revision of existing recipes and operating procedures. The capacity of existing production and service equipment was augmented to accommodate the production and maintenance of a complete frozen-food inventory and utilization of a new patient tray delivery system -- the Aladdin Temp-Rite II. The purpose of this report is to present the results of the experiment and provide recommendations to the Office of the Surgeon General (Proponent Agency). The new food production concept will be called Advanced Preparation rather than Frozen-Ready since a combination of cook-freeze, cook-chill, and cook-serve production methods are employed by the system.

The Army Hospital Food Service Mission

The primary mission of Army hospital food service is to provide comprehensive nutritional care, including special diets, to patients and other personnel authorized to use the hospital food service facilities.² The hospital food service must plan, produce, and serve wholesome, nutritionally adequate meals which are therapeutically beneficial and best support the total medical program of the patients. In addition to inpatient feeding, meals must also be provided for the hospital staff and other authorized personnel, such as members of an enlisted Medical Activity (MEDDAC) detachment who are entitled to three meals a day in the hospital dining room. Other important mission requirements include dietary counseling for patients, nutritional education for the military community, and applied research in the areas of medical nutrition.

Another area of the Army hospital food service mission is to provide for potential system expansion. The capability must exist to expand greatly

peacetime food service capacity in the event of an armed conflict or other emergency.²

Overview of the Conventional and Advanced Preparation Systems

Since the nutritional counseling and educational functions are virtually unaffected by the production system design and operation, this report will focus specifically on food service. When the project test began in 1979, the food service department at Moncrief Hospital used a conventional system, meaning cook-serve food production methods, hot-plating tray assembly, and a temperature maintenance tray delivery system (see Fig. 1). Most items were prepared from basic ingredients, with a small percentage of convenience items used. The menu format offered in the dining room was similar to that offered on the wards, both of which were on a 35-day cycle. Patient trays were loaded into food carts with separate sections for hot and cold foods. The carts were then delivered to the wards where hot and cold items were matched with soup, coffee, hot tea, and iced beverages portioned and assembled by food service attendants. The assembled trays were delivered to the patients by the nursing staff.

Under the new concept of Advanced Preparation, cook-freeze items are produced weeks in advance, blast frozen in half-size steamtable pan molds (high density polyethylene), packaged in shrink film, and held in frozen inventory for use as needed (see Fig. 2). Patient meals are prepared by cook-chill methods one day ahead of service if the food items are likely to be more acceptable when not frozen and/or if the items are economically infeasible to freeze. Examples of these items are eggs, grilled or breaded foods, and as-purchased frozen vegetables. For the dining room, such items are prepared by cook-serve methods on the day they are to be served.

Insulated serving trays and rethermalization carts (equipped with in-self heating elements) are used for delivery, service, and retrieval of all patient meals. Trays are cold plated several hours ahead of the meal period by a single early morning shift of assembly personnel. Breakfast is plated on the day before it is to be served. The loaded delivery carts are held in special refrigerators on the ward before and during heating. Those food items which come in contact with the heating elements of the Aladdin Temp-Rite II cart are rethermalized, while the items to be chilled are kept cool by circulating cold air. Rethermalized trays are delivered to the patients by the nursing staff. A 21-day menu cycle is used for both the dining room and wards.

Test and Analysis Methodology

In this report both the conventional (pretest) system and the Advanced Preparation (posttest) System are defined as they were operated at Moncrief Army Hospital, Fort Jackson, SC. The Advanced Preparation System was gradually implemented according to the following sequence of events:

1. Selection and procurement of new food production and packaging equipment;



Figure 1. Conventional system production flow.

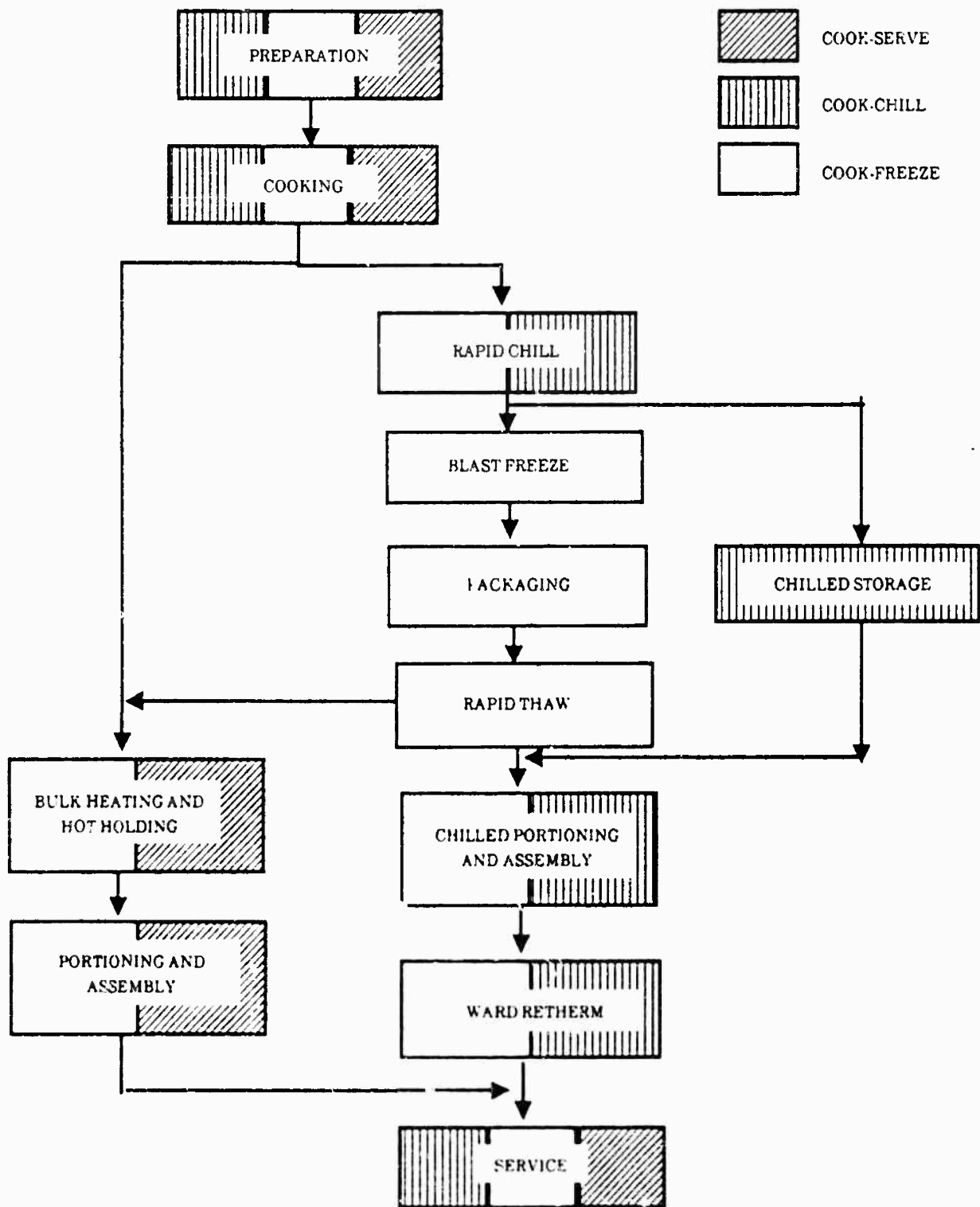


Figure 2. Advanced preparation system production flow.

2. Facility modification for an installation of food production and packaging equipment;
3. Collection of pretest data;
4. Menu design, modification of recipes, calculation of production batch sizes, and formulation of a production forecasting model;
5. Implementation of cook-chill and cook-freeze production;
6. Evaluation of commercially available cold plating patient tray delivery equipment;*
7. Facility modification for installation of the Aladdin Temp-Rite II rethermalization patient tray delivery system;
8. Collection of posttest data;
9. Data analysis and documentation of test results.

Each of the preceding steps was not conducted independently. Some overlap of events did occur. The conventional and Advanced Preparation Systems were analyzed and compared in terms of cost and effectiveness (see Fig. 3).

*At Moncrief Hospital, during May-June 1980, the 3M Integral, Sweetheart, and Aladdin Temp-Rite II rethermalization tray delivery systems, and the Thermo-Tray insulated tray delivery system were tested under operating conditions for 10 days each.

1. System Efficiency

Cost - food, labor, supplies, equipment

Energy consumption

Workload

Labor utilization

2. Consumer Opinion

Patient food acceptance

Dining room food acceptance

3. Employee Satisfaction

Nurse interviews

Food service staff interviews

4. Nutrition and Safety

Menu nutritional analysis

Microbiological analysis

Sanitation monitoring

Temperature monitoring

Figure 3. Areas of data collection.

II. THE ADVANCED PREPARATION SYSTEM CONCEPT

The new concept (see Fig. 4) will be described in three subsystems: Inventory Control, Food Production, and Patient Tray Delivery. Emphasis will be placed on areas that have been most affected by conversion to Advanced Preparation.

Inventory Control Subsystem

The warehouse is the focal point of the Inventory Control Subsystem at Moncrief Hospital (see Fig. 5). Personnel working in this department conduct all purchasing, receiving, and stock rotation procedures for the food service.

As is the case of many administrative tasks performed independent of food production, the purchasing and receiving functions have not changed to any great degree due to the system conversion. However, stock rotation, storage, and issue of the cook-freeze inventory items are additional responsibilities assumed by warehouse employees. One extra employee has been put on the staff to handle the increased workload. Training sessions were conducted to instruct personnel in the operation of the packaging and cold processing equipment, and proper handling and storage of frozen food.

Ingredient Control

The purpose of ingredient control is to monitor the allocation of ingredients from storage to main preparation. This task has become more important with large batch production since formulations hardly ever conform to common package or container sizes. The ingredients required by each recipe are measured, weighed, or prepared before being sent to the kitchen. As a result, less food is wasted and the cook does not have to be his or her own stock person.

Food Production Subsystem

Frozen-Ready is a term used to describe items that are produced on the premises, frozen, and stored for later use. The term, introduced to the food service industry by the Cornell School of Hotel Administration, originally meant frozen food production only, or making your own convenience foods. However, in any hospital food service utilizing this type of system, some menu items are chilled or prepared conventionally. For clarification, production methods practiced in the experiment at Moncrief are defined as follows:

- Cook-freeze foods - the menu item is produced in a prescribed large batch quantity, blast frozen, placed in frozen storage, and used upon demand;

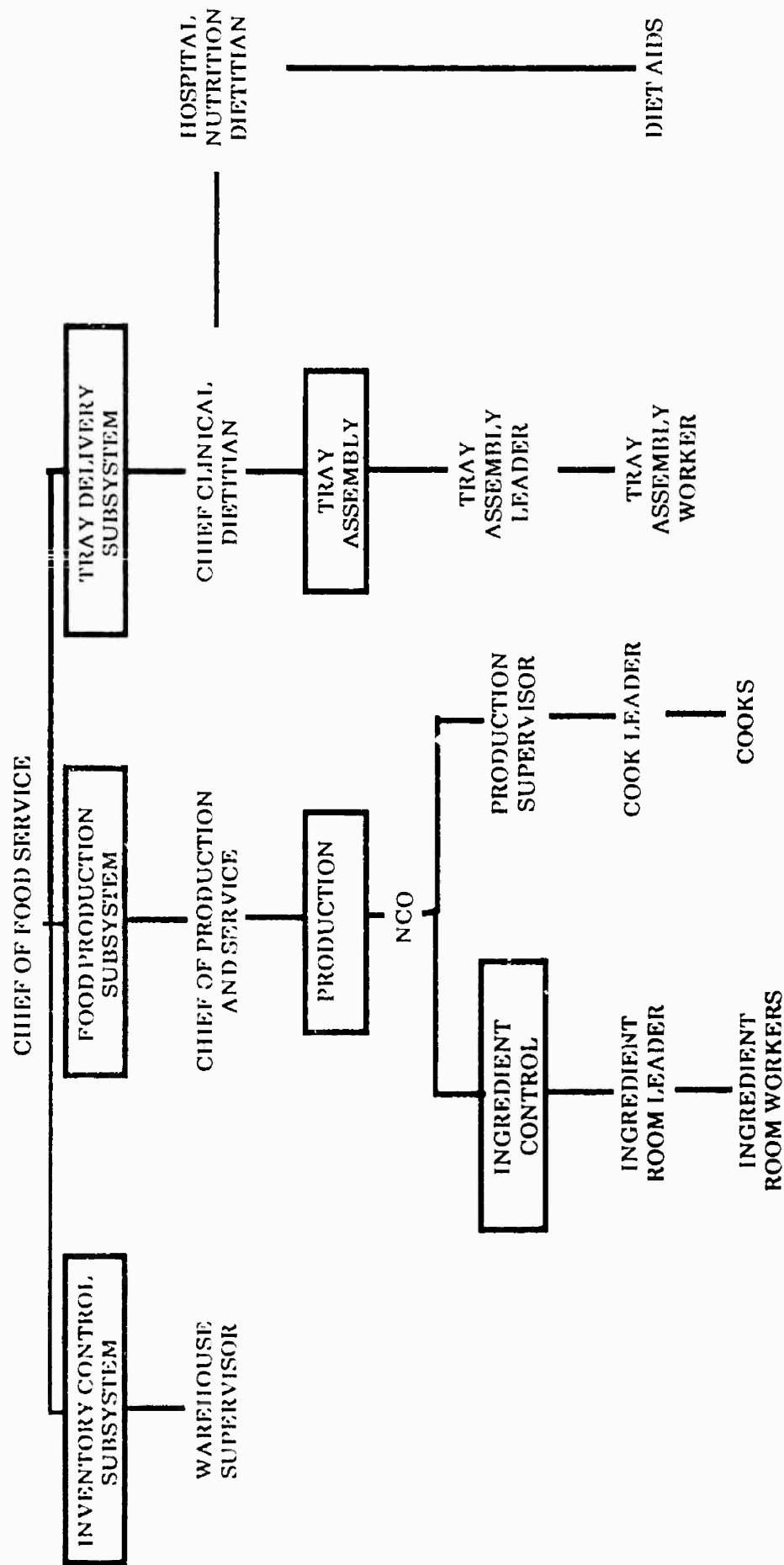


Figure 4. Organization of the advanced preparation system.

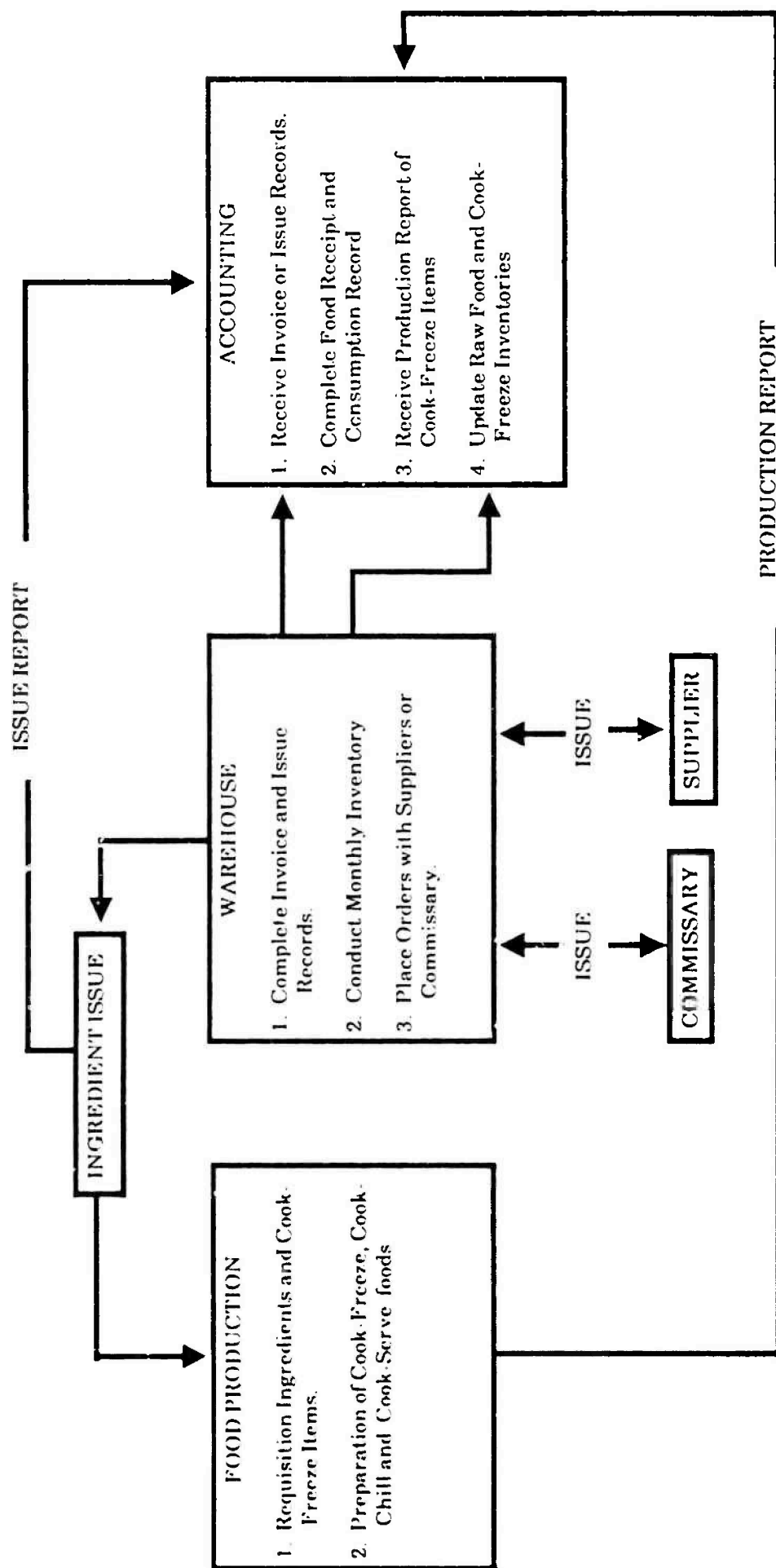


Figure 5. Inventory control subsystem.

- Cook-chill foods - the menu item is scheduled for advanced production, prepared, chilled, and served within two days;
- Cook-serve foods - the menu item is scheduled for day of service production, usually just prior to the meal in which it will be served.

Again, the term Advanced Preparation refers to all three methods of food preparation practiced within the production subsystem (see Fig. 6). The frozen food meal preparation process can be classified into two broad categories: production planning and production scheduling.

Production Planning addresses the problem of setting production goals so that equipment and manpower are used effectively in meeting customer demand. The plan depends on menu cycle length, customer demand, and calculated batch quantities.

Production Scheduling, given the production plan, considers the problem of how menu preparation should be scheduled. The schedule depends on availability of manpower and the food service supervisor's application of his or her knowledge concerning food preparation requirements and equipment operations.

Production Planning and Scheduling

Under the conventional system, it was not necessary to schedule production more than one day in advance. However, the current system requires scheduling to be done weeks ahead of the day food is to be served. The production schedule is made up according to target calculations based on a model used to forecast demand for each food item (Appendix A). Every week, target amounts are calculated by the food service Accounts Clerk. The Production Supervisor takes these target amounts, compares each to the corresponding food item on the Batch Size List (Appendix B), and schedules production according to the next highest batch size.

Cook-Freeze Production

Frozen food production takes place between the hours of 6 a.m. and 2:30 p.m. Monday through Friday. A single cook assigned to this shift has the responsibility of preparing each item on the production schedule, portioning cooked food into plastic molds for freezing, and transferring the finished product to low temperature processing (rapid chilling and blast freezing). Frozen foods are prepared on the early morning shift so that all products can be put through the chill box before afternoon cook-chill production. Basic ingredients are assembled and weighed in the ingredient control area and given to the cook according to the production schedule sequence.

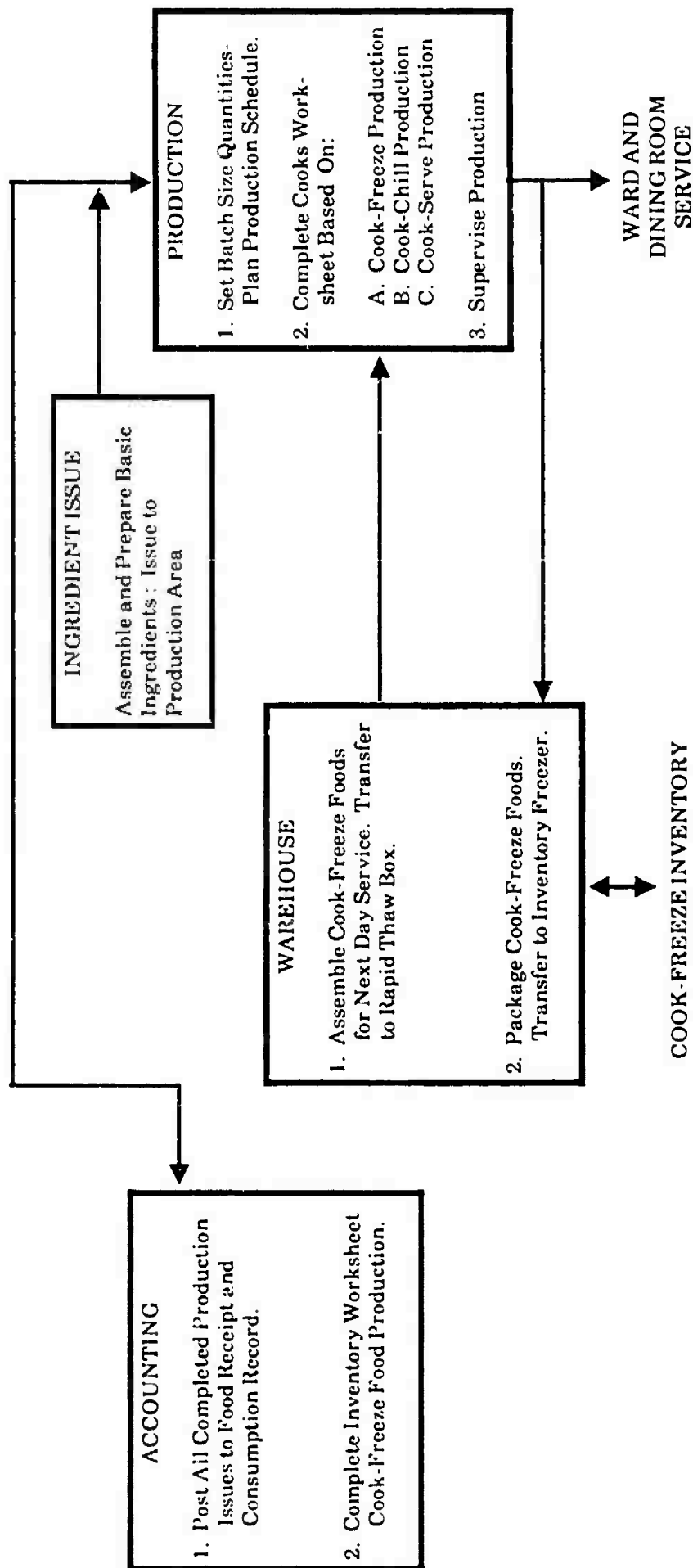


Figure 6. Production subsystem.

Modified starch is an ingredient necessary for frozen production that plays an important role in end-product quality. When flour or corn starch is added to liquid to make a gravy or sauce, the granules do not dissolve. With the application of heat, these granules begin to swell and absorb water surrounding them, eventually becoming a paste or gel. If the product is subsequently frozen, the paste can retrograde or revert back to insoluble form. The result after thawing is a product having a watery, curdled appearance. To prevent retrogradation, partial substitution of a modified starch for regular flour or corn starch is necessary. Accordingly, at Moncrief, sauces and gravies are not made from a basic roux (a mixture of flour and fat, cooked together in equal amounts and used as a thickening) but a cold water slurry composed of one part modified starch and one part flour or corn starch. Each cook had to be individually trained to work with the new ingredient combination.

The liquid content of each product to be frozen is an important concern and must always be measured. Simmering, rapid chilling, blast freezing, and reheating cause water evaporation. High water content is necessary to allow for the effects of evaporation during processing. Products correctly prepared for chilling and freezing will look thin by conventional standards. Production guides have been written to account for this additional fluid. Use of modified starch and adherence to unit volume measurements cannot be overemphasized. Management has the responsibility to train properly cooks and floor supervisors in these procedures. For cooks not to follow recipe directions in any case is a problem, but especially when production methods for freezing are involved.

Cook-Chill Production

Salads, sandwiches, and most breakfast items do not lend themselves to freezing. Items of this nature are prepared one day ahead of service and rapidly chilled to accommodate the cold plating requirements of the Aladdin system. After overnight refrigerated storage, the food is cold plated several hours before patient service and heated on the wards just prior to mealtime. Because of day-ahead work scheduling, production and assembly are conducted independently. This permits greater flexibility in the system and a more even distribution of the workload.

Cook-chill food items are made in amounts that meet customer demand for one day. Food preparation (except breakfast items) is started at noon when the bulk of other daily preparation tasks has been completed. By this time, cook-freeze items have been moved from the rapid chill box to the blast freezer, vacating the rapid chill box for cook-chill processing. Thus, the scheduling of cook-freeze in the early morning and cook-chill in the afternoon eliminates a potential traffic problem in the main preparation area.

All lunch and supper cook-chill products (including special diet items) are made by one cook. After rapid chilling, full carts containing approximately 440 portions are transferred to a walk-in storage refrigerator. Breakfast items are made early in the morning so that rapid chilling can be completed before breakfast tray assembly begins at 1 pm.

In general, cook-freeze and cook-chill preparation procedures are somewhat different than those used in conventional cookery. For this experiment, each recipe was independently considered before and during system conversion to determine what modifications were necessary. Proper panning and storage of finished product is vital for quick, safe rapid chilling. Temperature monitoring is paramount to insure that chilled food is kept below 40°F and hot food above 140°F. In short, astute supervision and additional training are required to insure end-product quality through implementation of detailed, but not insurmountable, operational procedures.

Cook-Serve Production

Cook-serve food production at Moncrief Hospital involves the preparation of menu items from basic ingredients on the same day as the food is served. These items are considered more acceptable when not prepared in advance (based on taste panel results conducted by the Moncrief food service staff) or are considered economically infeasible to freeze. An example is steamed white rice; far more labor effort is required in chilling, blast freezing, packaging, and rapid thawing this product than is required to prepare it. Since no labor is saved through cook-freeze production, steamed white rice is prepared by cook-serve and cook-chill methods. Other items not prepared by cook-freeze methods for the same reason are canned vegetables and as-purchased frozen vegetables.

An analysis of production procedures for a typical menu shows how cook-freeze, cook-chill, and cook-serve preparation methods have been integrated into the Advanced Preparation system (see Fig. 7). For example, consider entree, starch, and vegetable items offered for lunch on Day 2 of the 21-Day menu cycle. It is important to note again, at this stage of the report, that items for patient service must be prepared by cook-freeze or cook-chill methods because the rethermalization cart system requires cold plating for tray assembly. Items for dining room service can be prepared by cook-freeze methods if practical in terms of customer acceptance and economic feasibility, or by cook-serve methods (please review Fig. 2).

Day 2

French Fried Perch	Roast Lamb
	Chil.
Macaroni and Cheese	Stewed Tomatoes
Steamed Rice	Brussels Sprouts

Roast Lamb, Macaroni and Cheese, and Chili are items that can be frozen and rethermalized with good customer acceptance. Also, volume production more than offsets the effort required for packaging and low temperature processing. These items are prepared weeks ahead of service, blast frozen, packaged, and thawed in quantities as needed for ward or dining room service. French Fried Perch is a delicate item and does not withstand the handling required for packaging after blast freezing. Steamed rice is not labor intensive enough to

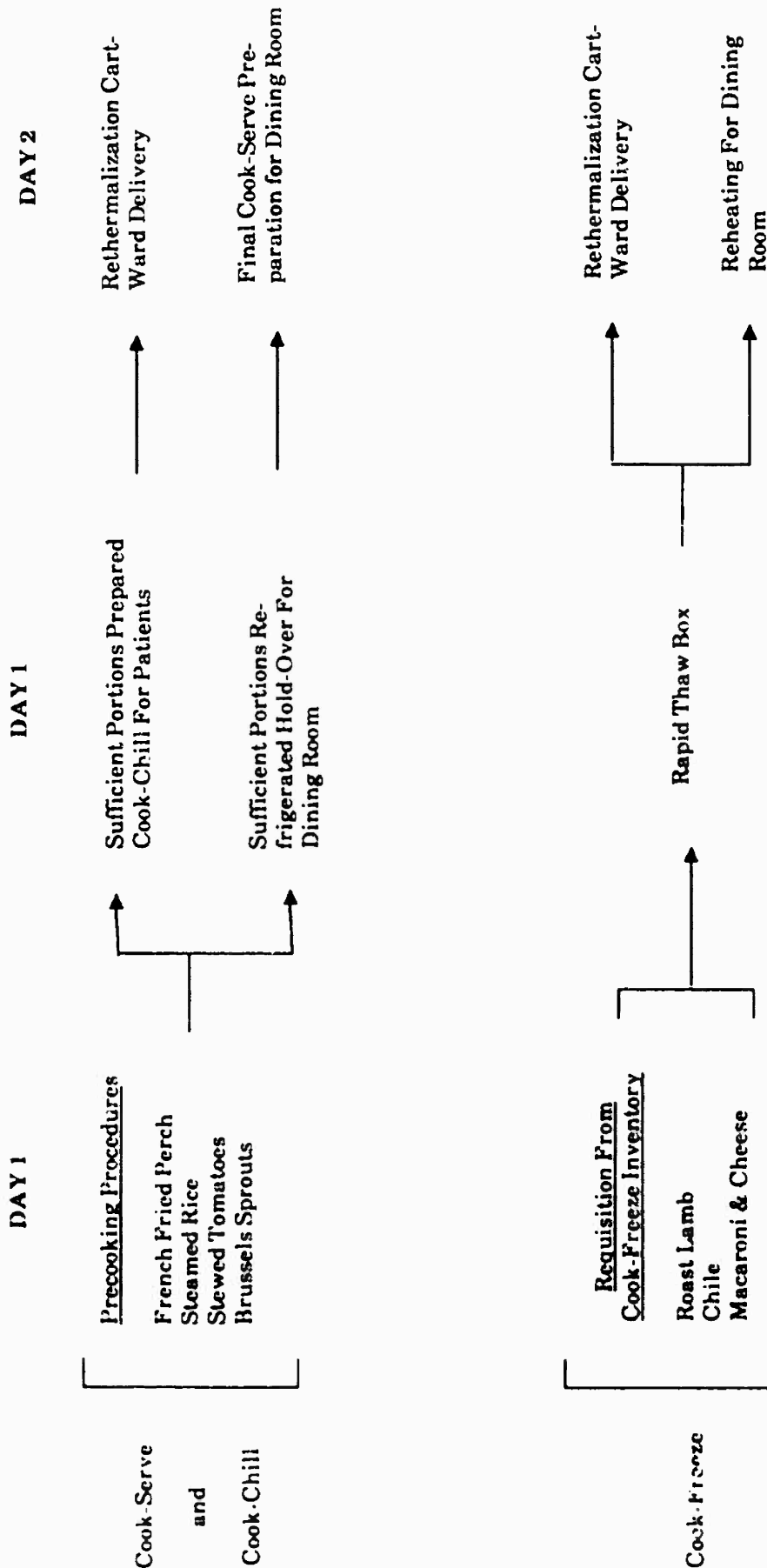


Figure 7. Production of a typical menu to show food preparation by production category.

bother with freezing, and canned stewed tomatoes and as-purchased frozen brussels sprouts are convenience products already. These three items are prepared by a combination of cook-chill and cook-serve procedures. The production cycle is accomplished in the following fashion. On Day 2 (the last day of the menu cycle) the cook-chill cook would cut the perch and dip each portion in an egg and milk mixture. After dredging in a combination of bread crumbs and flour, each piece would be terraced into a sheet pan or shallow half-size pan. Such precooking procedures would also be carried out for the rice, tomatoes, and brussels sprouts.

According to the beds-occupied census count, a required number of portions for patients would be cooked, rapid chilled, and stored in a refrigerator. Based on a forecast of patronage, some portions would be kept uncooked in the same refrigerator, but labeled for service in the dining room on the next day (Day 1). These products would then be pulled on Day 2 from the refrigerator and either 1) delivered in rethermalization carts to the wards for patient service, or 2) finally cooked for dining room service. The idea is that the individual in charge of cook-chill completely prepares the non-frozen items for patient consumption one day ahead of service, and also makes ready the same items for dining room service to the greatest extent possible short of final cooking. In this manner, the cold plating requirements (cook-chill) of patient service and the hot service essentials (cook-serve) of the dining room are both satisfied without duplication of labor.

The flow of cook-freeze, cook-chill, and cook-serve production and placement of new equipment can be seen in Fig. C-1 (the new equipment in this figure is numbered according to the recommendations in Appendix C and listed by cost in Table C-1). The division of entree preparation into these three methods of production is shown in Table 1.

TABLE 1. Entree Distribution by Production Method

	Patient Service		Dining Room Service
	Regular Diet	Modified Diet	
Cook-freeze	61%	86%	55%
Cook-chill	39%	14%	--
Cook-serve	--	--	45%

Menu

Advanced Preparation was ushered in at Moncrief along with a new 21-day menu. The main objectives in planning this menu were to add variety over and above that of the pretest 35-day menu, and to include items compatible with frozen production. Entrees were increased to four choices and starches

to three. Desserts remained at four choices, but selection was varied at the noon and evening meal.

The menu is the backbone of any food service operation. Labor and equipment requirements are determined by the foods served. Furthermore, Advanced Preparation methods affect what foods can be included on the menu. The challenge is to reformulate recipes, perfect modifications in production procedures, and design tray assembly techniques around the delivery system in use. Administrators must intelligently plan and continually critique the menu to insure that only items well suited to frozen and chilled production are used. General food item modifications made at Moncrief Hospital are discussed below:

1. Breakfast items (including eggs) for patients require special plating procedures since they are prepared cook-chill one day in advance of service;
2. Soups are costly to freeze and are prepared cook-chill for patients;
3. Deep-fat fried items tend to lose crispness when frozen, packaged, and thawed. Menu service frequency was decreased for these foods;
4. Plain meat items should be frozen in a gravy, sauce, or au jus whenever possible to help prevent dehydration during frozen storage;
5. The frequency of casserole and gravy/sauce items was increased because moisture helps maintain temperature after reheating;
6. Hot grilled sandwiches are not compatible with frozen production;
7. Many canned and frozen vegetables need little preparation and can be produced just prior to service.

Packaging

Commercially available methods of packaging for rapid chilling, blast freezing, and long-term frozen storage had to be investigated. For use in the Advanced Preparation System, high density polyethylene was selected as the material for the container in which foods are chilled and frozen. This plastic is approved for food use by the National Sanitation Foundation. It performs well within a temperature range of -60°F to +250°F, which meets the requirements of Advanced Preparation where the temperature of products is decreased from +160°F to -10°F. Sheets of polyethylene material were molded into the shape of half-size steamtable pans. This size was selected because it is easy to handle and familiar to the cooks. Each mold conveniently holds five pounds or 10 eight-ounce portions. In the case of whole meat items, 10 portions are simply counted and placed into the plastic pan. Gravy or sauce is then added. The pans of finished product are covered and put through the rapid chill and blast freezing processes (see Fig. 8). Each frozen food block is simply "popped" out of the mold like a cube from a plastic ice cube tray, and wrapped in polyethylene shrink film to help prevent dehydration during

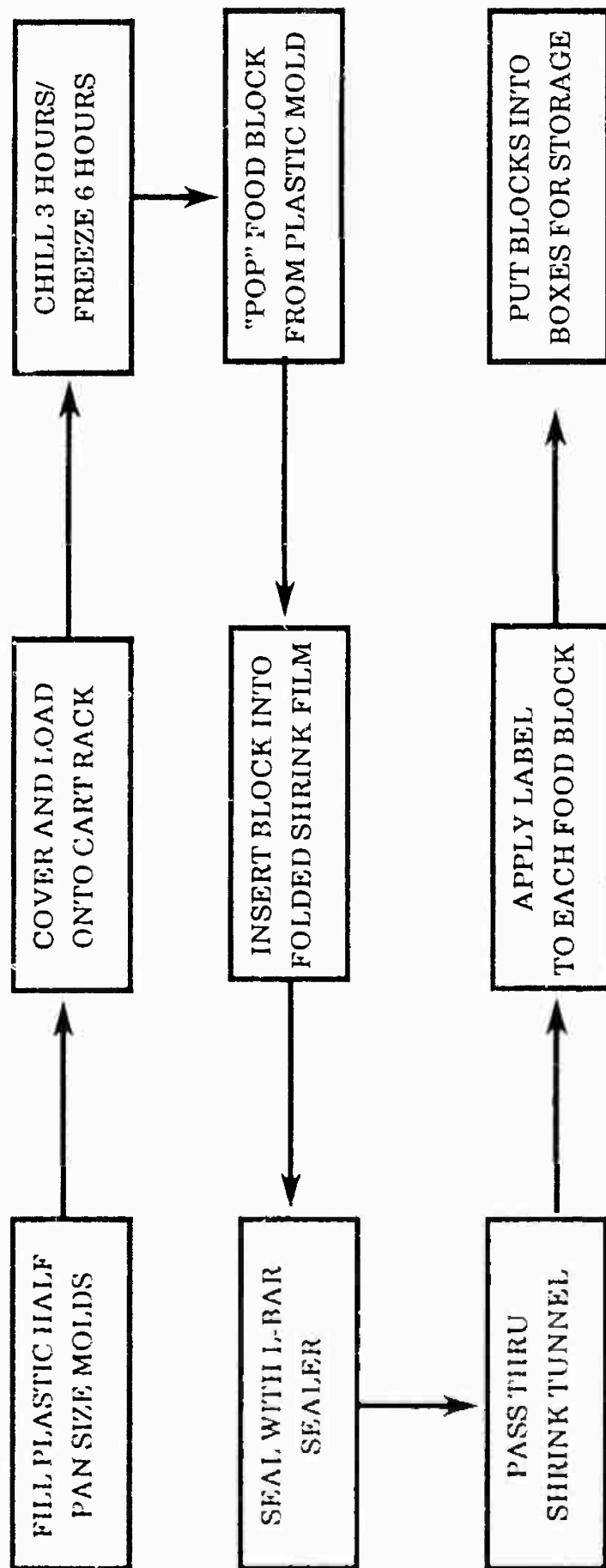


Figure 8. Packaging procedure for frozen products.

frozen storage (Fig. 9). This film is biaxially oriented, meaning it will contract in two directions when heated. The individually packaged blocks are labeled with the product name, production date, and number of servings, and placed into sturdy cardboard boxes (10 per box). These boxes are labeled and transferred to the prepared food inventory storage freezer.

Patient Tray Delivery Subsystem

Because the Aladdin Temp-Rite II System was tested at Moncrief for two weeks in August 1980, the patient tray workers were familiar with its operation. However, extensive training was necessary because of the many procedural changes required for the switch to cold plating and also the amount of time that had elapsed (months) between the test and actual implementation.

Aladdin System orientation began about two months before the actual startup date. Aladdin and Natick R&D Center representatives assisted the Moncrief personnel in the training and education process. Initially, instructional video tapes geared to specific work groups (i.e., cooks, patient tray workers, food service workers) were sent from Aladdin and shown to the food service staff. Two weeks after these film sessions, Aladdin representatives came to Moncrief and outlined tray assembly procedures. During this visit patient tray workers actively participated in a hands-on demonstration. At a later date, the video tapes were shown again to reinforce lessons learned from the Aladdin presentation. Finally, training officers from Aladdin came to Moncrief for one week when the system was actually put into operation. Natick R&D Center personnel were assigned to Fort Jackson for five weeks during the startup period. Training sessions were conducted whenever modifications were made to menu items.

Meal Assembly

Meals for patient delivery (see Fig. 10) at Moncrief are assembled by the trayline method. All food items are plated in a chilled state. Lunch assembly occurs at 8:30 a.m., supper at 10:00 a.m., and breakfast at 1:00 p.m. (the day before service). The work content of a typical meal is as follows:

1. Starter Station: A tray service attendant puts flatware, diet related and beverage condiments, and the menu onto the server tray base, and the server onto the trayline;
2. Cold Station: The tray service attendant places portioned juice, fruit, milk, salad, dressing, and some desserts onto the tray;
3. Hot Station: The cold-plating of an entree, starch and vegetable is assigned to a cook in this position. Hot cereal and soup are portioned prior to patient tray assembly;



Figure 9. Frozen food packaged in shrink film.

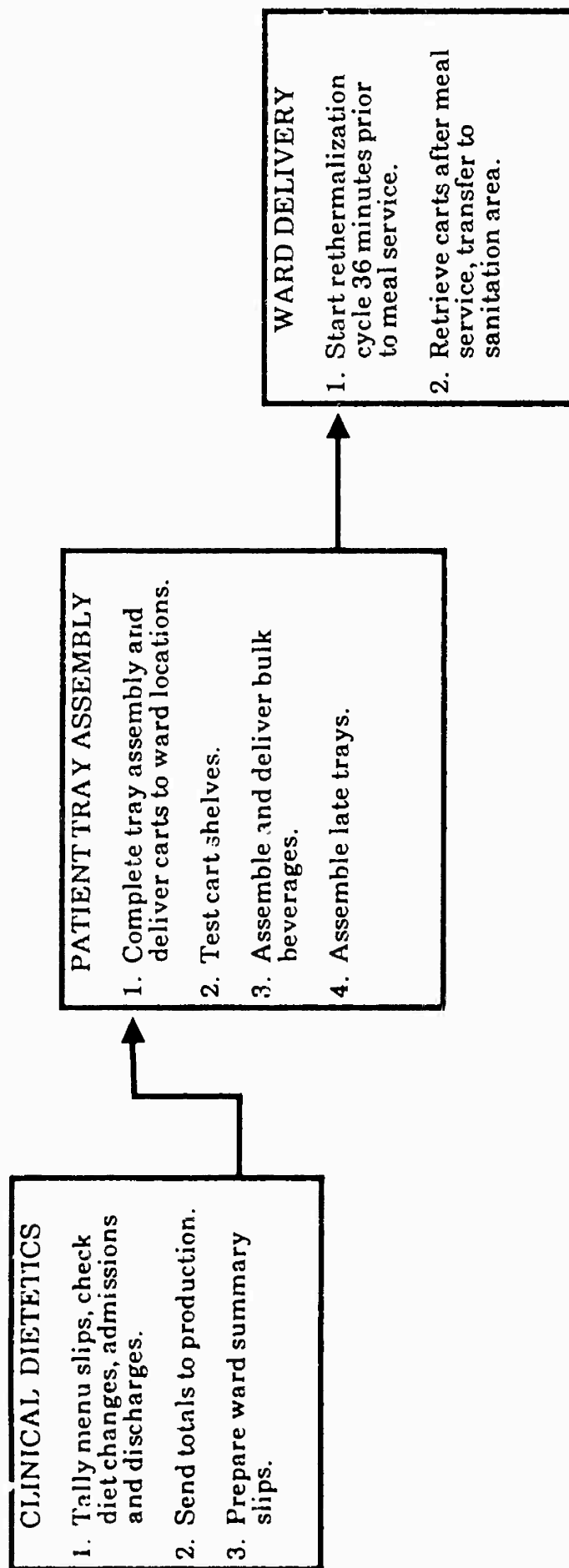


Figure 10. Patient tray delivery subsystem.

4. Checker Station: The purpose of this position is to check accuracy of food selection and placement. The tray leader assigned to this task must also place the menu so it will face the delivery person and patient, add certain desserts and beverages, and put the covered server into a delivery cart. Each cart is loaded from the bottom up. The trays are then strapped in on each side and moved to the cart storage refrigeration area.

All tasks related to cold plating assembly are performed during a single shift scheduled each day of the week (conventional system required a double shift schedule). Patient tray attendants portion and assemble all the daily cold menu items on the menu before any tray assembly is begun. These items would include salads, fruit, cakes, jello, beverages, and bread. Finished products are stored in refrigerators adjacent to the patient tray area and in cold pan units during assembly. All cold items are portioned and ready for service before the tray line is started so that the assembly process is continuous for three meals, with breaks in between.

Delivery

After assembly, completed carts are rolled into a walk-in refrigerator located in the main kitchen. When the final cart for a particular meal being assembled is finished, the cold station attendant begins cart delivery to the wards (see Fig. 11). Each cart is tested in the ward rethermalization units to insure that it is in working order. Breakfast carts are held overnight in the kitchen and delivered early in the morning on the day of service.

Service

Approximately 10 minutes before the Aladdin rethermalization cycle (36 minutes) is finished, patient tray workers begin to portion coffee and hot tea into insulated mugs, and cold tea into eight ounce tumblers filled with ice cubes. This operation takes place in the retherm area of each patient ward. These beverages are transported from the kitchen in bulk. When rethermalization is completed, the Aladdin cart and beverages are transported to the nursing station. Each tray and hot coffee, hot tea, or iced tea are handed to the nurse by the patient tray worker (see Fig. 12) who remains at the nurses' station with the rethermalization cart throughout the tray delivery process.

The nurse delivers all patient trays by receiving each one from the patient tray worker and walking back and forth from the nurses station to each patient's room. In order for projected labor savings to be accomplished (see Section III), the nursing staff should move the rethermalization cart (on wheels and very easy to maneuver) down the hall to each patient room. This would require less walking effort by the nurses than is currently necessary, and also would save approximately 0.5 full time equivalent for the food service department because the patient tray worker would not be required to remain on the ward during tray delivery.

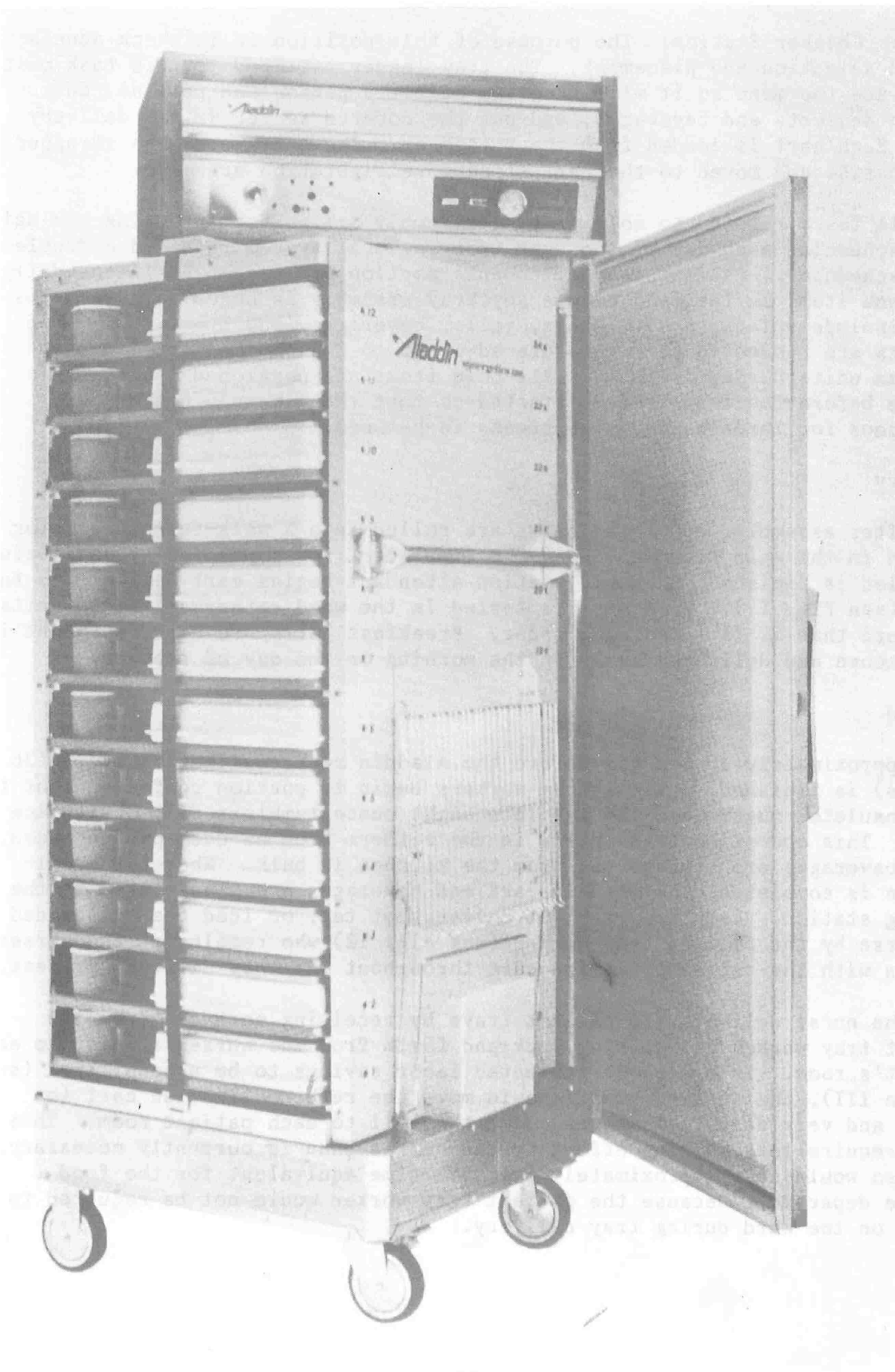


Figure 11. Aladdin rethermalization cart and ward refrigerator.



Figure 12. Nurse receiving tray from patient tray worker.

III. ECONOMIC ANALYSIS

Cost Analysis

The first step in the economic evaluation of the Advanced Preparation system compared to the conventional system in operation at Moncrief involves analysis of standard operating costs affected by the new system. Costs that remain unaffected (for example, overhead costs) by the system conversion are not included. Thus, the costs considered in this comparative analysis are:

- (1) Food service labor
- (2) Food
- (3) Equipment
- (4) Energy
- (5) Supplies

For Moncrief Hospital, a separate cost analysis of each concept was conducted. Pretest workload (see Table 2) is based on operating data for Fiscal Year 1979. Workload for the posttest is based on Fiscal Year 1982 (see Table 3).

Cost Elements

Labor

Labor requirements for the conventional system (see Appendix D) were based on authorized staff levels established in 1979 before implementation of the new system. Current labor requirements are the actual staff levels in effect at Moncrief Hospital in July 1982. Projected labor requirements were established through workload analysis of tasks to be performed. Advanced Preparation procedures and part-time labor are assumed to be part of the projected scenario. Qualified food service personnel are assigned to the positions of Cook-Freezer, Cook-Chill, Patient Tray Assembly Cook, and Patient Tray Assembly Leader. These positions require greater skill than the original Cook or Patient Tray Attendant positions of the conventional system.

It is assumed in this cost analysis that with Advanced Preparation, the nursing staff would remove patient trays from the delivery carts, place the appropriate hot or iced beverage and ice cream (if on the menu) on the patient tray, deliver the completed tray to the patient, and return each tray to the delivery cart. This process requires less effort by the nurses than ward tray delivery for the hot/cold cart system, or for the delivery ward service procedure that was in effect at the conclusion of the Advanced Preparation test (described in the section Patient Tray Delivery Subsystem/Service - similar to procedures followed with Hot/Cold cart).

Labor costs were calculated based on FY 1982 Composite Standard Rates for Military Personnel, step 5 for the General Schedule, and step 3 for Wage Grade pay scales (Tables D-2 and D-3).

Workload data used to calculate cost per meal over the course of the entire test is included in Appendix E.

TABLE 2. Meal Demand - Conventional System

Inpatient Meals		Percent of Total	
Regular Diet	139,247		44%
Modified Diet	<u>34,812</u>		<u>11%</u>
Total Inpatient		174,059	55%
Dining Room Meals		<u>142,412</u>	<u>45%</u>
Total Meals		316,471	100%
Average Patient Meals/Day 477			
Average Dining Room Meals/Day 390			
Average Total Meals/Day 867			

TABLE 3. Meal Demand - Advanced Preparation System

Inpatient Meals		Percent of Total	
Regular Diet	185,790		55%
Modified Diet	<u>37,158</u>		<u>11%</u>
Total Inpatient		222,948	66%
Dining Room Meals		<u>114,852</u>	<u>34%</u>
Total Meals		337,800	100%
Average Patient Meals/Day 611			
Average Dining Room Meals/Day 315			
Average Total Meals/Day 926			

Food

All food costs presented have been updated to 1982 levels according to increases in the Basic Daily Food Allowance (Appendix F).

Equipment

The cost for essential new equipment (refrigeration, freezing, packaging and patient tray delivery equipment) has been included in the total equipment cost for the Advanced Preparation System (refer to Appendix C). Subtracted from this amount is the purchase cost for a replacement set of temperature maintenance carts (i.e., hot/cold carts or similar) which would have been necessary if the new system had not been implemented. The installation cost of new equipment at hospitals other than Moncrief would be similar because implementation of the new system would probably occur at the end of the useful life of the existing conventional system. The cost of architectural and engineering work and installation is included in the cost of equipment. All costs have been updated to 1982 prices.³ Equipment was chosen under the assumption that a selective menu would be offered. Also included in Appendix C are detailed descriptions of each new equipment item and a flow diagram which shows equipment location.

Energy

The amount of electricity, gas, and water used by food service was monitored by meters installed in the hospital. The cost of electricity, cold water, hot water, sewage, gas, and steam was calculated from this data by using 1982 utility rates (Appendix G).

Supplies

Supply costs were taken from analysis of actual accounting data calculated by food service personnel at Moncrief and a routine internal audit performed during the summer of 1982 (Appendix H).

Economic Evaluation

Based on calculations adjusted for inflation, food cost increased three cents per meal after the system conversion (see Table 4). Menu experimentation, food sampling for microbiological analysis, and taste panels did cause food costs to increase during the course of the test. However, expenditures for food became stable during Fiscal Year 1982 when the menu became final and data collection was finished. It can be concluded that food costs for the Advanced Preparation System at Moncrief Hospital were about the same as the conventional system after adjusting for inflation. This is not surprising since raw food costs are controlled by regulation to within a constant plus or minus percentage of the Basic Daily Food Allowance.

TABLE 4. Food Cost

Time Period	Uninflated Food Cost/Meal	1982 Adjusted Food Cost/Meal
FY 1979	\$1.15	\$1.24
FY 1980	\$1.33	\$1.40
FY 1981	\$1.20	\$1.22
FY 1982	\$1.27	\$1.27

Under the Advanced Preparation concept, new equipment allows for different production schedules to be employed. The equipment-labor tradeoff serves to reduce the cost of labor-intensive food service operations by a margin large enough to compensate for higher costs in other areas. For example, energy consumption was carefully monitored to determine to what extent Advanced Preparation affected overall food service expenditures. In the posttest analysis, the total energy cost increase was about 4¢ per meal (see Table 5). The new cold temperature processing and storage equipment accounted for .02¢ per meal in electricity costs. However, the overall cost increase for kitchen electricity was only .014¢. It appears that additional power requirements of the equipment in the new system were somewhat offset through more efficient use of standard conventional equipment by combining single shift production with high volume preparation. It can be concluded that the Advanced Preparation system at Moncrief is slightly less energy cost effective than the system it replaced.

TABLE 5. Energy Cost

	Conventional System	Advanced Preparation System
Electricity-Kitchen	\$.078	\$.092*
Electricity-Ward	\$.007	\$.01
Steam	\$.047	\$.04
Gas	\$.005	\$.01
Water	\$.035	\$.055
Total	\$.172	\$.207

*New Low-Temp Processing Equipment:

Rapid Chill, Blast Freezer, Rapid Thaw, Cart Holding

Equipment	= \$.012
Storage Freezer	= .008
	<u>\$.020</u>

The cost for supply materials increased 10¢ per meal after conversion to Advanced Preparation (see Table 6). The system does require more use of expendable materials due to frozen food packaging and the disposable serving ware necessary for rethermalization of ward menu items. The cost of Aladdin disposables was 7.5¢ per meal, and packaging film less than 1¢ per meal. Aladdin Synergetics Inc. has developed a prototype permanent ware dish. A conversion from disposables to permanent ware would greatly reduce operating supply costs.

TABLE 6. Supply Cost

Time Period	Conventional System	Advanced Preparation System
FY 1979	\$.12	\$.15
FY 1980	\$.11	\$.12
FY 1981	\$.31	\$.31
FY 1982	\$.25	\$.25

Labor Utilization

Detailed staffing schedules for each system (Appendix D) show that labor is utilized differently for Advanced Preparation. Although the system does reduce total manpower requirements, some positions are more specialized and demand more skill, specifically the Cook-Chill, Cook-Freezer and Patient Tray Cook and Warehouse positions. The individual in charge of cook-chill must know how to operate the rapid chill box and be aware of special food production procedures required for chilled preparation. In addition to these responsibilities, the person responsible for cook-freezer must operate the blast freezer, be aware of the critical need for modified starch in sauces and gravies, and accurately measure the volume of such items to ensure that the starch-to-water ratio is correct. The Patient Tray Cook must understand the plating procedures of cold assembly. These procedures directly affect post-rethermalization food quality and consequently consumer acceptance. All three personnel must be sure that safe food temperatures are maintained from initial food preparation through tray assembly. The warehouse/packaging employee must operate the L-Bar sealer and shrink tunnel, understand First-In, First-Out (FIFO) inventory procedures, withdraw correct amounts of prepared frozen food as required by the production schedule, and maintain the prepared frozen food inventory stored in the outside freezer.

The Advanced Preparation system does reduce labor costs in comparison to the conventional system. Savings are accomplished through use of large batch preparation and a single shift in food production and tray assembly. At Moncrief Hospital, the new system, with projected part-time labor reductions, will provide meals at a lower annual cost than the conventional system (see Table 7). The additional capital cost of the equipment for new concept and

additional cost for energy and supply materials are offset by reduced labor expenses. The Advanced Preparation System, when evaluated over a 10-year period (Appendix I), is more cost effective than the conventional system. This is presented graphically in Figure 13.

TABLE 7. Cost Comparison of System Alternatives

	Conventional System	Advanced Preparation
Capital Cost		
<u>Equipment & Installation</u>	\$90,850	\$335,800
Total	90,850	335,800
<u>Operating Cost</u>		
Labor	1,363,655	1,128,913
Food	392,424	429,006
Energy	55,800	70,938
Supplies	47,471	84,450
<u>Total Operating Cost</u>	1,859,350	1,713,307
Total Meals	316,471	337,800
Total Operating Cost/Meal	5.87	5.07
Annual Cost Per Meal	5.90	5.16

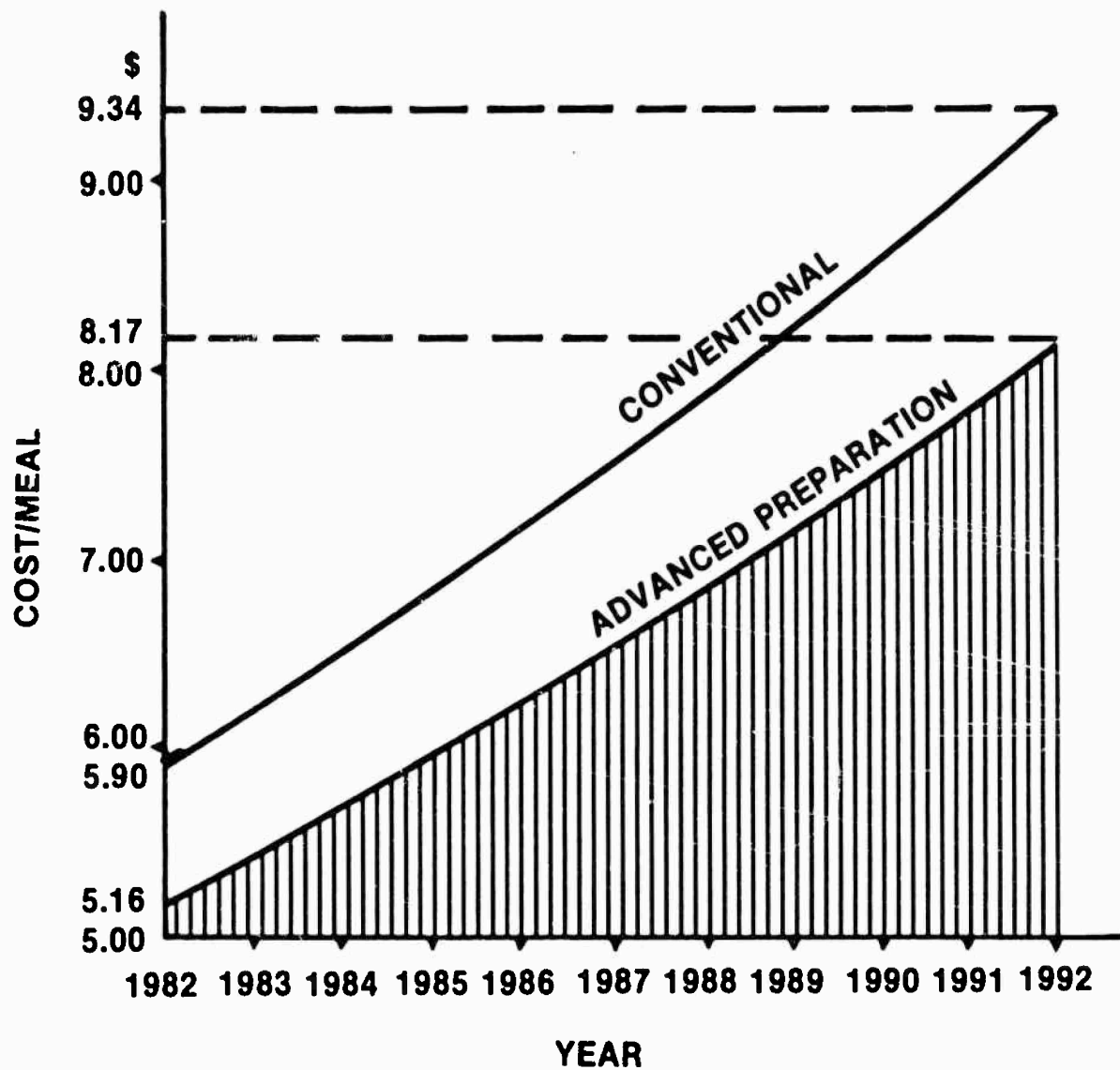


Figure 13. Advanced preparation system projected cost.

IV. OPINION SURVEYS

Food Acceptance

Two types of customer survey instruments were used to collect sensory data. The first, a five-page questionnaire given once to each individual surveyed (see Table 8), was designed to obtain general opinions of patient and dining room patrons. The second survey instrument, a food acceptance rating card (see Fig. 14), comprised five seven-point hedonic scales. The cards were distributed with each meal and the consumer was requested to rate specific food items for temperature, flavor, texture, portion size, and overall quality as he/she consumed the meal. Pretest data were collected during the period of 22-28 July 1979 when the hospital was utilizing the conventional system with hot/cold cart patient tray delivery. Two posttests were conducted during the periods of 30 November - 11 December 1981 (posttest 1) and 22-30 July 1982 (posttest 2) after implementation of the Advanced Preparation system. The second posttest was conducted to allow for greater user experience with the new system.

Results of Analysis of Variance (ANOVAs) and Neuman-Kuels Contrasts for the general opinion surveys of patients and dining room patrons for selected items are shown in Table 8. This means, concerning item #4, for example, respondents rated the courtesy and cheerfulness of employees significantly different on the wards as compared to the dining room. A main effect of PLACE (Ward vs. Cafeteria) can be seen for items #3, 4, 5c, 5e, and 6. Main effects of TIME (pretest vs. posttest) can be seen for items #1, 5b, 5e, and 7. Here respondents felt these areas of food service had changed significantly from the conventional system to the Advanced Preparation system.

Concerning "opinion of all meals (Item 1)," highest mean ratings were observed during the second posttest period (PT2). Concerning meals from outside services (Item 3), ward patients added food items less often than dining room patrons. Ward patients thought the servers were more courteous than dining room patrons (Item 4). Although there is a significant effect of time of test on whether food is served when desired (Item 5b), the variance of scores is around an ideal score of 3.0. Thus, it does not appear that this factor is important. The attractiveness of the dishes and silverware (Item 5c) is rated higher on the wards, although there is a significant PLACE X TIME interaction. The effect of the variable TIME was different for the ward than for the dining room. On the question of cold foods, it is clear that there is more of a problem on the wards than in the cafeteria, but the best responses to this item were observed in the second posttest period. In the analysis of dining room patron and patient food acceptance, tested food items were divided into "hot" and "cold" groups and separate ANOVAs conducted on each to assess the differential effect of the Aladdin rethermalization system.

For ward patients (see Table 9), it can be seen that no significant difference (NSD) was found among conditions on ratings of "overall satisfaction," "flavor," or "portion size" for cold foods. For temperature of cold foods, posttest 2 (PT2) ratings were not significantly different from Pretest (PRE)

FOOD ITEM _____

After you have eaten this item, rate it on the following characteristics. Select the ONE phrase that best describes your opinion of each and darken the box beside it.

TEMPERATURE (21)	FLAVOR (22)	PORTION SIZE (23)	TEXTURE (24)
Much too hot	Very good flavor	Much too big	Very bad texture
Too hot	Good flavor	Too big	Bad texture
Slightly too hot	Slightly good flavor	Slightly too big	Slightly bad texture
Just right	Neutral flavor	Just right	Neutral texture
Slightly too cold	Slightly bad flavor	Slightly too small	Slightly good texture
Too cold	Bad flavor	Too small	Good texture
Much too cold	Very bad flavor	Much too small	Very good texture

What is your OVERALL OPINION of this item? (25)

7	6	5	4	3	2	1
Very good	Good	Slightly good	Neutral	Slightly bad	Bad	Very bad

COMMENTS:

Please drop this card in the box as you leave. Thank you.

Figure 14. Opinion survey card.

TABLE 8. Results of General Opinion Survey (Mean Values)

	Ward vs. Cafet.	Posttest 2	Posttest 1	Pretest	Sign. Effects (p .05)
1. What is your opinion of <u>all</u> the meals you have eaten in this hospital? 1 = Very Bad 5 = Very Good	W C	3.73 3.62	3.47 3.49	3.67 3.36	TIME
2. What is your opinion of the variety of foods offered on the menu? 1 = Need Much More Choice 5 = Need Much Less Choice	W C	2.35 2.28	2.34 2.15	2.22 1.91	NSD
3. If you are a patient, do you add to, or replace, your meals at this hospital with food items other than those on the hospital menu (i.e., vending machines, food from home, etc.)? 1 = Almost Always 5 = Never	W C	4.37 3.61	3.98 3.07	4.16 3.35	PLACE
4. How do you feel about the courtesy and cheerfulness of the people serving your food? 1 = Very Dissatisfied 5 = Very Satisfied	W C	4.03 3.61	4.22 4.01	4.25 3.51	PLACE
5. The following 5 questions pertain to the meal you have just eaten. What is your opinion of the following aspects of the meal? a. Size of Food Portions 1 = Too Small 5 = Too Large	W C	2.84 2.84	2.81 2.77	2.78 2.85	NSD
b. Food Served When You Want It 1 = Too Late 5 = Too Early	W C	2.92 3.01	2.98 2.98	3.05 3.15	TIME
c. Attractiveness of Dishes, Silverware, and Tray 1 = Very Unattractive 5 = Very Attractive	W C	3.36 3.26	3.75 2.99	3.59 3.43	PLACE PLACE X TIME
d. Were your <u>hot</u> food items the temperature you like them when you ate them? 1 = Yes 2 = No	W C	1.25 1.30	1.26 1.48	1.30 1.36	NSD
e. Were your <u>cold</u> food items the temperature you like them when you ate them? 1 = Yes 2 = No	W C	1.15 1.14	1.36 1.22	1.34 1.19	TIME PLACE

TABLE 8. Results of General Opinion Survey (Mean Values) (cont'd)

	Ward vs. Cafet.	Posttest 2	Posttest 1	Pretest	Sign. Effects (p .05)
6. During the time that you have been at this hospital, how has the overall quality of the food changed? 1 = Greatly Improved 5 = Greatly Worsened	W C	3.71 3.57	3.50 3.78	3.60 4.24	PLACE PLACE X TIME
7. During the time you have been at this hospital, how has the overall food service changed? 1 = Greatly Improved 5 = Greatly Worsened	W C	3.61 3.44	3.69 3.47	3.64 4.01	TIME PLACE X TIME

TABLE 9. Overall Mean Ratings: Ward Comparisons - Cold Foods

(.050 Level)				
TEMPERATURE				
4 = JUST RIGHT	PRE	P2	>	P1
	4.12 =	4.06		3.84
FLAVOR				
7 = VERY GOOD		NSD =		5.41
PORTION SIZE				
4 = JUST RIGHT		NSD =		3.57
TEXTURE				
1 = VERY GOOD	P2	>	P1	PRE
	2.68		4.90	5.36
OVERALL SATISFACTION				
7 = VERY GOOD		NSD =		5.59

ratings, but both were significantly better than Posttest 1 (PT1) ratings. For "texture," PT2 ratings were significantly greater than PT1 ratings, which, in turn, were significantly greater than PRE ratings.* For "all hot items (see Table 10)," significant differences among conditions were found for all judged characteristics except "portion size." In the case of "texture," the same pattern of differences were observed for both hot and cold items, namely PT2 better than PT1 better than PRE. In the case of "temperature" ratings, the pretest condition also showed significantly lower ratings for hot items than either of the two posttest conditions. Ratings of "overall satisfaction" and "flavor" both show the same pattern of differences, (PRE-PT2) PT1 for "all hot items." The significantly lower ratings of PT1 for hot and cold food on some attributes suggest that problems may have existed during the initial posttest period, but that these problems were eliminated by the time of the second posttest period.

The fact that no significant differences were found for ratings of "portion size" supports the validity of the rating scales, since portion size was not altered in the changeover to the new system.

Responses made by patients, staff, and guests who patronize the hospital cafeteria (see Tables 11 and 12) show a complex pattern of results. The most salient feature to be noted, however, is that for no entry in the table are the results obtained during the pretest condition (PRE) significantly better than those obtained during both posttest periods (PT1 and PT2). The reverse situation, where PRE is significantly less acceptable than both posttest conditions, is frequently observed.

In summary, the results of the food acceptance testing show food can be produced under the new system that is at least as acceptable (if not more so) than food prepared under the old system. This statement is based on the fact that for no subset of foods, sensory characteristic, or location of testing were the pretest ratings significantly better than posttest ratings. Secondly, the new concept appears to have a greater impact on hot foods than cold foods, as reflected in the frequency of nonsignificant differences among test conditions for cold food items, as contrasted with hot food items. The significantly better temperature ratings across all hot foods in the ward data can be directly attributed to the Aladdin Temp-Rite II System. The overall dining room improvements, especially the "overall satisfaction," were unexpected. They may be attributable to the advanced preparation techniques, since food items are reheated immediately prior to service and not prepared far ahead of time or for long periods of time in warming cabinets, as was the case with the conventional system. Improved management and supervision were perceived to be other strong factors.

* Texture was rated on a reversed scale (see Fig. 14). This was done to ensure that respondents would read the category labels for each scale before making their evaluation. For example, a rating of 1 - Very Good Texture, 7 - Very Bad Texture.

TABLE 10. Overall Mean Ratings: Ward Comparisons - Hot Foods

(.050 Level)				
TEMPERATURE				
4 = JUST RIGHT	P1	>	P2	PRE
	4.51		3.76	3.57
FLAVOR				
7 = VERY GOOD	P2	=	PRE	P1
	5.03		5.15	4.64
PORTION SIZE				
4 = JUST RIGHT	NSD = 3.57			
TEXTURE				
1 = VERY GOOD	P2	>	P1	PRE
	3.21		4.54	4.81
OVERALL SATISFACTION				
7 = VERY GOOD	PRE	=	P2	P1
	5.27		5.18	4.85

TABLE 11. Overall Mean Ratings: Dining Room Comparisons - Cold Foods
(.050 Level)

TEMPERATURE 4 - JUST RIGHT	NSD = 3.99			
FLAVOR 7 - VERY GOOD	NSD = 5.41			
PORTION SIZE 4 - JUST RIGHT	P ₁ 3.92	>	P ₂ 3.75	= PRE 3.66
TEXTURE 1 - VERY GOOD	P ₂ 3.00	>	PRE 5.00	= P ₁ 5.28
OVERALL SATISFACTION 7 - VERY GOOD	NSD = 5.46			

TABLE 12. Overall Mean Ratings: Dining Room Comparisons - Hot Foods

(.050 Level)				
TEMPERATURE				
4 - JUST RIGHT	P1	>	P2	=
	4.56		3.62	PRE
				3.54
FLAVOR				
7 - VERY GOOD	P2	=	P1	>
	5.10		4.99	PRE
				4.73
PORTION SIZE				
4 - JUST RIGHT	P2	=	P1	>
	3.79		3.77	PRE
				3.64
TEXTURE				
1 - VERY GOOD	P2	>	PRE	>
	3.19		4.45	P1
				4.77
OVERALL SATISFACTION				
7 - VERY GOOD	P2	>	P1	>
	5.29		5.05	PRE
				4.78

Employee Satisfaction

The kitchen staff and nurses involved with tray delivery were interviewed before and after the Advanced Preparation System was implemented. The interviews were conducted under quiet surroundings. In general, the patient tray servers were pleased with the new food system and made the following comments:

- oThe delivery carts are much lighter and easier to maneuver;

- oThe hot food is much hotter than it was in the other (conventional) system. The cold food is also colder;

- oIsolation trays are much easier to handle;

- oTrays are easy to clean. Sanitation in general is easier because there are fewer dishes.

Problems with the system were those which occur in any food hospital service system. For instance, understaffing, communication problems with persons making diet rosters, and late tray call-ins were mentioned. Some tray attendants said that nurses are not always on time to serve the trays, thus making delivery late for other floors. There are, however, a few problems which may be related to the system itself. For example, according to patient tray attendant responses:

- oIt is difficult to return the trays to the delivery cart because of the low clearance between tray cover and the shelf directly above it;

- oIf the trays are not held properly foods spill;

- oEntree dishes could be sturdier, but the other dishes are fine;

- oThere is not always enough room on the tray to fit all the items that the patient requests.

Two cooks felt that the new patient tray system provides hotter food for the patient. One of these cooks felt that the system was good overall. Two others felt that there were no advantages to the system, but that there might be some if more food service workers could be hired. A lack of manpower was the major problem cited. There were comments that, because of a personnel shortage, food quality suffered and less attention was paid to sanitation. One person commented that, because the employees' tasks are so specialized, there was more pressure on the staff to prepare a meal on time when one employee was absent. One of the cooks felt that food quality also suffered, because the food was over processed during preparation, storage, and reheating.

Most cooks felt that the new system had increased their workload, but had not affected the way that they worked with others. Some felt that morale was poor. One cook leader stated that this poor morale was due to a lack of

cooperation in the kitchen, a lack of involved supervision (supervisor rarely interacted with staff; criticized more than he praised), and a decreasing amount of attention to sanitation. Other cooks felt that morale was generally good, except during a staff shortage or when the kitchen was hot. Three cooks felt that more personnel should be hired. One wished that the food could be cooked and served on the same day, another suggested that the hospital should go back to the old patient feeding system. One employee commented on the need for better communication among the kitchen staff, and one could think of no changes that he wanted to see.

The food service attendants liked the idea of not having dishes to wash. They felt that the new trays are easily cared for and stored, and there was sufficient time to clean everything for the following meal (when enough people are on shift).

The attendants offered no unfavorable comments and stated they have no more work than before. The system seems to have produced no change in day-to-day operations.

The ingredient workers did not feel rushed with the new system. They stated food can be prepared in advance, which eliminates last-minute work. Although they feel that there is more work to do, the pace is steady and the new work schedule is preferred.

The clinical diet aides feel that the new system keeps the hot food hot and the cold food cold. However, they have had problems responding to diet changes called down from the wards. Often, while the diet aides are in the wards learning what changes need to be made for a certain meal, that meal is already being plated in the kitchen. Therefore, "changed" meals arrive late on the wards, and "incorrect" meals are wasted. One aide feels that the diet roster should be completed early enough, so that a greater amount of time is left before tray assembly. The aides stated there is more work with the new system, because of these last-minute diet changes. The diet change and late tray problem has led to less cooperation in the kitchen. The kitchen workers blame the diet aides for last minute changes from the wards, when it is really not their fault. The aides feel that morale could be improved. There are problems when workers are on leave and there is not enough help in the kitchen.

The nursing staff seemed to have mixed feelings about the the survey results. The majority stated two positive reactions:

- oThe tray system is very convenient to operate in removing trays. The carts are easy to manage and are always at the wards on time;

- oThe food is regarded as being hotter than it was in the old system and isolation trays are easier to assemble and serve than with the hot/cold cart.

The major complaint that nurses had concerned communication with the food service department, particularly on the diet rosters and diet changes. This problem is evident in any hospital but seemed to be somewhat aggravated by the new system. Nurses also observed that:

°Servings were small and some patients were still hungry after a meal. (Note that ward patient ratings of portion size on the consumer opinion cards were not significantly different with the new system);

oIt was difficult to put trays back into the carts after patients finish the meal;

oAlso, nurses felt that the food does not appear to be assembled in a careful manner.

Overall, hospital employees felt that the new system is sometimes more difficult to operate with reduced manpower, that it has exacerbated the pre-existing problem of lack of a communication among employee groups, and that certain specific problems (e.g., difficulty of returning trays to cart) still exist. However, these same employees see advantages in the new system, such as hot food hotter, cold food colder, as well as the carts being easier to clean and handle.

V. QUALITY ASSURANCE

Advanced Preparation systems are potentially more vulnerable to microbiological problems than conventional systems. Through production, chilling, freezing, packaging, storing, tempering, and cold plating, there is more opportunity for exposure to improper temperatures than there is with the conventional system. Therefore, quality assurance was stressed to show that the new system as implemented at Moncrief could be operated safely.

Microbiological and Sanitary Testing

Prior to implementation of the new system, Natick R&D Center microbiologists collected food samples over a two week period in June 1979. A second survey was conducted during the eight months immediately after frozen food production was started and before installation of the new patient tray delivery system. Food samples were transported from Fort Jackson to the Natick Center for laboratory analysis. After the new patient tray system was installed, the Fort Jackson Post Veterinarian assigned a technician to the food service department at Moncrief Hospital, full time for four months and part time for two additional months. Also, the US Army Regional Veterinary Laboratory at Fort Gordon, GA, agreed to analyze up to 25 food samples per week, and the Environmental Sanitation Unit at Moncrief provided laboratory space for limited microbiological analysis. The combined efforts at Fort Jackson, Fort Gordon, and the Natick R&D Center made it possible to perform appreciable microbiological and sanitation testing. Rodac and swab tests were performed for one or more of the following indices: Aerobic Plate Count, Coliform Count, Escherichia coli, Staphylococcus aureus, Clostridium perfringens, and Yeast and Mold Count.

Compliance with microbiological requirements for food items produced under the Advanced Preparation system is shown in Table 13. The overall noncompliance of entree, starch and vegetable items ranges from six to eight percent, similar to the incidence experienced in the original system.⁴ Monthly analyses of the data demonstrated that the microbiological quality of the menu items and of food contact surfaces improved with time (see Table 14). After introduction of the new system, discovering difficulties, and addressing them, microbial quality improved by the fourth month (December). Subsequently, Natick personnel were unable to monitor closely the quality assurance program so that the incidence of noncompliance rose for salad items⁴ (see Table 14).

Sanitation, when measured by Rodac plates, followed the same trends as those noted for food analysis (see Table 15). The cleanliness of the facility increased through December and then decreased somewhat in January. Surfaces tested by swabs generally increased in cleanliness throughout the study.

TABLE 13. Microbiological Analysis of Menu Items

	No. of Samples	% in Compliance	Indices Exceeded
Entree	135	94	APC, coliform, <u>E. coli</u> , <u>S. aureus</u>
Starch ^a	25	92	Coliform
Vegetables	13	92	APC
Gravy	9	100	
Salad ^b	13	58	APC, coliform
Salad ^b	8	75	APC
Breakfast items	43	95	APC, coliform

^aPotato, macaroni

^bTuna, chicken, salmon, turkey, and ham

TABLE 14. Microbiological Noncompliance by Month

	Samples in Noncompliance			
	%			
	Entree	Starch ^a	Vegetable	Salad
September	6	0	-	25
October	7	20	0	67
November	10	14	100	0
December	0	0	0	0
January	6	0	0	40

^aPotato, macaroni

TABLE 15. Evaluation of Food Contact Surfaces

	Surfaces tested by	
	Rodac plates	Swab
	% nonconforming	
September	33	80
October	23	47
November	15	62
December	6	28
January	12	23

Rodac plate counts are not comparable to swabs since they evaluate different surfaces. Usually the flat food-contact surfaces tested by Rodac plates contained less of a bioburden than the more irregular, more inaccessible surfaces examined by swabs. The more specific, chronic problems were certain tables, the conveyor belt, and the food delivery cart. The latter is a design problem and not mainly due to personnel negligence.

Time-Temperature Profiles

To assure microbiological safety after tray assembly and during delivery to the wards, time-temperature profiles (see Fig. 15) of 126 selected food items were taken. Thermocouples were secured in hot and cold food items on two or three sample trays placed at various locations in the delivery cart. A portable, multi-point recording thermometer monitored food temperatures at selected time intervals during transportation to the wards, reheating in the ward refrigerators, and under ambient conditions while the trays were being delivered.

Except for breakfast items, hot food heated quite well (see Table 16). Ninety five to 100 percent of all items served for dinner or supper achieved an after-delivery temperature of 140°F. Those foods that did not heat particularly well were substituted with similar items (for example, barbecue chicken for fried chicken). Also, some production guides were reformulated. In the case of vegetables, a butter sauce was added to increase the heat transfer properties of the product. Broccoli was impossible to heat adequately without the presence of a fair amount of sauce. Special plating and assembly procedures did improve the heating of breakfast items, but, as shown in Table 16, not to the level of items served at other meals. However, as stated in the section on consumer evaluation, patients perceived hot food temperatures to be significantly better with the new system.

TABLE 16. Percentage Achievement of Temperature Parameters

	Breakfast Items	Dinner Items	Supper Items
Temperature 140°F	53%	100%	95%
Temperature 165°F	25%	90%	66%

Temperature profiles of 10 production batches were taken immediately after cooking, before the rapid chilling cycle, and at various times during rapid chilling and blast freezing. Similar monitoring was performed during the rapid thaw cycle. The cooling and thawing curves obtained assisted management in establishing as achievable operating standards a 3-hour rapid-chill, 6-hour blast-freeze, and 24-hour rapid-thaw cycle, all of which fell within acceptable time-temperature relationships.

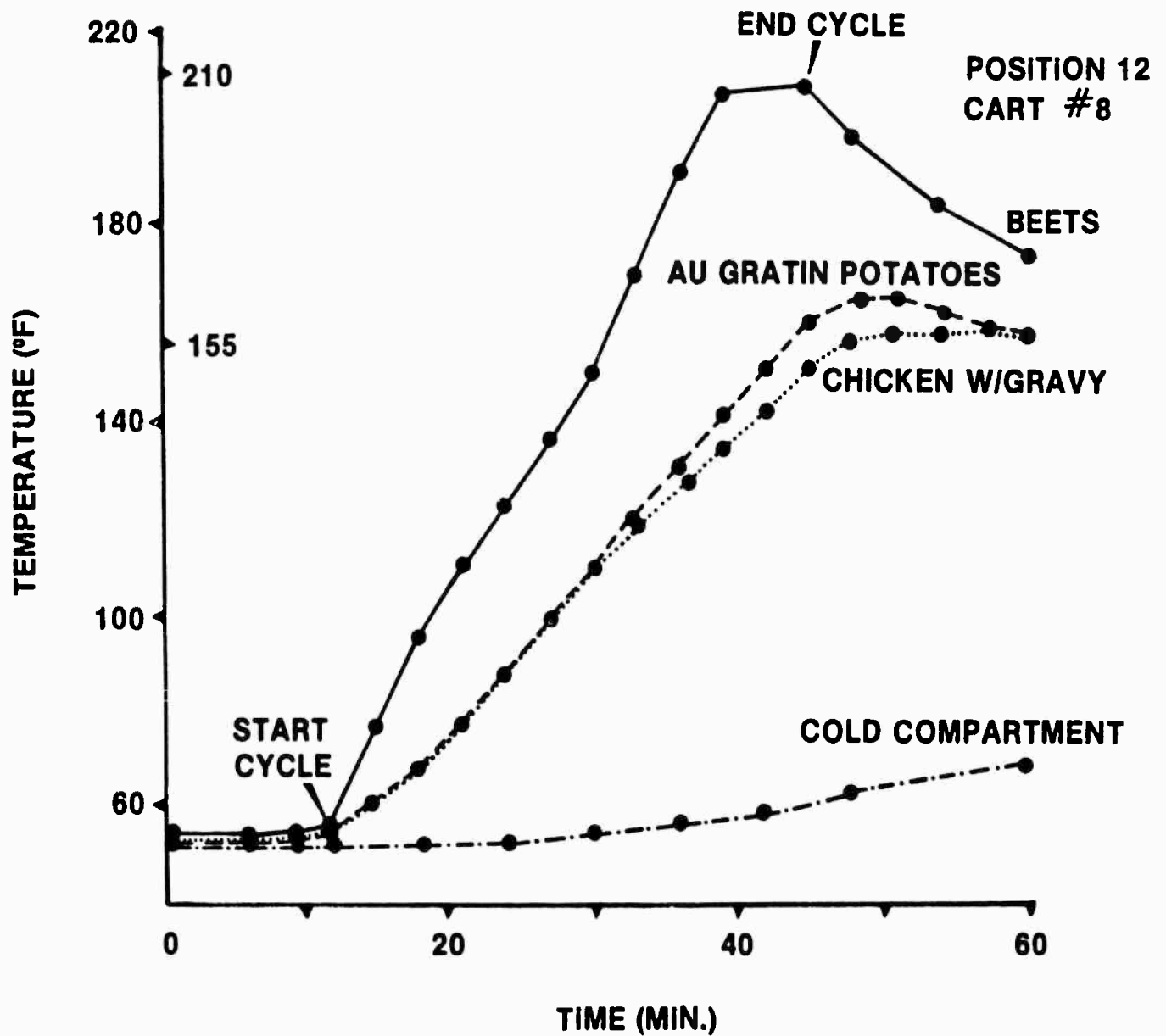


Figure 15. Sample rethermalization curve.

VI. NUTRITION

The menu at Moncrief Hospital had to be revised to accommodate frozen food production and cold plating tray assembly. Some method of demonstrating the effect of the menu changes on nutrition was necessary. Natick R&D Center maintains an extensive database containing Armed Forces recipes and US Department of Agriculture Handbook Food Composition data. Computer programs are available to determine the nutrient composition of menus. Values are calculated for those nutrients that have a daily dietary allowance prescribed by military regulations. These values are summed by meal, day and menu cycle. Military issue factors and consumption data collected during meals at Moncrief Hospital were used to estimate the amount of each menu item that would be taken by food service patrons. For example, it was found that only 80% take a vegetable. These consumption factors were put into the computer and an estimate of the average nutrition available from the menu was produced. The results are shown in Table 17.

The computer data show that the Military Required Daily Allowance (MRDA) is more than adequately satisfied in all nutrient categories. There is a reduction in calories and fat with the new 21-Day Menu designed for the Advanced Preparation system. It must be noted that the energy allowances of the MRDA represent average ranges of caloric intake designed to support maintenance of ideal/desirable body weight for healthy individuals under conditions of moderate physical activity in an environment compatible with thermal comfort. The allowances are not to be interpreted as individual requirements and may not be applicable to personnel requiring special treatment for conditions such as infection, chronic disease, trauma, unusual stress, pregnancy, or weight reduction.

VII. RESULTS AND CONCLUSIONS

The experiment successfully conducted at Moncrief Army Hospital, Ft. Jackson, SC, yielded the following conclusions:

1. An Advanced Preparation system utilizing rethermalization cart patient tray delivery is more cost effective than a conventional preparation system utilizing the hot/cold cart patient tray delivery.

oAccording to projections, staffing can be reduced 17.5% from pretest authorized levels at Moncrief Army Hospital. This is accomplished mainly by using part-time workers and realigning traditional roles performed under the conventional system by the food service and nursing staff. It is noted that the staffing reductions are projected because the system was not in operation long enough for verification under actual operating conditions. After 12 months of operation, the hospital reverted back to a conventional system in preparation for an electrical/mechanical upgrade, which forced the food service to be operated from a temporary location. The relatively short period of operation did not allow attrition, with replacements in the form of part-

TABLE 17. Menu Nutrient Composition

Moncrief Hospital 35 Day Average

	Energy (k cal)	Protein (Gm)	Fat (Gm)	CA (Mg)	Iron (Mg)	Vit. A (Mcg RE)	B1 (Mg)	B2 (Mg)	Niacin (Mg NE)	Vit. C (Mg)
Breakfast	1098	46	54	694	6.5	407	.77	1.3	5.4	45
Noon	1589	60	76	647	9.6	994	.77	1.3	12.0	66
Evening	1519	53	67	603	9.0	1177	.78	1.3	11.0	70
Daily Avg.	4205	159	197	1944	25.1	2578	2.3	3.9	28.0	181
MRDA	3200	100	124	1000	14	1000	1.6	1.9	21.0	60
% of MRDA	124	159.4	158	194	179	258	144	205	133	302

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Moncrief Hospital 21-Day Average

	Energy (k cal)	Protein (Gm)	Fat (Gm)	CA (Mg)	Iron (Mg)	Vit. A (Mcg RE)	B1 (Mg)	B2 (Mg)	Niacin (Mg NE)	Vit. C (Mg)
Breakfast	1189	47	52	710	6.8	371	.90	1.4	6	42
Noon	1043	46	49	406	6.6	584	.53	.9	9	47
Evening	1005	43	46	394	6.3	665	.55	.9	9	49
Daily Avg.	3237	136	147	1509	19.7	1620	2.0	3.1	24.0	138
MRDA	3200	100	124	1000	14.0	1000	1.6	1.9	21.0	60
% of MRDA	101	136	118	151	141	162	125	163	114	229

time labor, to take its course. However, staffing was reduced 11% over the course of the test.

oThe Advanced Preparation system has equal or better food acceptance when compared to the conventional system for both dining room patrons and patients.

oIt is projected that total operating cost per meal can be reduced 12.5%, from \$5.90 to \$5.16 in 1982 dollars.

oProductivity can be improved about 29%, from 2.4 to 3.1 meals per man-hour on the basis of projected staff reductions.

2. The system can be operated with microbiological safety.

3. An Advanced Preparation system can be operated within the food cost budgetary constraints of Army hospital food service.

4. Energy consumption does not increase significantly, comprising only 4% of the new system total operating meal cost versus 3% pretest.

5. Fewer total skilled employees are required but greater skill is necessary for management and some production positions.

6. The higher the percentage of frozen food produced the better the system will be able to respond to large increases in workload. This is important to the military mobilization mission in terms of expansion flexibility.

7. The problem of diet change communication between nursing and the dietary department appeared to be aggravated by the new system because trays are assembled further ahead of service. Concentrated efforts on the part of both departments helped to increase the percentage of successful diet changes.

8. Retrofit of equipment did require space in areas other than food service. For example, the freezer for storage of cook-freeze items was constructed adjacent to the receiving dock outside the hospital. Careful consideration of this fact and consultation with all persons involved (hospital engineers, administrators, nurses) made the conversion more efficient.

9. Advanced Preparation does impose some menu limitations, and some items are prepared differently than under a conventional system. However, the different production techniques followed are not outside the scope of expertise of a typical Army cook.

10. The Aladdin Temp-Rite II System was very reliable and can be operated with virtually no mechanical problems.

VIII. RECOMMENDATIONS

1. A larger hospital (medical center) should be converted to the Advanced Preparation system to verify cost effectiveness.
2. From start-up and during the first six months of operation, an intensive quality assurance program should be conducted by trained personnel. After this period, a structured monitoring program with major emphasis on time-temperature profiles and sanitation should be administered by the food service supervisory staff.
3. Freezing, chilling, tempering, and packaging (bulk and individual) capability should be installed in all sizes of Army hospitals as part of electrical/mechanical upgrades.
4. A staffing and workload trend analysis for all CONUS Army hospitals should be conducted over the period of FY 1979 to FY 1982. Such an analysis would determine if labor savings achieved to date at Moncrief Hospital were completely due to the Advanced Preparation system or labor reduction actions taken as a result of standard manpower surveys conducted for all Army hospital food service departments.

This document reports research undertaken at the US Army Natick Research and Development Command and has been assigned No. NATICK/TR-857023 in the series of reports approved for publication.

IX. REFERENCES

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3. US Department of Labor, Producer Prices and Price Indexes, "Producer Price Indexes for Selected Stage-of-Processing Groupings, Seasonably Adjusted," Bureau of Labor Statistics, Washington, DC 1982.
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Appendix A

PREPARED FROZEN FOOD

PRODUCTION AND INVENTORY WORKSHEET

APPENDIX A
PREPARED FROZEN FOOD PRODUCTION
AND INVENTORY WORKSHEET

This form will be used to determine the quantity to be produced for each prepared frozen food. The values for X, Y, and t will be supplied by the Natick R&D Center. The constants X and Y are obtained through computer analysis, and t is the time in months which insures an optimum inventory level.

An explanation of each column follows:

- Column E - Enter the total number of blocks of frozen food used during the last menu cycle (21 days) from column F of the Food Receipt and Accounting Record.
- Column F - Enter the average number of blocks of frozen food used last menu cycle from column I of last month's Frozen Food Production and Inventory Worksheet.
- Column G - Multiply the "Total Used" from column E by the X-value and enter the product (Z1) in column G.
- Column H - Multiply the "Old Average" from column F by the Y-value and enter the product (Z2) in column H.
- Column I - Add the Z1 and Z2 from columns G and H to obtain the "New Average" and enter the sum in column I.
- Column J - Multiply the "New Average" from column I by the t-value to obtain the "Target Level" and enter the product in column J.
- Column K - Obtain the "Total on Hand" from column G of the Food Receipt and Consumption Record and enter it in column K.
- Column L - Subtract the "Total on Hand" (column K) from the Target Level (column J) to obtain the "Amount Needed" and enter the difference in column L. If this is a negative number no production is required. If this is a positive number, proceed to next step.
- Column M - The number of servings needed is calculated by multiplying the number in column L by the number of servings per block.

INVENTORY WORK SHEET
FOR
FROZEN FOOD PRODUCTION

MO-DY-YR
/ /

Page No. 1a

X = 1/2
Y = 1/2
t = 1.5

Item Name	E	F	G	H	I	J	K	L	M
			X x E	Y x F	Z1 + Z2	t x J	Total	K - L	Blocks x
	Total Used	Old Ave	Z1	Z2	New Ave	Target Level	On Hand	Blocks Needed	Srgrs/Blck Servings Needed
Baked Chicken/gravy									
Baked Chicken/grvyNa/R									
Baked Ham Macaroni&Tom									
Baked Stuffed Prk Chps									
BBQ Beef Cubes									
BBQ Chicken									
BBQ Ground Beef									
BBQ Pork Slices									
BBQ Sliced Beef									
BBQ Spare Ribs									
Beef and Corn Pie									
Beef Filling (Tacos)									
Beef Jardiniere									
Beef Pot Pie									
Beef Stew									
Beef Stroganoff									
Braised Beef Cubes									
Braised Beef CubesNa/R									
Chicken Ala King									
Chicken Chow Mein									
Chicken Fried Steak									
Chicken Pot Pie									
Chicken Tetrazzini									
Chicken Vega									
Chili Con Carne/beans									
Creamed Ground Beef									
El Rancho Stew									
Ginger Pot Roast									
Grilled Prk Slices/grvy									
Ham Loaf									
Hot Tamale Pie									

INVENTORY WORK SHEET
FOR
FROZEN FOOD PRODUCTION

MO-DY-YR
/ /

Page No. 2a

X = 1/2
Y = 1/2
t = 1.5

Item Name	E	F	G	H	I	J	K	L	M
			X x E	Y x F	Z1 + Z2	t x J	Total	K - L	Blocks x
	Total Used	Old Ave	Z1	Z2	New Ave	Target Level	On Hand	Blocks Needed	Srge/Blck Servings Needed
Lasagna									
Meat Loaf/grvy									
Meat Sauce/Spaghetti									
Pineapple Chicken									
Pork Adobo									
Pork Chop Suey									
Pot Roast									
Roast Beef/grvy									
Roast Lamb/grvy									
Roast Pork/grvy									
Roast Turkey/grvy									
Roast Turkey/grvy Na/R									
Roast Veal/grvy									
Salisbury Steak/grvy									
Savory Baked Chicken									
Sauerbraten									
Southern Fried Chicken									
Stuffed Green Peppers									
Sweet and Sour Pork									
Swedish Meatballs									
Swiss Steak/grvy									
Syrian Beef Stew									
Tuna Ala King									
Tuna Loaf									
Tuna Noodle Casserole									
Turkey Ala King									
Turkey Chow Mein									
Turkey Noodle Casserole									
Turkey Tetrzzini									
Veal Parmigiana									
Yakisoba									

INVENTORY WORK SHEET
FOR
FROZEN FOOD PRODUCTION

MO-DY-YR
/ /

Page No. 3a

X = 1/2
Y = 1/2
t = 1.5

Item Name	E	F	G	H	I	J	K	L	M
			X x E	Y x F	Z1 + Z2	t x J	Total	K - L	Blocks x
	Total Used	Old Ave	Z1	Z2	New Ave	Target Level	On Hand	Blocks Needed	Srgs/Bick Servings Needed
Yankee Pot Roast									
Creole Macaroni									
Macaroni & Cheese									
Potatoes Au Gratin									
Refried Beans									
Texas Hash									
Cornbread Dressing									
Sausage Dressing									
Savory Bread Dressing									
Cheese Sauce									
Mustard Sauce									
Pizza Sauce									
Raisin Sauce									
Taco Sauce									
Brown Gravy									
Cream Gravy									
Chili Gravy									
Giblet Gravy									
Mushroom Gravy									

Appendix B
BATCH SIZE LIST

Appendix B

BATCH SIZE LIST

Menu Item	Portion Size	Equipment/Batch
Beef, Boneless:		
1. Barbecue Beef Slices	4 oz. meat	Revolving Tray Oven/200 portions
2. Ginger Pot Roast	4 oz. meat	Revolving Tray Oven/200 portions
3. Pot Roast	4 oz. meat	Revolving Tray Oven/200 portions
4. Roast Beef	4 oz. meat	Revolving Tray Oven/200 portions
5. Sauerbraten	4 oz. meat	Revolving Tray Oven/200 portions
6. Yankee Pot Roast	4 oz. meat	Revolving Tray Oven/200 portions
Beef, Boneless Swiss:		
1. Swiss Steak w/Brown Gravy	1 steak, 4 oz. gravy	Revolving Tray Oven/480
2. Swiss Steak w/Tomato Sauce	1 steak, 4 oz. gravy	Revolving Tray Oven/480
Beef, Diced:		
1. Barbecue Beef Cubes	1C	30 gal kettle/250 40 gal/400 60 gal/600
2. Beef Pot Pie	1C	30 gal kettle/250 40 gal/400 60 gal/600
3. Beef Stroganoff	1C	30 gal kettle/250 40 gal/400 60 gal/600
4. Braised Beef Cubes	1C	30 gal kettle/250 40 gal/400 60 gal/600
Beef, Ground:		
1. Chile w/Beans	1C	30 gal kettle/250 40 gal/400 60 gal/600
2. Chile Dog	1/2C	30 gal kettle/500 40 gal/800 60 gal/1200
3. Creamed Beef	1C	30 gal kettle/250 40 gal/400 60 gal/600
4. Creole Macaroni	1C	30 gal kettle/250 40 gal/400 60 gal/600
5. Enchiladas	1.5 oz.	by menu cycle demand
6. Jumbleletta	3/4C	30 gal kettle/350 40 gal/550 60 gal/800
7. Lasagna	8 avg. per 1/2 size pan	Revolving Tray Oven/350 (use 40 lbs ground beef)
8. Meatloaf	4 oz. gravy, 1 slice	Revolving Tray Oven/600 (use 180 lbs ground beef)
9. Salisbury Steak	4 oz. gravy, 1 steak	Revolving Tray Oven/480
10. Sloppy Joe	2/3C	30 gal kettle/350 40 gal/550 60 gal/800
11. Spaghetti Meat Sauce	1C	30 gal kettle/250 40 gal/400 60 gal/600
12. Stuffed Green Peppers	2 each	Revolving Tray Oven/320 Two batches 640
13. Swedish Meatballs	3 each	Revolving Tray Oven/360
14. Tacos	3 oz.	by menu cycle demand
15. Texas Hash	6 oz.	30 gal kettle/300 40 gal/400 60 gal/650

Appendix B

BATCH SIZE LIST (cont'd)

Menu Item	Portion Size	Equipment/Batch
Ham, Cooked Boneless:		
1. Ham Loaf	1 slice	Revolving Tray Oven/650
Lamb:		
1. Roast Lamb	4 oz meat	Revolving Tray Oven/200
Pork, Diced:		
1. Chop Suey	1 1/4 C	30 gal kettle/200 40 gal/250 60 gal/400
2. Sweet and Sour	1 C	30 gal kettle/250 40 gal/400 60 gal/600
Pork, Loin Boneless:		
1. Pork Slices/Barbecue Roast	4 oz. sauce or gravy	menu cycle demand
Pork Slices, Chops:		
1. Baked Stuffed Pork Chops		menu cycle demand
Pork Spareribs:		
1. BBQ	2 double ribs	Revolving Tray Oven/350
Veal, Cutlets Breaded:		
1. Parmesan (sauce only)	4 oz.	30 gal kettle/500 40 gal/800 60 gal/1200
Fish:		
1. Tuna Noodle Casserole	9 oz.	30 gal kettle/200 40 gal/300 60 gal/500

Appendix B

BATCH SIZE LIST (cont'd)

Menu Item	Portion Size	Equipment/Batch
Turkey, Boneless Frozen:		
1. Turkey A La King	1C	30 gal kettle/250 40 gal/400 60 gal/600
2. Turkey Chow Mein	1C	30 gal kettle/250 40 gal/400 60 gal/600
3. Turkey Noodle Casserole	1C	30 gal kettle/250 40 gal/400 60 gal/600
4. Turkey Pot Pie	1C	30 gal kettle/250 40 gal/400 60 gal/600
5. Turkey Tetrazzini	1C	30 gal kettle/250 40 gal/400 60 gal/600
6. Hot Turkey Sandwich		menu cycle demand
7. Turkey Croquettes		menu cycle demand
Chicken:		
1. BBQ Chicken	2 pieces	menu cycle demand
2. Chicken w/Dumplings	1C	menu cycle demand
3. Pineapple Chix	2 pieces	menu cycle demand
4. Chicken Pot Pie	1C	menu cycle demand
5. Savory Baked Chix	2 pieces	menu cycle demand
Starch:		
1. Au Gratin Potatoes	6 oz.	30 gal kettle/300 40 gal/400 60 gal/650
2. Fried Rice	3/4C	menu cycle demand - multiples of 150
3. Rice Pilaf	3/4C	menu cycle demand - multiples of 150
4. Mexican Rice	3/4C	menu cycle demand - multiples of 150
5. Macaroni and Cheese	1C	30 gal kettle/250 40 gal/400 60 gal/600

Appendix B

BATCH SIZE LIST (cont'd)

Menu Item	Portion Size	Equipment/Batch	
Sauce:			
1. Barbecue	4 oz.	30 gal kettle/500	40 gal/800 60 gal/1200
2. Hot Mustard	4 oz.	30 gal kettle/500	40 gal/800 60 gal/1200
3. Pineapple	4 oz.	30 gal kettle/500	40 gal/800 60 gal/1200
4. Pizza	4 oz.	30 gal kettle/500	40 gal/800 60 gal/1200
5. Raisin	4 oz.	30 gal kettle/500	40 gal/800 60 gal/1200
6. Tomato	4 oz.	30 gal kettle/500	40 gal/800 60 gal/1200
7. Cream	4 oz.	30 gal kettle/500	40 gal/800 60 gal/1200
Gravy:			
1. Brown	4 oz.	30 gal kettle/500	40 gal/800 60 gal/1200
2. Chile	4 oz.	30 gal kettle/500	40 gal/800 60 gal/1200
3. Mushroom	4 oz.	30 gal kettle/500	40 gal/800 60 gal/1200
4. Vegetable	4 oz.	30 gal kettle/500	40 gal/800 60 gal/1200

Appendix C

ESSENTIAL EQUIPMENT

APPENDIX C

ESSENTIAL EQUIPMENT

Existing food production equipment capacity at Moncrief Hospital was adequate to handle large volume batch preparation used in the new system. However, several new pieces of equipment were purchased for cold processing, storage, and patient tray service. These items are considered essential to any Advanced Preparation system. The following discussion provides in-depth descriptions of the equipment used.

1. Rapid Chill Unit - This two door roll-in unit is a refrigeration system capable of chilling 400 pounds (200 per section) of precooked foods from 140°F to 45°F in approximately three hours, depending on product density. High velocity convected air cools down hot food fast before bacterial growth reduces storage life. At the termination of the chill processing cycle, the cabinet automatically converts for use as a 38°F storage refrigerator. The chiller is engineered with a 1½ horsepower condensing unit per section and is constructed of stainless steel. Remote compressors were necessary.
2. Rapid Blast Unit - The rapid blast unit (needed only if cook-freeze production procedures are employed) is a two-door, roll-in mechanical blast freezer capable of maintaining circulating air temperatures of -20°F at a velocity of 3300 cubic feet per minute. Four hundred pounds of food (200 per section) can be frozen from a chilled state in five to six hours. Processing times are dependent on product density. The unit is fabricated of stainless steel. Remote compressors were necessary.
3. L-Bar Semi-Automatic Sealer - This piece of equipment is used to package five pound food blocks frozen in half-size pan polyethylene molds. The food product is removed from the mold and placed on a conveyor (part of the sealer) within an envelope of polyethylene shrink film. An electro-magnetic sealing head is brought down over the product (manually) and a seal is made by radiant impulse. After the seal is made, a conveyor automatically moves the packaged product into the shrink tunnel. Adjustable temperature control permits a full range of thermoplastic films to be used.
4. Shrink Tunnel - This unit shrinks the polyethylene film tight around the food product by means of high velocity convected hot air. The automatic conveyor (variable speed 70 feet per minute) has double entry and exit curtains. An adjustable heat pattern can be thermostatically controlled to 450°F.
5. Label Machine - This piece of equipment automatically prints plain stencil labels using pressure sensitive tape. The adhesive is made especially for use under subzero conditions.
6. Prepared Food Inventory Storage Freezer - This walk-in freezer was constructed outside the hospital, adjacent to the receiving dock. It measures 29 feet long X 12 feet wide, and is powered by two-five horsepower, low-temperature compressors (one for backup).

7. Rapid Thaw Unit - This piece of equipment uses high velocity air flow and a system of alternating cycles of heating and refrigeration. The self-contained cabinet is designed so that internal temperature never exceeds 45°F throughout the thaw cycle. Six hundred pounds (two hundred per section) of frozen product distributed in five pound steamtable pans can be thawed in 24 hours. The cabinet operates as a conventional 38°F storage refrigerator when not being used for thawing.

8. Tray Assembly Cold Pan Units - Made of 20 gauge stainless steel, these cold pans are equipped with self-contained $\frac{1}{4}$ HP condensing units, air-cooled with screen enclosure. Each table is 34-3/4" high and has hard rubber non-marking wheels. This equipment is considered essential for cold plating tray assembly.

9. Walk-In Refrigerator - Used for storage of assembled patient trays and bulk cook-chill items prepared ahead of service. Powered by a 3 HP condensing unit, the refrigerator is 21 feet long and 15 feet wide.

10. Ward Service Equipment - The equipment used for patient tray service consisted of the following: three cubic foot self-contained freezers for storage of ice cream and iced beverages; plug-in 120 volt hot water dispensers for portioning of hot tea, Sanka, and hot chocolate; portable three gallon 120 volt coffee urns and Duramold construction utility carts for transportation of the coffee urns.

11. Rethermalization System - The rethermalization system installed at Moncrief Hospital is designed for use with advance food production methods. It consists of the following subsystems:

Mobile rethermalization carts (24 meal capacity) which serve as the tray storage, delivery, and retrieval vehicle;

Patient tray server base and insulated server cover;

Roll-in refrigerator units for the carts.

Patient meals are preassembled and selectively heated on the ward as they are held in a refrigerated environment.

TABLE C-1. Essential Equipment

	Purchased Price	Index	1982 Adjusted Cost
Rapid Chill, Blast Freezer Rapid Thaw Units	\$29,129	221.5	36,411
Rear Dock Storage Freezer	43,500	221.5	54,375
Remote Compressors	1,050	221.5	1,313
Label Machine	1,100	221.5	1,375
Shrink Tunnel	2,300	221.5	2,875
L-Bar Sealer	3,600	221.5	4,500
Tray Assembly Cold Pan Units	6,930	248.2	7,762
Walk-In Refrigerator	21,000	248.2	23,520
Ward Service Equipment	5,341	248.2	5,982
Aladdin Rethermalization System	157,550	248.2	176,456
Architectural and Engineering Kitchen Design/Wiring	16,985	221.5	21,231
	<u>\$288,485</u>		<u>\$335,800</u>
Less: Replacement set of Temperature Maintenance Carts (Hot/Cold Carts)			<u>\$ 90,850</u> <u>\$244,950</u>

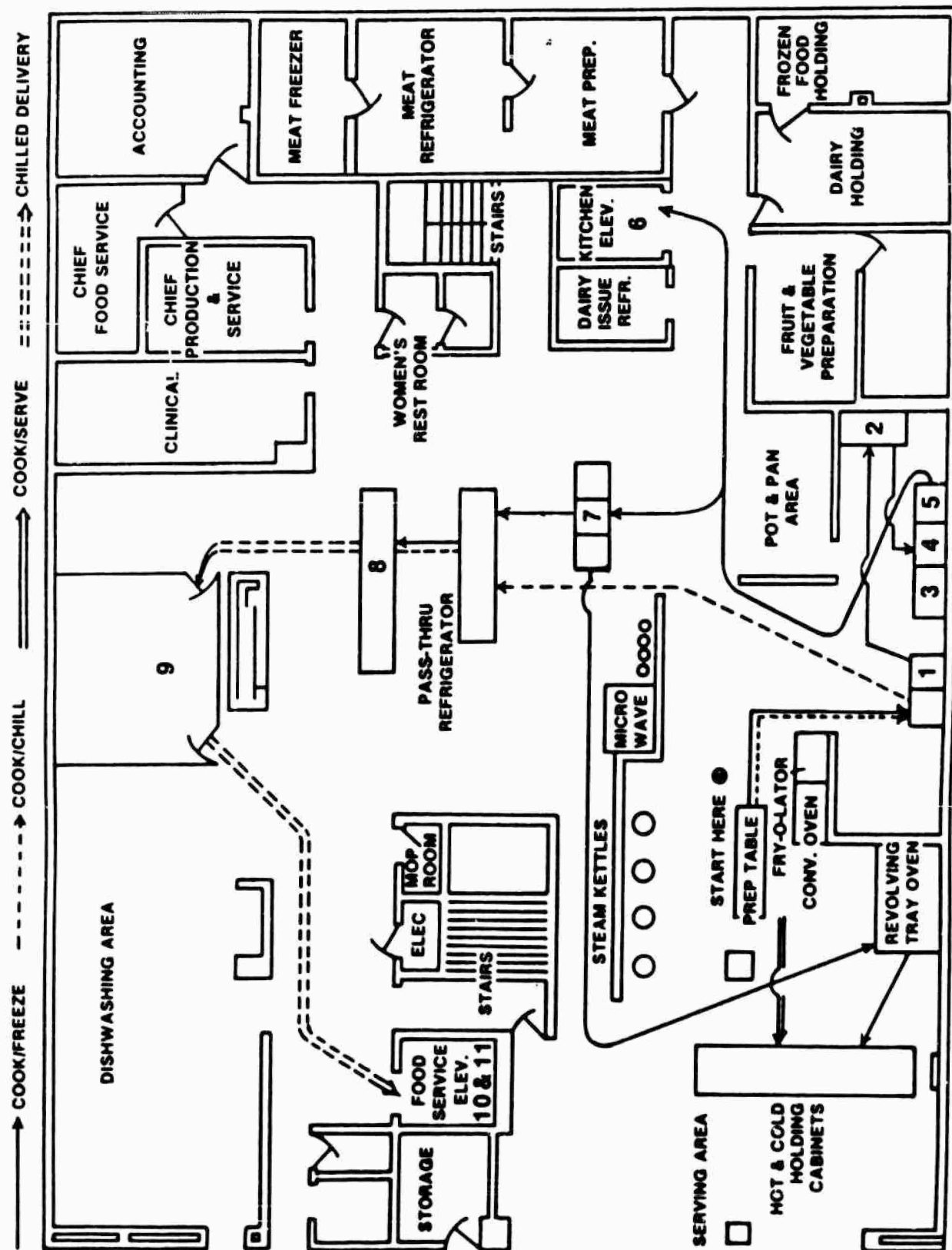


Figure C-1. Moncrief Hospital advanced food preparation (Note: numbers correspond to Appendix C, Essential Equipment)

Appendix D
LABOR REQUIREMENTS

APPENDIX D

LABOR REQUIREMENT

TABLE D-1. Staff Requirements

Moncrief Hospital
(\$1932)

Category	Pretest Authorized	Current Actual	Posttest Projected
Food Service Division	4	4	4
Production Service Branch	8	7	8
Clinical Dietetics Branch	7	7	7
Cooks Section	16	14	9.5
Ingredient Section	4	4	4
Tray Service Attendants	12	11	7.5
Food Service Attendants	$\frac{12}{63}$	$\frac{9}{56}$	$\frac{12}{52}$
	\$1,363,655	\$1,241,260	\$1,128,913
Labor Cost/Meal	\$4.31	\$3.67	\$3.34
Meals/Worker Hour	2.42	2.90	3.12
Worker Hours/Meal	0.41	0.34	0.32

TABLE D-2. Labor Cost Calculation

Civilian

Labor Cost = (Base Salary) X 1.204 (Civil Service Retirement) X 1.0565
(Health, Life Insurance, and other benefits).

Enlisted Personnel

Labor Cost = (Military Composite Rate) X 1.23 (Operating Appropriation Support
= Medical, Quarters, Food Subsistence, and Commissary Support) X 1.265
(Military Retirement).

Officers

Labor Cost = (Military Composite Rate) X 1.08 (Operating Appropriation
Support) X 1.265 (Military Retirement).

TABLE D-3. Staffing Requirements by Job Classification

		Conventional Base Authorized	Conventional Current Authorized	Advanced Preparation Projected
FOOD SERVICE DIVISION				
SP 04	Chief	1 \$57,348	1 \$57,348	1 \$57,348
NC E8	Food Service Supv	1 41,806	1 41,806	1 41,806
GS 05	Secretary Typist	1 18,353	1 18,353	1 18,353
GS 04	Accounts Clerk	1 16,408	1 16,408	1 16,408
CLINICAL DIETETICS BRANCH				
SP 03	Chief	1 46,818	1 46,818	1 46,818
SP 02	Hospital Nutrition Dietitian	1 36,511	1 36,511	1 36,511
NC E7	Hospital Food Service SGT	1 35,361	1 35,361	1 35,361
GS 03	Medical Diet Aide	4 58,456	4 58,456	4 58,456
PRODUCTION AND SERVICE BRANCH				
SP 03	Chief	1 46,818	1 46,818	1 46,818
NC E7	Hospital Food Service SGT	1 35,361	1 35,361	1 35,361
NC E6	Hospital Food Service SGT	2 59,758	2 59,758	2 59,758
WS 08	Cook Foreman	1 30,019	1 30,019	1 30,019
WS 04	Warehouse Supervisor	1 24,214	1 24,214	1 24,214
WG 04	Warehouse Worker	1 19,491	0	1 19,491
WG 06	Motor Vehicle Operator	1 19,491	1 19,491	1 19,491
COOK SECTION				
NC E6	Hospital Food Service 1st Cook	1 29,879	1 29,879	0
NC E5	Hospital Food Service 1st Cook	1 25,241	1 25,241	0
WL 08	Cook Leader	3 74,004	3 74,004	2 49,336
WG 08	Cook	9 207,789	8 179,368	6.5 145,736
WG 08	Baker	1 22,421	1 22,421	1 22,421
WG 08	Meatcutter	1 22,421	0 0	
FOOD SERVICE ATTENDANT SECTION				
WL 02	Food Service Worker Leader	3 45,321	3 45,321	3 45,321
WG 02	Food Service Worker	9 123,678	6 82,452	9 123,678
TRAY SERVICE ATTENDANT SECTION				
WL 04	Food Service Worker Leader	3 54,972	3 54,972	2 36,648
WG 04	Food Service Worker	9 149,544	8 132,928	5.5 91,388
INGREDIENT SECTION				
WL 04	Food Service Worker Leader	1 18,324	1 18,324	1 18,324
WG 04	Food Service Worker	3 49,848	3 49,848	3 49,848
Total Staff		63 \$1,363,655	56 \$1,241,480	52 \$1,128,913

NOTE: Funding includes salaries and all benefits (see Table D-2).

Appendix E

FOOD SERVICE WORKLOAD

Average Monthly Meal Workload

	Patient	Nonpatient	Annual Total Meals
FY 1979	14,504	11,868	316,471
FY 1980	15,212	12,598	333,720
FY 1981	15,392	13,393	345,420
FY 1982	18,579	9,571	337,800

Appendix F

FOOD COST ADJUSTMENT*

Time Period	BDFA
FY 1979	\$3.39
FY 1980	\$3.49
FY 1981	\$3.61
FY 1982	\$3.68

* Adjusted Cost Per Meal = Actual Food Cost X $\frac{1982 \text{ BDFA}}{\text{Subject Year BDFA}}$

Appendix G

ENERGY COST CALCULATION

Cost of Gas

Btu's = Cubic Feet X 1000

Cost = \$0.2859 Per Btu's 10^5

Cost of Steam

Btu's = Pounds X 973.5

Cost = \$5.95 Per Btu's 10^6

Cost of Electricity

KWH = Meter Reading X 160

Cost = \$0.0482 X KWH

Cost of Water

\$0.4713 Per 1,000 Gallons

Cost of Heating Water

Btu's = Gallons Consumed X 834

Cost = \$5.95 Per Btu's 10^6

Cost of Sewage

Gallon = (0.8) Total Water Consumption

Cost = \$0.2791 Per 1,000 Gallons

Appendix H

SUPPLY COST ADJUSTMENT*

Time Period	Producer Price Index*
FY 1979	219.8
FY 1980	256.0
FY 1981	279.3
FY 1982	280.1

$$* \text{ Adjusted Cost Per Meal} = \text{Actual Supply Cost} \times \frac{\text{1982 Index}}{\text{Subject Year Index}}$$

Appendix I

PROJECTED COSTS

Conventional System

	1982 (Base) ^a	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Labor	\$1,363,655	\$1,431,838	\$1,507,793	\$1,581,567	\$1,655,886	\$1,730,478	\$1,808,343	\$1,889,753	\$1,974,709	\$2,063,619	\$2,156,484
Food	392,424	412,438	433,707	461,137	475,892	497,319	519,687	543,076	567,524	593,070	620,030
Equipment	9,085	9,548	10,040	10,528	11,017	11,513	12,031	12,572	13,139	13,730	14,367
Energy	55,800	56,646	61,760	64,661	67,669	70,715	74,939	77,222	80,698	84,330	88,242
Supplies	47,470	49,892	52,465	55,009	57,568	60,160	63,754	65,695	68,652	71,743	75,009
Total	1,868,434	1,962,362	2,065,765	2,172,902	2,268,032	2,370,185	2,478,754	2,588,318	2,704,722	2,826,492	2,954,132
Cost/Meal	5.90	6.20	6.53	6.87	7.17	7.49	7.83	8.18	8.55	8.93	9.34

Advanced Preparation System

	1982 (Base) ^a	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Labor	\$1,128,913	\$1,185,359	\$1,248,239	\$1,309,313	\$1,370,839	\$1,432,591	\$1,497,052	\$1,564,448	\$1,634,779	\$1,708,384	\$1,785,263
Food	429,006	450,885	474,137	497,132	520,256	543,679	568,133	593,701	620,448	648,357	678,430
Equipment	31,413	33,015	34,718	36,401	38,095	39,810	41,600	43,472	45,429	47,474	49,676
Energy	70,938	74,556	78,401	82,203	86,027	89,900	93,943	98,171	102,590	107,590	112,181
Supplies	84,450	88,757	93,334	97,861	102,413	107,023	111,837	116,878	122,132	127,629	133,549
Total	1,744,720	1,832,572	1,928,829	2,022,910	2,117,630	2,213,003	2,312,565	2,416,670	2,525,378	2,639,434	2,759,099
Cost/Meal	5.16	5.43	5.71	5.99	6.27	6.55	6.85	7.15	7.48	7.81	8.17

^aInflation Guidance Department of the Army, Headquarters, US Army Materiel Development and Readiness Command, Alexandria, VA, 1983.