PATIENT TRAY FOOD SERVICE EQUIPMENT: AN EVALUATION OF THE ALADDIN RETHERMALIZATION SYSTEM

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HOSPITAL FEEDING	REFRIGERATION	
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Aladdin rethermalization system was evaluated by the Food Engineering Laboratory (FEL) US Army NLABS to determine its operating characteristics under standardized laboratory conditions. Results show that many food items rethermalize well in this system. Problems were encountered in maintaining products at optimum chilled temperatures prior to rethermalization.

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PREFACE

The Aladdin food rethermalization system was evaluated by the Food Engineering Laboratory (FEL) of the US Army Natick Research and Development Laboratory. The investigations were conducted in conjunction with studies of the Operational Research Systems Analysis (ORSA) Office. This project was funded under O&MA .19. The Aladdin rethermalization system has been selected by ORSA for use in a detailed evaluation of a cook/freeze food production, cold plating/cold heating concept at Montcrief Army Hospital, Fort Jackson, SC. The Aladdin system was evaluated by FEL to determine its basic operating characteristics under standardized laboratory conditions. The first portion (Part I) used standardized test media, whereas the second portion (Part II) used food items commonly served in hospital feeding systems.

The assistance of Miss Nancy Jacobson in conducting the tests is gratefully acknowledged. Mr. John Swift and Mr. Bruce Thomas rendered valuable assistance in installing the equipment and insuring that it operated according to design. Mr. Ronald Bustead and Mr. Robert O'Brien assisted in the coordination of the project. Ms. Clara Contos was responsible for the drawings of the components of the system.

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INTRODUCTION

The Aladdin food rethermalization system is being used at Montcrief Army Hospital, Fort Jackson, SC, in a project entitled "Systems Analysis of Army Hospital Food Service." This project, sponsored by the Offices of the Surgeon General (TSG), is designed to analyze US Army Health Care food-service operations. The initial systems analysis phase recommended a cook/freeze system with cold plating of food at a centralized hospital location. Some food brought to the ward would be heated in a refrigerated environment while other food was not. To determine which rethermalization system commercially available would be most appropriate to use in evaluating this test concept, three cart systems were tested at Montcrief Army Hospital.

The Aladdin system was selected for further use because it performed successfully for the purpose of the test and had a ward refrigerator as an integral part of the system, thus eliminating the necessity to design and procure refrigerators for the other two commercially available systems. This selection, however, does not indicate that the other systems were unsatisfactory or that the Aladdin system has been selected for general use in military feeding operations.

The Aladdin rethermalization system is produced by Aladdin Synergistics, Inc. of Nashville, Tennessee. It is designed to transport chilled food in a refrigerated environment then heat some foods to a range of 71°C to 82°C (160°F to 180°F) while maintaining other foods in a chilled state without rehandling by hospital workers. The cart is then used to return trays to the kitchen. Aladdin Synergistics, Inc., describes the system as follows:

> After preparation, food items are portioned into pans and chilled in bulk or preplated and frozen. Frozen food must be in a thawed state before rethermalization, while freshly-cooked food must be chilled. All food items are brought to the trayline in a 38°F to 40°F (30°C to 4°C) state. Meals are assembled into the Aladdin servers, covered and placed into Aladdin rethermalization carts. The carts are to be refrigerated in designed units usually on the patient floors at least two hours before meal service. Forty minutes before meal time, rethermalization is started and the hot foods are reheated while the cold foods remain in a chilled environment.[1]

There are three main components of the system. The major component is the delivery and rethermalization cart; the second, the trays and dishes; and the third, the stand-alone, refrigerated compartment into which the cart can fit. The cart (Figure 1) contains 24 shelves, each with three independently operating, thermostatically controlled heating elements (Figure 2). Food is placed on Aladdin disposal polypropylene dishes (Figure 3) and placed in Aladdin temp-rite ® serving trays (Figure 4). Each tray has three compartments (labelled

[1] Aladdin Rethermalization System, Operating Instructions, Aladdin Synergistics, Inc., April 1981.

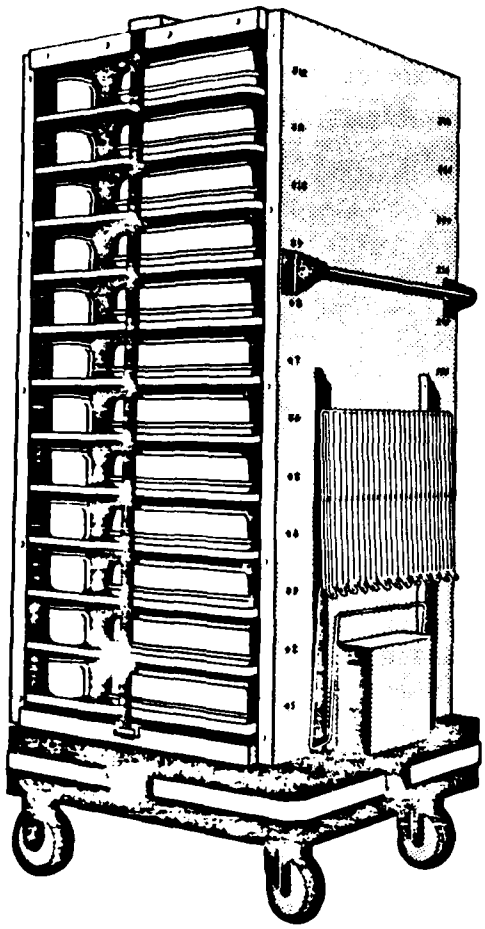


Figure 1. The Aladdin cart filled with trays

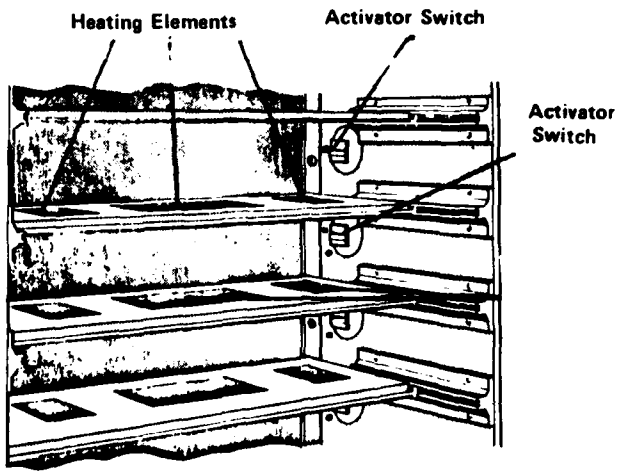


Figure 2. Heating shelves

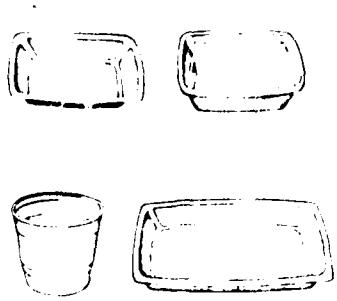
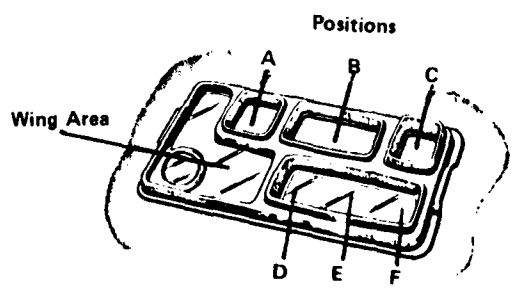


Figure 3. Aladdin disposable dishes



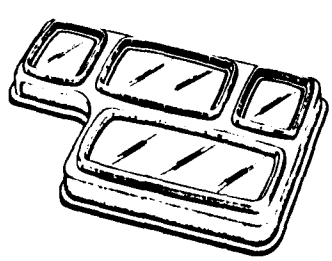


Figure 4. Aladdin temp-rite tray and tray cover

A, B, and C) for holding foods to be heated. These compartments have openings on the bottom so that when the proper size dish is placed in the compartment it will rest on one of the three heating elements on each shelf. The remaining compartments (D, E, and F) on the tray are designed to hold food to be served cold. A wing area on the tray is designed to hold beverages, flatware, napkins, and menus. The Aladdin temp-rite ® insulated cover is placed over the food after plating (Figure 4), covering compartments A, B, C, D, E, and F but not the wing area. As each tray is placed in the cart, its cover trips an activator switch (Figure 2) which readies the shelf for the heating cycle. Trays containing all cold meals are placed on the shelves backwards, so that the wing area of the tray slides under the switch without tripping it. In this position foods will not heat. Likewise empty shelves do not heat. If the switch is activated by placing the tray in the normal direction, all three elements will heat during the rethermalization cycle. There is no means of individually activating each element on one shelf. The actual start of rethermalization is controlled by buttons on the control board on the refrigerator unit. Insert dishes are provided to cover heated positions not containing food. The insert dishes are flat, nondisposable plastic dishes that serve to cover any open holes in the tray not containing food items.

When a cart is brought to the patient floor, it is rolled into the refrigerated compartment (Figure 5). The cart when placed in the compartment automatically connects to a three-wire receptacle in a floating receiver in the cart. A flanged metal piece on the floor guides the cart into the correct position in the refrigerator.

A panel board near the top of the roll-in refrigerator (Figure 6) contains various indicators for monitoring the cart's performance. The test button, when pressed, lights indicators on the cart for each shelf activated for rethermalization. A digital temperature display gives the interior temperature of the unit. A digital time display shows the minutes remaining in the rethermalization cycle. The cart is activated into rethermalization by turning the on/off switch to the on position and pressing the start button.

For this study, NLABS received on loan from Aladdin Synergistics, Inc. a rethermalization cart, a roll-in refrigeration unit, 20 Aladdin temp-rite ® trays and a supply of disposable dishes. Dishes to insert in tray openings to cover heating elements, soup and juice covers, and permanent dishes recommended for plating certain food items were also received.

Evaluation Criteria

The characteristics important to the assessment and evaluation of the Aladdin cart were compiled from earlier laboratory evaluations of patient tray delivery systems,[2,3] from claims

[2] C. Shaw, G. Darsch, and J. Tuomy. Examination of Patient Tray Food Service Equipment; an Evaluation of the Alpha Cart. NATICK/TR–79/036, 1979 (AD A083 161).

[3] G. Darsch, C. Shaw, and J. Tuomy. Examination of Patient Tray Food Service Equipment; an Evaluation of the Sweetheart Food Service. NATICK/TR–79/026, 1979 (AD A071 571).

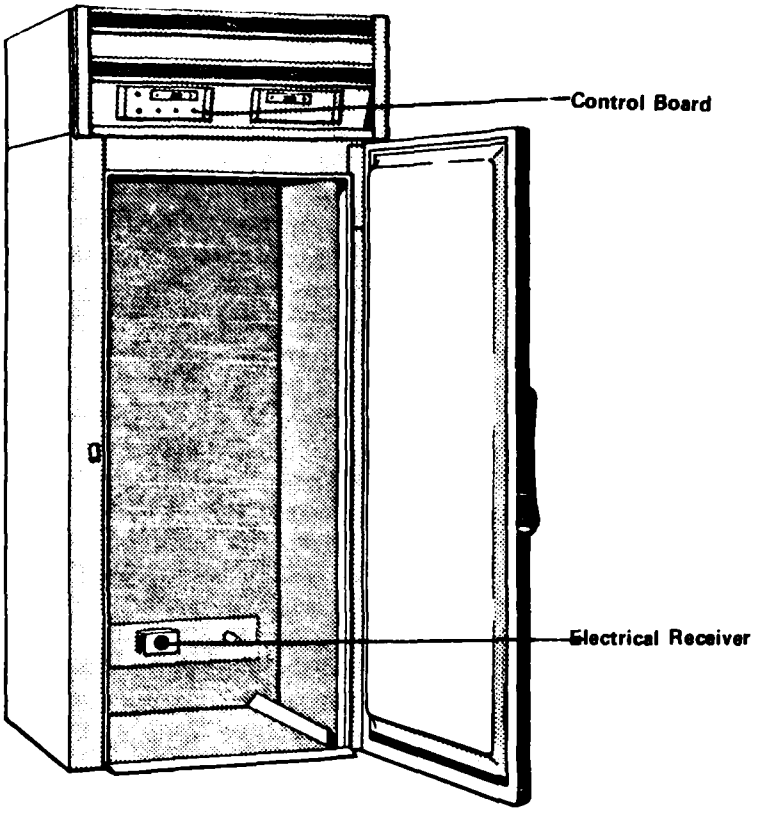


Figure 5. Refrigeration compartment

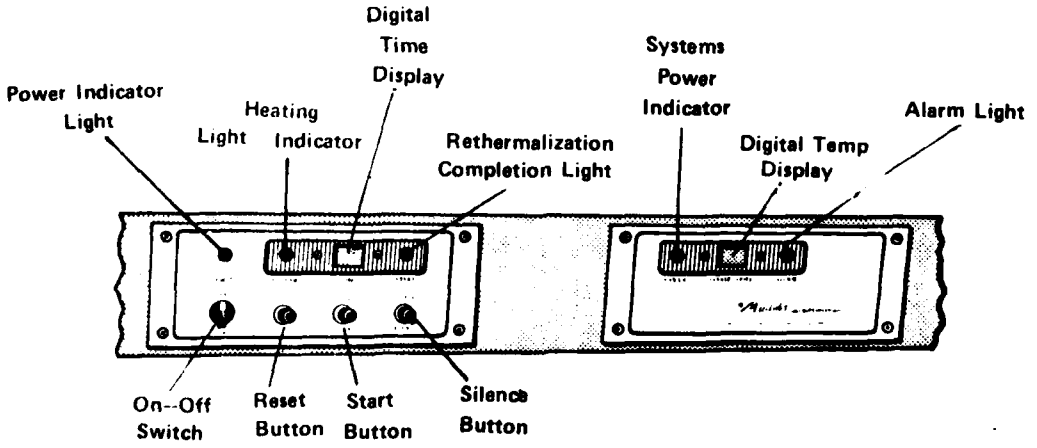


Figure 6. Panel board on rethermalization compartment

made in the Aladdin brochure and operating instructions,[1] and from experience in operating the cart at Moncrief Hospital, Fort Jackson, SC. Because of the specified requirements in US Public Health Regulations[4] and Army Regulations AR 40–5[5] for holding food at temperatures not higher than 7°C (45°F) or lower than 60°C (140°F), these temperatures were considered critical in the assessment of the cart. Some of the operational capabilities and/or characteristics considered important in the cart assessment are listed below.

1. The ability of the cart to rethermalize consistently products from the chilled state 4°C to 7°C (39°F to 45°F) to desired rethermalization temperatures, 71°C to 82°C (160°F to 180°F), throughout the various locations of the cart.

2. The ability of the system to retain cold items at properly chilled temperatures 7°C (45°F) or below in various locations while rethermalizing hot items.

3. The ability of the refrigerator unit to reduce temperatures of items that have risen above 7°C (45°F) during transport or plating to 7°C (45°F) or below.

4. The ability of the maintenance cycle to keep products at desired temperatures after rethermalization.

5. The ability of the trays to maintain products at desired temperatures after removal from refrigeration.

6. The effect on the trays and other foods of leaving heating positions empty or filled only with a cavity insert dish.

7. The ability of the system to rethermalize items commonly found on hospital menus in cook/freeze or cook/chill systems with special attention to such factors as final rethermalization temperatures, food appearance, flavor and texture, scorching, and moisture condensation.

8. The effects on items known to be difficult to handle in patient tray rethermalization systems, such as toast, egg products, fried foods, waffles, and bone-in meat items.

9. The effects of rethermalization on chilled foods.

10. The functional characteristics and performance of control panel indicators and switches, including the timer, test switch, power switch, indicator lights and digital thermometer.

[4] Food Service Manual, US Department of Health, Education and Welfare, Public Health Service, Food and Drug Administration, 1962.

[5] Army Regulations AR 40–5, Food, Sanitary Quality, 25 September 1974.

11. The adequacy of the disposable dishes for normal-sized portions and for the food-service system.

12. The energy consumption of the system under normal refrigeration, rethermalization and maintenance conditions.

MATERIALS AND METHODS

Bentonite Testing

For the first phase of testing, a standardized bentonite-glycerine-water mixture was used as a test media. The bentonite mixtures were used to avoid introducing variations inherent in most natural food products. However, bentonite, glycerine, and water combinations, unlike water alone, have heat retention characteristics similar to many foods.[6] A mixture of 5.0% bentonite, 47.5% glycerine, and 47.5% water mixture was used to simulate solid foods. A 1.0% bentonite, 49.5% glycerine, and 49.5% water mixture was used to simulate juices and soups. These mixtures were placed in the disposable polypropylene dishes to represent a typical volume of food product. Dishes used were identified as follows:

A34 entree dishes

A037 side dishes

B20 bowls

juice cups

In many instances it was not possible to fill the disposable dishes with the recommended volume capacity without spilling some of the test media while rolling the cart in and out of the refrigerator unit. Therefore, the dishes were filled to a volume considered practical in a normal feeding operation as follows:

[6]J.M. Jackson and F.C.W. Olson. Sterilization of Canned Foods; Theoretical Considerations in the Sterilization of Canned Foods. American Can Co., Research and Technical Department, pp 35–47, 1973.

Position	Hot/Cold	Dish No.	Type of Dish	Design Capacity (Stated)	Volume Bentonite (Used)	Bentonite Percent
A	hot	A037	side	3 oz/veg/bread	227 mL (8 oz)	5
B	hot	A34	entree	4 oz meat 3 oz starch 3 oz vegetable	100 mL (3.5 oz)	5
C	hot	B20	soup	6 oz soup/cereal	170 mL (6 oz)	1
D	cold	B20	soup	6 oz salad	170 mL (6 oz)	5
E	cold	A037	side	3 oz dessert	100 mL (3.5 oz)	5
F	cold	--	juice	4 oz juice	85 mL (3 oz)	1

The hot positions were used to simulate vegetables on position A, entree and starch on position B, and soup on position C, while the cold positions simulated salad on position D, dessert on position E, and juice on position F. The soup dishes on position C and juice cups in position F were covered with Aladdin plastic lids. The location of these positions are shown in Figure 4.

To measure the temperature of the bentonite mixtures during the various tests in the Aladdin cart, 48 thermocouples were calibrated at 0°C in an ice bath and 100°C in boiling water. In each dish used for temperature recording, a thermocouple was attached to a nylon post cemented in the center of the dish. The thermocouples were held in place by a slit in the center of the nylon post that held the thermocouple in the middle of the depth of bentonite. A hole was drilled 0.5 cm from the top of the dish to allow passage of the thermocouple wire through the dish. Contact cement was used to pack the hole to hold the thermocouple wire in place and to prevent leaking. In this manner soup and juice lids could be used as recommended without interference from the wire. When used in the cart, the thermocouple wires were passed through the rubber gasket of the front door, and tape was used to close any slight gap created by the wires. The wires were connected to a Honeywell 112 recorder. After each experiment the thermocouples and nylon posts were checked to ensure they remained in the proper position and that another test was not conducted until all components of the system were thoroughly chilled.

For most experiments, shelves 1, 7, 12, and 19 were filled with covered trays containing six dishes fitted with thermocouples to record bentonite temperatures. This allowed the monitoring of a top, center, and bottom tray on the left side of the cart and a center tray on the right side of the cart. The other trays in the cart were filled with dishes containing similar amounts and concentrations of the bentonite mixtures, covered, and heated during rethermalization trials, but temperatures were not recorded unless otherwise specified.

Food Testing

A. Energy Usage

The energy usage of the cart was monitored when the refrigeration unit was empty, when the full cart was put into refrigeration, during the 40 minute rethermalization cycle, during 60 minutes of maintenance in the cart after rethermalization, and after removal of the cart from the refrigerator. The actual foods used to fill the cart are listed in the Appendix. For the determination of energy consumption, a watt/hour meter, manufactured by Electro Industries, Model WH300 was used.

B. Heating of Common Food Items

A selection of food items commonly served on hospital menus and also on the Fort Jackson Montcrief Hospital menu were prepared for testing in the cart. Items that were suitable for a cook/freeze system were precooked, blast frozen at −29°C (−20°F), and kept in frozen storage at −23°C (−10°F) before tempering. The products were tempered at 4°C (40°F) before plating. Items that were not suitable for cook/freeze were prepared in advance and chilled at 4°C (40°F). Foods were removed at 4°C (40°F) and plated in a 10°C (50°F) room, put in trays, covered and returned to 4°C (40°F) storage. All foods were below 7°C (45°F) when placed in the cart.

Immediately after the 40-minute rethermalization, temperatures of the items were taken by a Digital Dependatherm (Model 53025–50) thermometer manufactured by Kane-May Instrumentation Co. To prevent too long a delay in recording temperatures of each item in the cart, only temperatures of foods on even numbered trays were recorded after each rethermalization trial. Initially temperatures of the top, side, and internal surfaces of each food were recorded; however, the eveness of temperatures of most items indicated this was generally not necessary, and only internal temperatures were recorded in the latter trials. Comments were made on the appearance, flavor, and texture of the food. Results were recorded on a form adapted from other rethermalization studies (Figure 7).

C. Heating of Problem Food Items

Food items commonly known to be difficult to rethermalize in cook/freeze and cook/chill systems and in rethermalization equipment, or difficult to handle in most types of hospital feeding situations were also tested. These items were tested in different locations and by various plating methods including those suggested in the Aladdin literature. Temperatures, appearance, flavor, and texture results after reheating were recorded as previously described.

Experimental Plan – Bentonite Testing

An experimental plan to investigate the operating characteristics of the Aladdin rethermalization system was developed for bentonite as outlined below.

Refrigerator Temp Initial °F

40-Min. °F

Date

Food Item	Portion Size	Tray No.	Home Heater Pos.	Dish	Cover	Food Temp				Comments
						Initial °F	After Retherm			
							Top °F	Side °F	Internal °F	

Figure 7. Form used to record food rethermalization results

Experiment Number	Experiment	Purpose
1	Fill three hot locations (A,B,C) and three cold locations (D,E,F) on trays 1, 7, 12, and 19 with bentonite mixture in dishes fitted with thermocouples. Cover soup dishes in position C and juice cup in position F with plastic lids. Cover each tray with insulated tray cover and place in cart. Fill remainder of cart with covered trays containing bentonite-filled dishes not equipped with thermocouples and place cart in refrigerator unit. When bentonite temperatures in cart reach 7°C (45°F) or below, start rethermalization cycle. Record thermocouple readings in the six positions in each of the four trays being monitored during the 40-minute rethermalization cycle and 40-minute maintenance cycle. Record interior temperature of refrigerator unit with thermocouple probes during rethermalization and maintenance cycle.	1. To determine if cart will consistently heat testing medium to stated rethermalization temperatures (71°C–82°C) (160°F–180°F). 2. To determine if chilled medium stays chilled in unheated positions. 3. To determine if variation exists between top, center, and bottom of cart or from left to right side of cart. 4. To determine effectiveness of maintenance cycle. 5. To determine if digital read-out temperature display is representative of internal cart temperature.
2	Fill cart with bentonite as in Experiment 1, but reverse direction of trays 1, 7, 12, and 19 thus heating all trays except 1, 7, 12, and 19.	To determine effect of rethermalization of other trays on four unheated trays.
3	Interchange trays 1, 7, 12, and 19. Repeat Experiment 1.	To determine if change of dish, tray and thermocouple locations affect rethermalization temperature.
4	Fill cart as previously but use thermocouple equipped dishes only on entree positions on shelves 1, 7, 12, and 19. Chill until 7°C (45°F) or lower is reached in refrigerator unit. After chilling, remove cart from refrigerator and leave at ambient temperature until bentonite reaches 1. 13°C (55°F) 2. 24°C (75°F) Replace filled cart in refrigerator unit. Record temperatures of bentonite until it reaches 7°C to 8°C (45°F to 46°F) or below.	To determine the length of time required to bring the medium to chilled temperatures if cart is left unrefrigerated long enough to warm media to 13°C (55°F) or 24°C (75°F).

Experiment Number	Experiment	Purpose
5	Repeat Experiment 1, but remove cart from refrigerator after rethermalization. Do not disturb dishes, trays, or covers. Record temperature changes in bentonite mixtures over 40-minute period at ambient temperature.	1. To determine heat and chill retention of test media after cart is removed from refrigerator. 2. To compare holding media in cart in refrigerator on maintenance mode with holding media in cart at ambient temperature.
6	Fill dishes with 4°C (40°F) bentonite in 10°C (50°F) room, cover as previously. Place filled trays in prechilled cart in refrigerator storage, 4°C (40°F), for two hours. Record temperatures of bentonite in trays 1, 7, 12, and 19 during the two hours of refrigerator storage.	To determine effect of two-hour chilled storage period on bentonite temperatures.
7	Place filled trays in cart in 4°C (40°F) refrigerator storage until bentonite equilibrates to 4°C (40°F). Remove cart from refrigerator storage and leave at ambient temperature for 60 minutes. Record temperatures of bentonite in trays 1, 7, 12, and 19 over the 60-minute period.	To determine amount of warming after removal from refrigerator storage as would simulate warming during travel to patient floors.

Experimental Plan – Food Testing

The aspects of the experimental plan that deal with food testing areas follows.

Experiment Number	Experiment	Purpose
1	Record energy consumption of empty refrigeration unit for one hour. Fill cart with normal load of food. Take energy consumption before rethermalization for one hour, during 40-minute rethermalization, for one hour on maintenance cycle, and for one hour after cart is removed.	To determine energy consumption of system.
2	Fill cart with food items commonly found on hospital menus. Record temperature and condition of food after rethermalization.	To determine ability of system to handle common hospital food items.

Experiment Number	Experiment	Purpose
3	Fill cart with items known to be difficult to handle in cook/freeze, cook/chill and rethermalization systems. Try various methods of plating and handling problem items.	To determine ability of cart to handle problem food items.

RESULTS

Bentonite Testing

A. Experiment 1

Although this experiment was originally run in duplicate, the data from Experiment 1 are supplemented by six other controlled rethermalization trials from later experiments conducted according to the same procedures. The eight rethermalization tests are analyzed and compared in Table 1.

The mean rethermalization temperature of all heated elements was 75°C (167°F). Using the amounts of bentonite specified for each dish, position B (entree) heated to the highest mean temperature, 87°C (189°F), while position C (soup) heated to the lowest temperature elements of the three, 63°C (45°F). Little difference was noted between the heating of the four trays in the different locations in the cart. Considerable variation in heating from one trial to another occurred in Position A and to a slightly lesser extent in Position B. Position C (the covered soup dish) showed little variation from trial to trial. A significant factor in the higher standard deviation in Positions A and B was two very high rethermalization temperatures, 102°C (215°F) and 110°C (230°F). The 110°C (230°F) bentonite showed signs of having boiled during rethermalization. Although the rethermalization temperatures were not always in the 71°C to 82°C (160°F to 180°F) range indicated in the Aladdin brochures, and recommended for reheating of foods, almost all were higher than the 60°C (140°F) temperature necessary for storage of food. Therefore, the heating characteristics were generally satisfactory although some final temperatures were not consistent and not always within the range indicated in the Aladdin literature.

In the chilled positions, the cold media maintained a mean temperature of 7°C (45°F) after rethermalization. An increase of 1°C to 3°C (2°F to 4°F) was common. In four instances, chilled items rose to temperatures of 10°C (50°F) or above (Table 1). Few significant differences were noted between the various locations in the cart, although the cold items stayed slightly cooler in the top shelf than in other locations in the cart. Position D, which contained a larger volume of bentonite (170 mL), stayed cooler than positions E and F, which contained 100 mL and 85 mL, respectively. The results show that if the media are well chilled before rethermalization, the temperature rise during rethermalization is usually within acceptable limits.

For each tray position tested and shelf location, the data are summarized in Table 2.

Table 1. Final Rethermalization and Chilled Temperatures from Eight Experimental Runs Using Stnadardized Bentonite Solutions

	Run 1 (°C)	Run 2 (°C)	Run 3 (°C)	Run 4 (°C)	Run 5 (°C)	Run 6 (°C)	Run 7 (°C)	Run 8 (°C)	Mean Rethermalization Temperature (°C)	Standard Deviation	Maximum Difference (°C)
Tray 1											
Position A	64	68	67	88	84	68	66	67	72	9.1	24
Position B	82	76	74	79	81	90	89	91	83	6.5	16
Position C	64	63	63	55	59	60	61	61	61	2.9	9
Position D	6	8	6	7	7	8	6	6	7	0.9	2
Position E	7	9	8	7	7	7	8	8	8	0.7	2
Position F	6	9	8	6	7	10	8	8	8	1.4	4
Tray 7											
Position A	75	73	73	68	70	66	62	65	69	4.5	13
Position B	110*	80	80	80	82	89	92	92	88	10.3	30
Position C	61	64	64	60	60	64	62	66	63	2.2	6
Position D	6	6	6	6	8	6	7	6	6	0.7	2
Position E	10			6	8	6	7	7	7	1.5	4
Position F	11			10	8	7	7	8	9	1.6	4
Tray 12											
Position A	71			79	102	84	86	90	85	10.4	31
Position B	82			86	83	90	92	92	88	4.5	10
Position C	64			60	62	62	62	62	62	1.3	4
Position D	6	5	5	8	6	6	6	6	6	0.9	3
Position E	7	6	7	7	6	6	6	6	6	0.5	1
Position F	7	6	6	8	6	6	6	6	6	0.7	2
Tray 19											
Position A	74	81	85	80	79	91	69	59	77	9.9	32
Position B	89	93	91	90	83	91	91	85	89	3.4	10
Position C	62	63	63	63	63	66	67	66	64	1.9	5
Position D	7	8	7	6	6	7	7	7	7	0.6	3
Position E	8	8	7	6	6	7	7	7	7	0.8	3
Position F	8	9	8	7	7	7	7	7	8	0.8	2

*Appeared to have boiled

Table 2. Summary of Rethermalization Data from Runs 1–8 by Dish Position and Shelf Position

	Mean (°C)	Range (°C)	Standard Deviation
Shelves 1, 7, 12, 19			
Position A	75	59–102	10.2
Position B	87	74–110	6.9
Position C	62	55–67	2.4
Position D	6.5	5–8	0.8
Position E	6.8	6–10	1.6
Position F	7.5	6–11	1.3
Hot Position			
Shelf 1	72	55–91	11.1
Shelf 7	73	60–110	12.7
Shelf 12	78	60–102	13.3
Shelf 19	77	59–93	11.9
Cold Position			
Shelf 1	7.3	6–10	1.1
Shelf 7	7.3	6–11	1.5
Shelf 12	6.2	5–8	0.7
Shelf 19	7.1	6–9	0.7

Although the rethermalization tests in Experiment 1 were designed to extend through a 40-minute maintenance cycle, the data obtained indicate that the maintenance cycle was not functioning. It was confirmed by representatives of Aladdin Synergistics, Inc., that the maintenance mode was not operative in the cart tested at NLABS. Although the data are not valid for the purpose intended, they make it possible to compare temperatures maintained when the cart is left in the refrigerator unit after rethermalization. The results of these tests are reported in Experiment 5, where the results are compared with temperatures maintained when the cart is left at ambient temperatures after rethermalization.

The digital read-out thermometer on the outside of the refrigerator unit corresponded well to the temperature measurement probes inside the cart during rethermalization or when the temperatures were all equilibrated. However, when the door to the refrigerator was opened, the temperature of the digital display usually rose more quickly than the internal probes. This is undoubtedly due to the location of the sensing device near the refrigerator door.

B. Experiment 2

In Experiment 2, in which 4 trays were not heated and 16 trays were heated, 21 out of 24 temperature recordings showed the chilled media on the unheated trays had final temperatures of 7°C (45°F) or below. Three final temperatures of 8°C (46°F) were recorded. The temperature rise (difference) in the unheated trays was 0°C to 2°C (0°F to 3.6°F) during rethermalization, as shown in Table 3. Therefore, the chilled trays maintained temperature quite well during the rethermalization of other trays. The refrigeration temperature, as measured by probes in the refrigerator, rose 3°C to 4°C (5°F to 7°F) during rethermalization.

C. Experiment 3

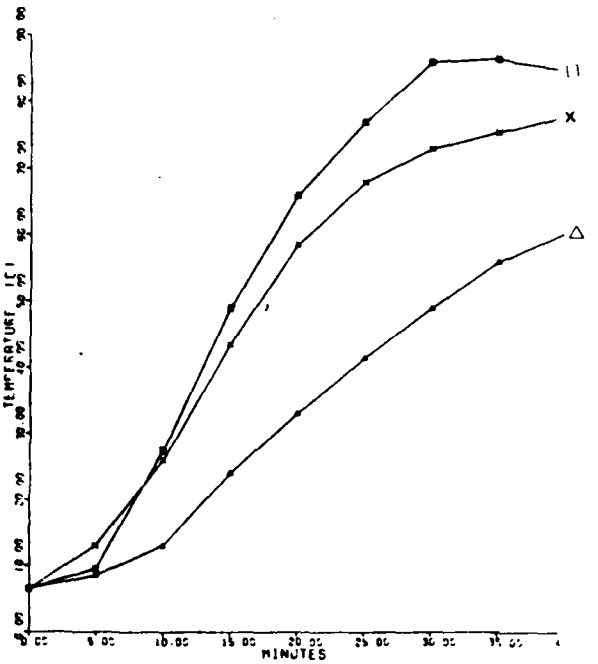
Results of Experiment 3 showed no consistent differences in heating characteristics attributed to the rearrangement of dishes, trays, and/or thermocouples. Figures 8 and 9 are graphic representations of typical rethermalization curves from Experiment 3 (runs 5 and 6 on Table 1) by tray shelf position (shelves 1, 7, 12, and 19) and by hot dish location (side, entree, soup dish). These results illustrate the general trend of the entree dish heating to the highest final temperature, the side dish the next highest and the soup dish to the lowest temperature. They show no consistent significant differences attributable to shelf position. The rethermalization curves for all hot positions on shelves 1, 7, 12, and 19 are shown in Figure 10.

D. Experiment 4

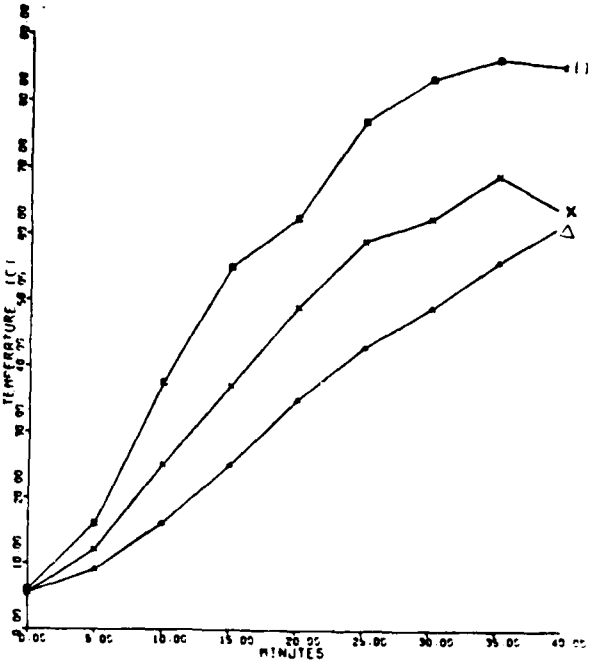
Part 1. In Experiment 4 the chilled cart filled with bentonite samples was removed from the refrigerator unit and allowed to stand at ambient room temperature until the bentonite reached temperatures of approximately 13°C (55°F). The filled entree dishes monitored by thermocouples did not warm up evenly at ambient temperature. Thus, the initial temperature range going into the refrigerator unit varied from 12°C (54°F) to 17°C (63°F). It took seven hours to chill the 12°C (54°F) bentonite to 8°C (46°F) and after nine hours it had not dropped below 8°C (46°F). The refrigerator temperature rose to 14°C (57°F) after the door was opened

Table 3. Temperatures of Four Cold Trays During Rethermalization of 16 Hot Trays

		Initial Temp °C (°C)	After 40-m in Retherm. Cycle (°C)	Difference (°C)
Tray 1				
Position	A	6	7	1
	B	6	6	0
	C	7	7	0
	D	6	8	2
	E	6	8	2
	F	6	8	2
Tray 7				
Position	A	4	6	2
	B	5	6	1
	C	5	6	1
	D	5	6	1
	E	5	6	1
	F	5	6	1
Tray 12				
Position	A	5	6	1
	B	5	6	1
	C	5	6	1
	D	4	6	2
	E	4	6	2
	F	4	6	2
Tray 19				
Position	A	5	7	2
	B	5	7	2
	C	5	6	1
	D	5	7	2
	E	5	7	2
	F	5	7	2
Reefer Probe	1	4	8	4
	2	5	8	3



Shelf 1



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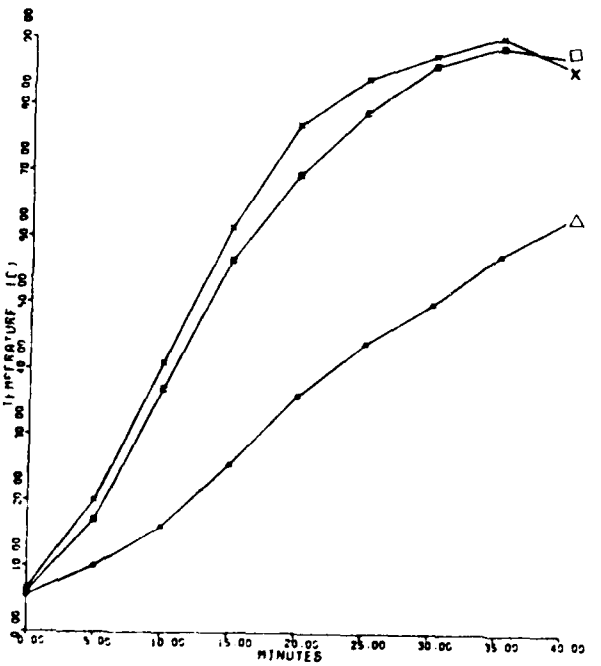

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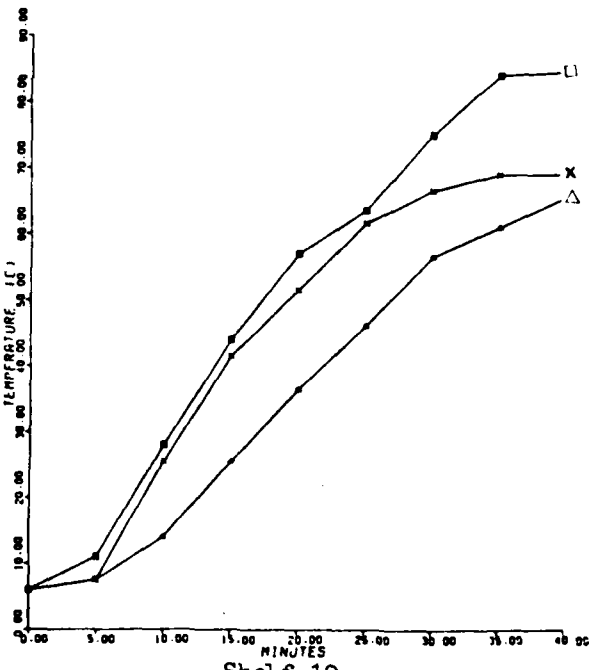
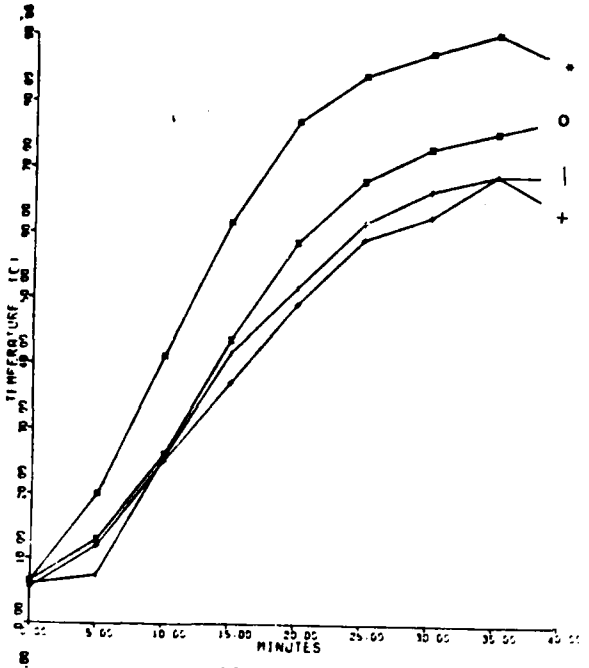


Shelf 19

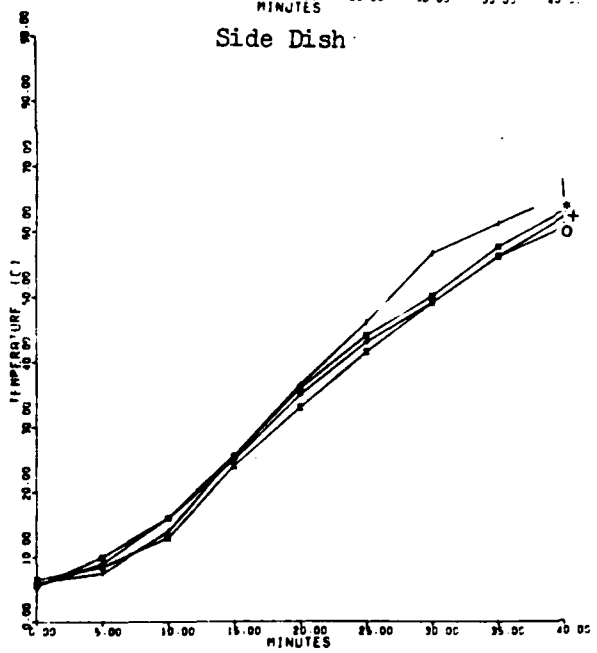
Figure 8. Rethermalization curves of hot positions on shelves 1, 7, 12, and 19

Key:

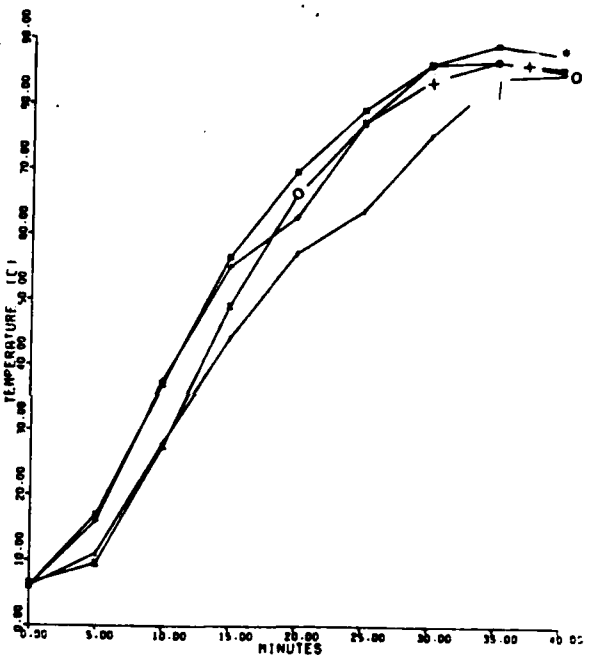
□ = entree dish
x = side dish
△ = soup dish



Side Dish



Soup dish



Entree Dish

Figure 9. Rethermalization curves of side, soup, and entree dishes on shelves 1, 7, 12, and 19

Key:

o = shelf 1
+ = shelf 7
• = shelf 12
| = shelf 19

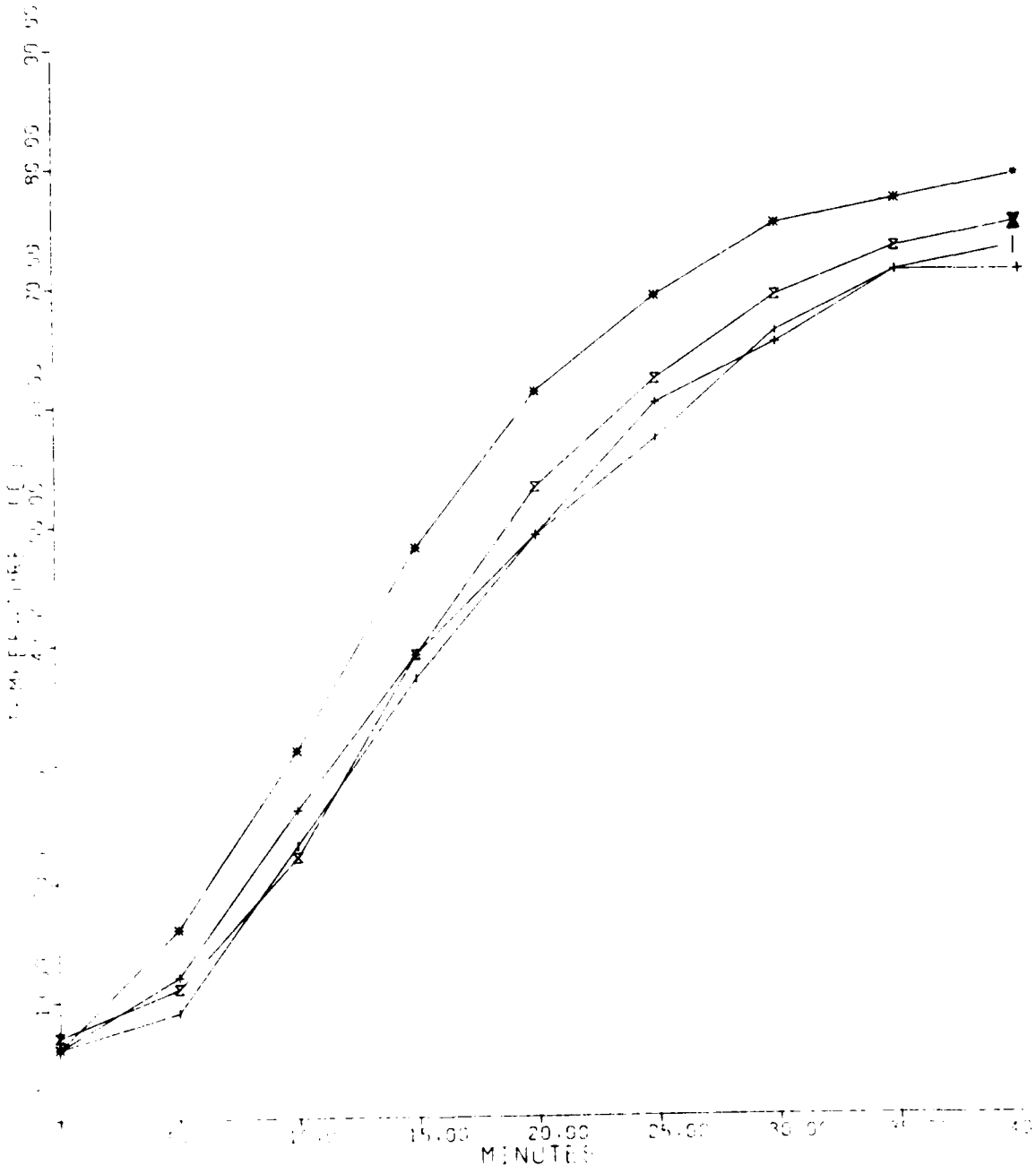


Figure 10. Mean rethermalization curves of all hot positions on shelves 1, 7, 12, and 19

to insert the cart and it took five hours to equilibrate the cart at 7°C (45°F). As shown in Figure 11, after eight hours only one of the four entree dishes was at 8°C (46°F), and after nine hours two were at 8°C (46°F) and two of the four were at 9°C (48°F). The test was discontinued after nine hours.

Part 2. The initial bentonite temperatures in Part B ranged from 22°C to 24°C (72°F to 75°F) when the cart was placed in the refrigeration unit. The refrigerator temperature was at 15°C (58°F) after the door was opened to insert the cart but the temperature dropped more quickly than in the Part A experiment (Figure 12). After two hours it was 7°C (45°F) and it remained at 7°C (45°F) or below after this time. The experiments were conducted in a non-air-conditioned environment and fluctuations in ambient temperatures markedly affected the refrigeration's capability to return samples to a properly chilled state. After eight hours one bentonite-filled dish had dropped in temperature from 22°C (72°F) to 8°C (46°F). After 10 hours, two of the four dishes were at 8°C (46°F) or lower, and after 11 hours all were 8°C (46°F) or lower. After 12 hours when the test was discountinued, two samples were at 8°C (46°F), and two were at 7°C (45°F). The refrigeration unit equilibrated after 10 hours at 5.5°C (42°F).

The following summary represents the time required to chill 227 mL (8 oz) of bentonite in entree dishes in the trays covered on the cart from the various initial temperatures to 8°C (46°F) in the refrigerator.

Experiment 4A	Initial Temp (°C)	Time to Chill to 8°C (hours)
Shelf 1	14	9
Shelf 7	16	9+ *
Shelf 12	14	9+ *
Shelf 19	12	7

*Test discountinued before medium reached 8°C (45°F)

Experiment 4B	Initial Temp (°C)	Time to Chill to 8°C (hours)
Shelf 1	23	11
Shelf 7	22	8
Shelf 12	24	10
Shelf 19	22	11

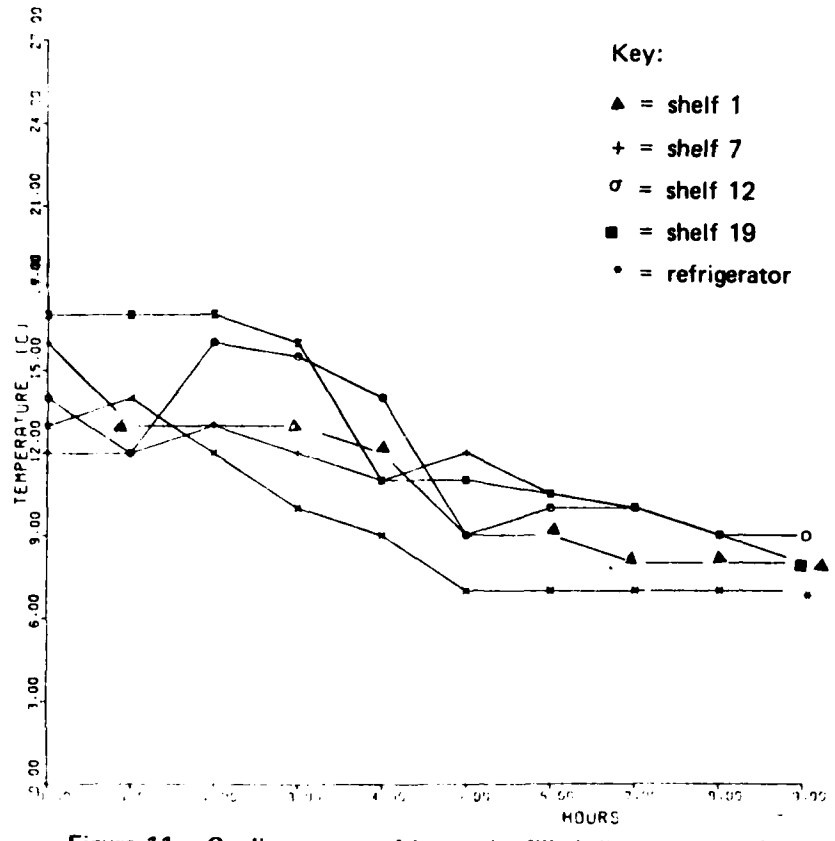


Figure 11. Cooling curves of bentonite-filled dishes from 13°C to 8°C in Aladdin refrigerator

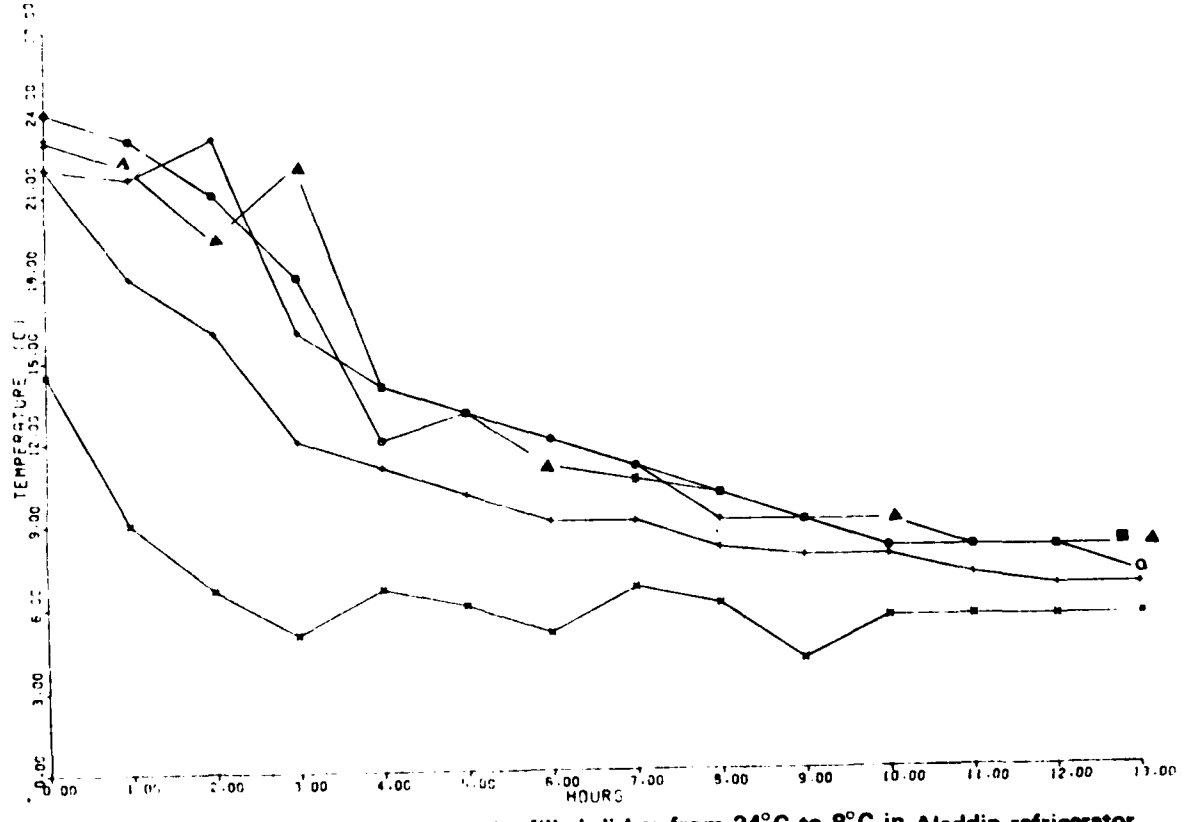


Figure 12. Cooling curves of bentonite-filled dishes from 24°C to 8°C in Aladdin refrigerator

It is obvious from this experiment that the Aladdin system cannot adequately chill products being placed in the refrigeration unit. The system chills to only somewhat above optimum desired temperatures. Even with plating food at chilled temperatures and storing the filled carts in a cold-storage area, some temperature increase will occur during transfer to the floor. Opening the refrigerator door to introduce a slightly warm cart will further reduce the refrigeration capability. An effective patient tray system of this type must be able to hold foods at proper storage temperatures, 7°C (45°F) or below, so as to conform with Public Health and military food service regulations. Otherwise, instructions must be given not to store foods over a certain length of time in the refrigeration unit or to rethermalize the food as quickly as possible after it reaches the rethermalization unit. Moreover, the insulated tray cover, which is beneficial in retaining heated and chilled products, is a disadvantage when one wishes to chill products in a refrigerated environment. The tray's wing area, not covered by the insulated cover, does not have this disadvantage.

E. Experiment 5

In Experiment 5, the cart was removed from the refrigerator, but the covered trays were left undisturbed in the cart for 40 minutes at ambient temperature. The mean temperature of the hot positions was 72°C (162°F) after rethermalization. In a 40-minute period the hot media dropped an average of 12°C (22°F) to 60°C (140°F). The cold temperatures, averaging 8°C (46°F) after rethermalization, rose 6°C (11°F) to an average of 14°C (57°F) after 40 minutes (Figure 13). Although the maintenance cycle of the cart was not operational, data from Experiment 1 can be used to compare leaving the filled cart in the refrigeration after rethermalization with holding it at ambient temperatures (Figure 19). The mean rethermalization temperatures from Experiment 1 were somewhat higher than Experiment 5. The average of the hot media was 76°C (169°F) after rethermalization in Experiment 1 and dropped an average of 21°C (38°F) to 55°C (131°F) after 40 minutes in the cart. The cold temperatures rose from a mean of 7°C (45°F) to 12°C (54°F).

Thus the hot temperatures dropped considerably more in the refrigerator than at ambient room temperatures while the cold media were only very slightly cooler in the refrigerator. Without a maintenance cycle, leaving the cart in the refrigerator after rethermalization is not recommended. The mean data are summarized as follows.

Holding Condition Refrigerator	Mean Temperature After Rethermalization (°C)	Mean Temperature After 40 Min (°C)	Change (°C)
Hot Media	76	55	−21
Cold Media	7	12	+5
Ambient Temp:			
Hot Media	72	60	−12
Cold Media	8	14	+6

Key:

* = hot positions held outside of cart

o = hot positions held inside of cart

Y = cold positions held outside of cart

Z = cold positions held inside of cart

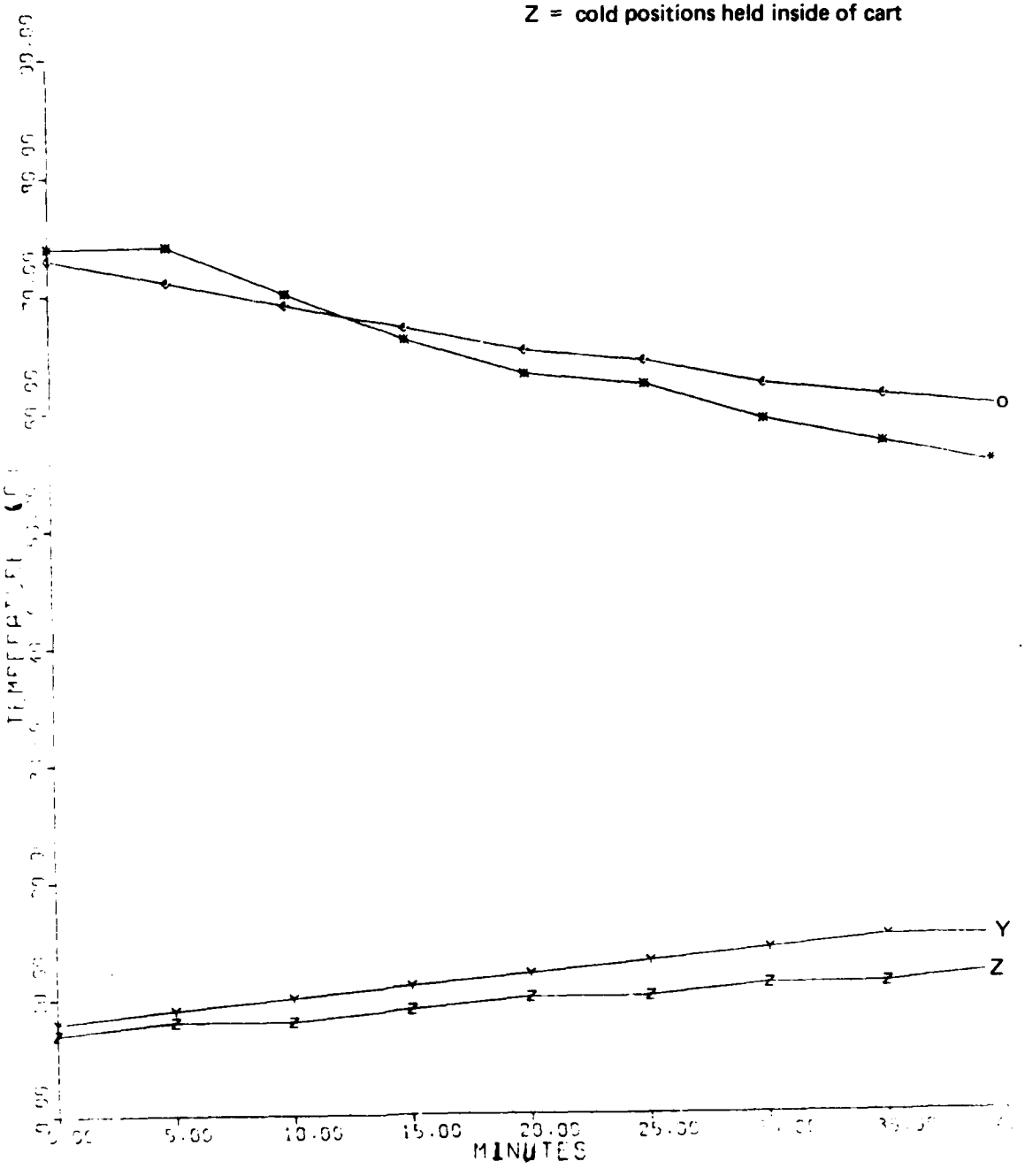


Figure 13. Maintenance curves after rethermalization at refrigerator and ambient temperatures

F. Experiment 6

In Experiment 6, bentonite at 4°C (40°F) was plated into dishes and trays, covered with the insulated tray cover, and loaded into a prechilled cart. The plating was done in a 10°C (50°F) room. The loaded cart was then placed in a chilled storage area at 4°C (40°F) for two hours as recommended in the Aladdin plating procedure. Upon entering the 4°C (40°F) storage refrigerator, the 24 bentonite-filled dishes had a mean temperature of 7.3°C (45.2°F). After one hour of refrigerator storage, the mean temperature rose to 7.4°C (45.4°F), and after two hours returned to 7.3°C (45.2°F).

Thus, the placing of filled carts in refrigerator storage for two hours prior to placement in the Aladdin refrigerator unit had no significant effect on the chilling of the product inside the covered trays. However, it would serve to cool the exterior of the cart and trays and thus lessen the effect of placing a warm cart in the Aladdin refrigeration unit. It is emphasized that in this and other tests in which bentonite or food products were plated, the plating was always done in a 10°C (50°F) room. Thus, the plating conditions were optimum but perhaps not typical of actual hospital plating conditions. If plating had been done in a 21°C (70°F) environment, one could assume that the bentonite temperature would have been above 7°C (45°F) upon entering refrigeration storage.

G. Experiment 7

In Experiment 7, thoroughly chilled bentonite, trays and carts were removed from 4°C (40°F) storage and allowed to stand at ambient temperatures for 60 minutes. This was to simulate travel from chilled conditions to the patient floor and to determine the temperature rise one might expect in a given time period. Shown below are the mean temperatures over a 60-minute time period for the six positions as determined from temperatures recorded on trays 1, 7, 12, and 19.

Position	Initial Temp (°C)	15 min (°C)	30 min (°C)	45 min (°C)	60 min (°C)	Change after 30 min (°C)	Change after 60 min (°C)
A	4	10	15	18	21	+11	+17
B	4	10	14	14	20	+10	+16
C	4	7	9	9	14	+5	+10
D	4	6	9	9	13	+5	+9
E	4	6	10	10	14	+6	+10
F	4	8	10	13	15	+6	+11

It is interesting to note that positions A and B, hot side and entree positions not covered by the plastic Aladdin lids, rose in temperature to a greater extent than the other positions. These are also positions that have openings in the bottom of the tray. These openings allow for faster heat transfer and thus produce a higher temperature change. Position C, which is also an open position, probably retained cold slightly better because the dish was covered and also contained a larger volume of content in a relatively small container. No large differences were found attributable to tray location (top, middle, or bottom shelves).

This experiment shows that even very well-chilled bentonite at 4°C (40°F) in chilled trays and cart will warm to over 7°C (45°F) in 15 to 30 minutes at ambient temperatures. As shown in Experiment 4, the Aladdin refrigerator cannot be relied upon to bring products down to desired temperatures. Again, it is obvious that the insulation of the trays and covers, which is beneficial in retaining temperatures of the hot and cold foods, also acts to prevent refrigeration temperatures from significantly cooling products in a reasonable time period.

Experiments 4, 6, and 7 show that extreme caution must be taken to keep products well-chilled throughout the operation. It is doubtful that most hospitals could effectively chill the products to the extent necessary with conventionally designed cook/freeze or cook/chill systems. Increasing the refrigeration power and decreasing the temperature, redesigning the trays to allow quicker cooling under refrigerated conditions, or not permitting holding of foods in covered trays in the refrigeration unit except during rethermalization may be necessary to keep foods effectively chilled.

Food Testing

A. Energy Usage

The following results are the mean kilowatt hours of energy usage by the Aladdin system under the operating conditions s ed.

Operating Condition	KWH
Refrigeration Only (60 min)	26
Full Cart Loaded (Prechilled) into Refrigeration (60 min)	54
Rethermalization (40 min)	232
After Rethermalization, Cart Not Removed (60 min)	77
After Removal of Cart from Refrigerator (60 min)	43

The cart was kept in the refrigerator after rethermalization because it was assumed initially that there was a maintenance cycle. However, under practical conditions, especially if no maintenance cycle exists, the cart would be removed more quickly from refrigeration. The foods placed in the cart during the energy usage tests are listed in the Appendix.

B. Foods Rethermalized in Aladdin Cart

In the experimental plan, difficult to heat or problem type items were separated from other food items for testing purposes. However, the results of the testing will be discussed by meal and food types. Some temperature variation was inevitable once rethermalization had ended and the cart was removed from the refrigerated unit. Products on 10 trays were recorded and readings made within 15 minutes of the end of the cycle. This period could be considered comparable to the time it would take to deliver the tray to the patient. Initially temperatures were recorded in three locations in a food item (top, side, and internal), but little variation was noted in the three readings. Thus, temperatures were recorded from the center of each item to allow faster temperature recording. Results for Breakfast are summarized in Table 4 and for Luncheon/Dinner on Table 5.

C. Breakfast Foods – Heated

Cereal. The hot cereal (oatmeal) heated to a satisfactory end temperature with no scorching or sticking to the plate. The texture was thick even though it was quite runny when plated. If the optimum viscosity can be consistently obtained, hot cereals should present no heating problem.

Entrees. Breakfast entrees are difficult to rethermalize in most systems. Variations in plating location, and plate types were tested. Commercial frozen waffles were tried with no further cooking but were very soft and soggy. After toasting they were slightly moist and soft on the top surface and slightly hard on the bottom surface. Two waffles stacked had low final rethermalization temperatures in three out of four tests. Pancakes tended to be soft and soggy after rethermalization and also had low final temperatures. Two slices of commercial, frozen, french toast heated satisfactorily on an entree dish but had to be toasted before plating to avoid the soggy texture. None of these items adapted very well to the system, from an aspect of final rethermalization temperature or product quality.

The egg products were also difficult to handle well. Although variations in cooking times before chilling were tried, the variation in the heating of the elements themselves makes it difficult to obtain a consistent final product. The temperature differential between a slightly undercooked to somewhat overcooked egg is slight, yet quite important to most consumers. The best method of plating seemed to be on the china side dish placed on the entree dish. However, the final temperatures were generally lower than desired if the final product was not overcooked. When butter was added to the dish as suggested, it did not melt. However, none of the egg products scorched or stuck excessively to the dishes as might have been expected.

Breads. Donuts placed on the insert dishes were generally satisfactory. The donuts tended to be somewhat soft on top and harder on the bottom, but the slightly warmed temperature

Table 4. Foods Rethermalized in Aladdin Cart -- Breakfast Items

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Breads							
Donut	1	Insert	D	Wrapped	24	75	Slightly hard on bottom, slightly soft on top
Donut	1	Insert	D		20	68	Slightly hard on bottom, slightly soft on top
Donut	1	Insert	D		32	90	Slightly hard on bottom, slightly soft on top
Donut	1	Side	A	In paper	13	55	Slightly hard on bottom, slightly soft on top
Donut	1	Side	D		18	65	Slightly hard on bottom, slightly soft on top
Donut	1	Soup	C		58	136	Slightly hard on bottom, slightly soft on top
Donut	1	Insert	D		24	75	Slightly hard on bottom, slightly soft on top
Donut	1	Insert	A		59	121	Slightly hard on bottom, slightly soft on top
Donut	1	Insert	D		31	87	Slightly hard on bottom, slightly soft on top
Donut	1	Insert	D		47	117	Slightly hard on bottom, slightly soft on top
Donut	1	Side	C		47	117	Slightly hard on bottom, slightly soft on top
Donut	1	Insert	A	Wrapped	24	75	Slightly hard on bottom, slightly soft on top
Donut	1	Soup	C		48	119	Slightly hard on bottom, slightly soft on top
Donut	1	Soup	C		67	153	Slightly hard on bottom, slightly soft on top
Donut	1	Side	A		52	126	Slightly hard on bottom, slightly soft on top
Donut	1	Insert	A		43	110	Slightly hard on bottom, slightly soft on top
Toast	1	Insert	B		41	105	Best, slightly soggy
Toast	1	Soup	A		41	105	Soggy
Toast	2	Side	A		43	109	Soggy
Toast	2 Halves	Soup	C	Placed on edge	53	128	Soft
Toast	1	Side	A		52	126	Soft, moist on bottom
Buttered English Muffin	1	Soup	C		50	122	Satisfactory
Buttered English Muffin	1	Side	A		48	118	Satisfactory

Table 4. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Breads (cont'd)							
Corn Muffin	1	Side	A	In paper	56	133	Satisfactory
Corn Muffin	1	Soup	C		56	133	Satisfactory
Corn Muffin	1	Insert	D		19	66	Satisfactory
Corn Muffin	1	Insert	C		44	112	Satisfactory
Corn Muffin	1	Entree	B		44	112	Satisfactory
Corn Muffin	1	Side	A		53	128	Slightly too crisp
Starches							
Grits	4	Side	A	Plated thin	61	143	Thick
Grits	4	Side	A	Plated thin	68	155	Thick
Grits	4	Soup	C	Plated thin	66	150	Thick
Grits	4	Soup	C	Plated thin	47*	116*	Thick, cool
Cereals							
Oatmeal	4	Soup	C		68	154	Thick
Oatmeal	4	Side	A		67	152	Thick
Oatmeal	4	Soup	C		61	141	Thick, dry
Oatmeal	4	Side	A		76	169	Stiff
Entree							
Waffles	2	Entree	B	Toasted	52*	126*	Slightly moist and soft on top
Waffles	2	Entree	B	Uncooked	46*	114*	Soggy on top
Waffles	2	Entree	B	Uncooked	50*	122*	Very soggy
Waffles	2	Entree	B	Toasted	67	153	Slightly soft on top, sl. hard on bottom
Pancakes	1	Side	A		48*	118*	Hard on bottom, soft on top
Pancakes	1	Soup	C		49*	121*	Slightly soft

*Under recommended temperatures

Table 4. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Entree (cont'd)							
Pancakes	1	Side	A		51*	123*	Slightly soft
Pancakes	1	Side	A		47*	117*	Soggy
Pancakes	2	Entree	B		51*	124*	Very soggy
Pancakes	1	Soup	C		49*	120*	Soggy
Pancakes	2	Insert	B		49*	120*	Satisfactory, better on insert than disposable or china dish
Pancakes	1	Side	A		53*	127*	Hard on bottom, soft on top
Pancakes	2	Entree	B		45*	113*	Slightly hard on bottom, soft on top
French Toast	2 Slices	Soup	C		44*	112*	Soft
French Toast	2 Slices	Entree	B	Uncooked	62	143	Slightly soft
French Toast	2 Slices	Entree	B	Toasted	76	168	Slightly soft on top
Eggs							
Fried Egg	1	China dish on entree	B	Butter placed on egg uncooked	64	148	Butter did not melt, overcooked
Fried Egg	1	China dish on entree	B	Undercooked	69	156	Yolk cooked, overcooked
Scrambled Eggs		China dish on side	A	Undercooked	49*	121*	Undercooked, slightly watery
Scrambled Eggs	3	China dish on entree	B	Cooked well	63*	145	Slightly dry
Scrambled Eggs	3	Soup insert on side	A	Undercooked	52	126*	Undercooked
Scrambled Eggs	3	Entree	B	Undercooked	58	136	Undercooked
Scrambled Eggs		China dish in entree	B	Undercooked	63	145	Good
Scrambled Eggs	3	China dish in entree	B	Undercooked	64	148	Good

*Under recommended temperatures

Table 4. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Eggs (cont'd)							
Poached Egg	1	Insert dish in soup	C	Undercooked	48*	118*	Good
Poached Egg	1	China dish in entree	B	Undercooked	69	156	Good
Poached Egg	1	China dish on entree	B	Undercooked	71	160	Extra butter did not melt, hard yolk
Poached Egg	1	China dish on entree	B	Undercooked butter on egg	59*	138*	Soft, Good
Hard Boiled Egg	1	Soup	C	Wrapped in foil	45*	113*	Hard, rubbery
Hard Boiled Egg	1	Entree	B	Unwrapped	43*	109*	Undercooked
Soft Boiled Egg	1	Entree	B	Wrapped in foil	43*	110*	Undercooked
Soft Boiled Egg	1	Entree	B	Unwrapped	61	142	Slightly rubbery
Juice							
Orange Juice	4	Cup	F		5	41	Satisfactory
Orange Juice	4	Cup	E		10	50	Satisfactory
Orange Juice	4	Cup	F		7	45	Satisfactory
Orange Juice	4	Cup	F		8	46	Satisfactory
Orange Juice	4	Cup	F		9	49	Satisfactory
Orange Juice	4	Cup	F		13	55	Satisfactory
Orange Juice	4	Cup	F		12	54	Satisfactory
Orange Juice	4	Cup	F		10	50	Satisfactory
Orange Juice	4	Cup	F		13	55	Satisfactory
Orange Juice	4	Cup	F		5	41	Satisfactory
Orange Juice	4	Cup	F		7	44	Satisfactory

*Under recommended temperatures

Table 5. Foods Rethermalized in Aladdin Cart – Luncheon/Dinner

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
HOT							
Soups							
Vegetable Soup	6	Soup	C		73	164	Satisfactory
Vegetable Soup	6	Soup	C		75	167	Satisfactory
Vegetable Soup	6	Soup	C		78	172	Satisfactory
Chicken Broth	6	Soup	C		69	157	Satisfactory
Chicken Broth	6	Soup	C		66	151	Satisfactory
Chicken Broth	6	Soup	C		79	175	Satisfactory
Chicken Broth	6	Soup	C		79	174	Satisfactory
Cream of Mushroom	6	Soup	C		72	162	Satisfactory
Cream of Mushroom	6	Soup	C		71	159	Satisfactory
Entrees							
Hamburger	4	Soup	C	No roll	59*	138*	Temp. slightly low, product satisfactory
Hamburger	1	Entree	B	No roll	57*	135*	Temp. slightly low, product satisfactory
Hamburger	3	Soup	C		44*	111*	Temperature low
roll on top	1	Soup	C		45	113	Roll soft and limp
Hamburger	4	Entree	B	No roll	65	149	Satisfactory
Cheeseburger	1	Entree	B		35*	131*	Temp. slightly low, product satisfactory
roll separate	1	Entree	B		58	136	Roll hard
Cheeseburger	4	Entree	B		49*	120	Temperature low
roll tented	1	Entree	B		48	119	Roll slightly soft
Cheeseburger	4	Entree	B		63	146	Satisfactory, no sticking of cheese, even though melted on dish
roll		Entree	B		44	112	Bottom slightly hard

*Under recommended temperatures

Table 5. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Entrees (cont'd)							
Steak (rare)	3	Entree	B		70	158	Cooked to well done
Steak (med. rare)	3	Entree	B		76	165	Cooked to well done
Steak (med. rare)	4	Entree	B		81	178	Cooked to well done
Fried Fish	4	Soup	C		59*	138*	Soft
Fried Fish	3	Entree	B		86	187	Satisfactory, slightly soft
Baked Chicken Leg	4	Entree	B		74	157	Satisfactory
Baked Chicken Breast	6	Entree	B		39*	103*	Slightly scorching, low temperature
Baked Chicken Leg	6	Entree	B		52*	125*	Low temperature
Fried Chicken Leg	4	Soup	C		56*	133*	Slightly low temp., slightly soft
Fried Chicken Breast	6	Entree	B	Meat down	38*	101*	Low temperature
Fried Chicken Leg	6	Entree	B	Meat up	57*	134*	Slightly low temperature, slightly soft
Fried Chicken Leg	6	Entree	B		57*	135*	Soft, slightly low temperature
Baked Chicken Leg	1	Entree	B		67	153	Satisfactory
Pork Chop	1	Entree	B		65	149	Satisfactory
Boneless Pork Chop	6	Entree	B		67	153	Satisfactory
Ham Slice	3	Entree	B		68	154	Slight. scorching under ham, not objectionable
Ham Slice	3	Entree	B		68	154	Satisfactory
Spareribs	6	Entree	B	Meat side up	57*	135*	Slightly low temperature
Spareribs	6	Entree	B	Meat side up	57*	134*	Slightly low temperature
Salisbury Steak	3 oz Meat & 3 oz Gravy	Divided Entree	B		67	152	Satisfactory
Salisbury Steak	3 oz Meat & 3 oz Gravy	Entree	B		60	140	Satisfactory
Veal Parmesean	3 oz Meat & 3 oz Gravy	Entree	B		83	181	Satisfactory

*Under recommended temperatures

Table 5. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Entrees (cont'd)							
Veal Parmesean	3 oz Meat & 3 oz Gravy	Entree	B		79	174	Satisfactory
Roast Turkey and Gravy	3 oz Meat & 3 oz Gravy	Entree	B		86	187	Satisfactory
Baked Fish with Cheese Sauce	3 oz Meat & 3 oz Sauce	Divided Entree	B		66	151	Very slight scorching
Beef Stew	3	Soup	C		79	175	Satisfactory
Beef Stew	6	Entree	B		83	181	Satisfactory
Beef Stew	6	Entree	B		71	159	Satisfactory
Macaroni & Cheese	6	Entree	B		62	142	Satisfactory
Macaroni & Cheese	6	Entree	B		68	154	Very slight scorching
Macaroni & Cheese	8	Entree	B		86	186	Satisfactory
Lasagna	6	Entree	B		61	142	Satisfactory
Lasagna	8	Entree	B		54*	130*	Slightly low temperature
Chicken Pot Pie	6	Divided Entree	B		61	142	Slightly soft crust
Chicken Pot Pie	6	Entree	B		61	142	Slightly soft crust
Chipped Beef	6	Divided Entree	B		71	159	Satisfactory
Stuffed Peppers	1 Whole	Entree	B		56*	133*	Slightly low temperature
Stuffed Peppers	1 Whole	Entree	B		53*	127*	Slightly low temperature
Stuffed Peppers	1 Whole	Entree	B		78	173	Satisfactory
Turkey Croquettes	2 oz Meat & 2 oz Gravy	Entree	B		64	148	Slightly soft, slightly mushy, not objectionable, very slightly scorched
Turkey Croquettes	2 oz Meat & 3 oz Gravy	Entree	B		60	140	Very slightly scorched
Corned Beef Hash	6	Entree	B		69	157	Satisfactory

*Under recommended temperatures

Table 5. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Entrees (cont'd)							
Corned Beef Hash	6	Entree	B		72	162	Satisfactory
Grilled Cheese	1	Entree	B		78	172	Satisfactory
Grilled Cheese	1	Insert	B		53*	128*	Very soggy
Pizza	1 Slice	Side	E	Not precooked	53*	128*	Cheese melted on top, crisp on top – Good
Pizza	1 Slice	Entree	B	Not precooked	44*	112*	Slightly too crisp
Pizza	1 Slice	Entree	B	Not precooked	61	142	Cheese melted, crust slightly hard
Pizza	1 Slice	Insert	A	Not precooked	44*	111*	Good
Pureed Bland Beef	8	Entree	B		79	174	Satisfactory
Pureed Bland Beef	3	Side	A		70	158	Satisfactory
Pureed Bland Beef	6	Soup	C		76	169	Satisfactory
Dental Liquid Beef	3	Side	A		78	154	Satisfactory
Dental Liquid Beef	8	Entree	B		67	153	Satisfactory
Dental Liquid Beef	6	Soup	C		62	143	Satisfactory
Starches							
Baked Potato	2	Entree	B	Not wrapped in aluminum	61	142	Satisfactory
Baked Potato	4	Entree	B	Wrapped in alum.	49*	120*	Low temperature
Baked Potato	4	Entree	B	Wrapped in alum.	49*	121*	Low temperature
Baked Potato	1	Entree	B	Wrapped in alum.	43*	110*	Low temperature
Baked Stuffed Potato	1	Entree	B	Not wrapped	61	142	Satisfactory
Baked Stuffed Potato	1	Entree	B	Not wrapped	53*	127*	Low temperature
Baked Stuffed Potato	1	Entree	B	Not wrapped	51*	124*	Low temperature
Baked Stuffed Potato	1	Soup	C	Not wrapped	41*	106*	Low temperature
Baked Stuffed Potato	4	Entree	B	Not wrapped	53*	127*	Low temperature

*Under recommended temperatures

Table 5. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Starches (cont'd)							
Baked Stuffed Potato	4	Divided Entree	B	Not wrapped	51*	124*	Low temperature
Baked Stuffed Potato	1	Soup	C	Not wrapped	41*	106*	Low temperature
Mashed Potatoes	4	Entree	B		69	156	Satisfactory
Mashed Potatoes	4	Entree	B		57*	135*	Satisfactory
Mashed Potatoes	4	Entree	B		82	180	Satisfactory
Mashed Potatoes	4	Divided Entree	B		54*	129*	Low temperature
Mashed Potatoes	4	Entree	B		46*	115*	Low temperature
Glazed Sweet Potato	4	Entree	B		82	179	Satisfactory
Glazed Sweet Potato	4	Entree	B		76	169	Satisfactory
Oven Browned Potato	3	Entree	B		67	153	Soft, slightly mushy
Oven Browned Potato	4	Entree	B		51*	124*	Low temperature
Oven Browned Potato	4	Entree	B		64	148	Soft, very slightly mushy
Oven Browned Potato	4	Entree	B		65	149	Soft, very slightly mushy
Shoestring Potatoes	4	Divided Entree	B		74	166	Soggy, very slight scorching
Scalloped Potatoes	4	Entree	B		74	165	Satisfactory
Scalloped Potatoes	4	Entree	B		74	166	Satisfactory
Scalloped Potatoes	4	Entree	B		74	166	Satisfactory
French Fries	3	Side	A		65	149	Soft, soggy
French Fries	3	Insert	A		47*	116*	Low temperature, soggy
French Fries	4	Soup	C		68	154	Soft, soggy
French Fries	4	Soup	C	No further cooking	43*	109*	Raw tasting, dry, starchy, mealy

*Under recommended temperatures

Table 5. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Starches (cont'd)							
French Fries	4	Entree	B		51*	123*	Soft, low temperature
French Fries	4	Side	A	No further cooking	52*	125*	Raw, soggy
French Fries	4	Soup	C	No further cooking	42*	107*	Raw tasting, dry, starchy, mealy, low temperature
Hash-Browns	4	Entree			51*	124*	Low temperature
Hash-Browns	4	Side	A		63	146	Satisfactory
Hash-Browns	3	Side	A		58*	136*	Slightly low temperature
Macaroni	3	Entree	B		53*	127*	Slightly low temperature
Macaroni	4	Entree	B		73	163	Satisfactory
Macaroni	2	Entree	B		70	158	Needs butter, but satisfactory
Rice	3	Entree	B		70	158	Satisfactory
Rice	3	Entree	B		38*	101*	Low temperature
Toast	1 Slice	Insert	C		32	90	Hard on bottom, mostly soft inside
HOT							
Vegetables							
Broccoli, Chopped	3	Side	A	a	73	164	
Broccoli, Whole	3	Side	A	a	53*	128*	Slightly raw, very slight scorching, very slightly undercooked
Broccoli, Chopped	3	Side	A	a	86	186	
Broccoli, Chopped	3	Side	A	a	64	148	Slightly crunchy but satisfactory
Broccoli, Chopped	3	Side	A	a	78	172	Very slight scorching, very slightly undercooked
Broccoli, Whole	3	Side	A	a	51*	124*	Slightly crunchy, slightly undercooked
Broccoli, Chopped	3	Side	A	a	61	141	Slightly undercooked

*Under recommended temperatures

a – plated uncooked

Table 5. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Vegetables (cont'd)							
Brussel Sprouts	2	Side	A	a	68	155	Good
Brussel Sprouts	3	Side	A	a	44*	111*	Very slightly undercooked
Brussel Sprouts	3	Side	A	a	40*	104*	Slightly undercooked
Cauliflower	3	Side	A	a	49*	120*	Slightly undercooked
Cauliflower	3	Side	A	a	44*	111*	Slightly undercooked
Cauliflower	3	Side	A	a	49*	120*	Slightly undercooked
Carrots	3	Side	A	a	55*	131*	Undercooked
Carrots	3	Entree	B	a	64	148	Slightly undercooked
Carrots	4	Side	A	a	64	147	Slightly undercooked
Corn	3	Side	A	canned	73	164	Satisfactory
Corn	4	Side	A	canned	69	157	Satisfactory
Corn	3	Side	A	canned	64	147	Satisfactory
Corn	3	Side	A	canned	58*	136*	Satisfactory
Green Beans	3	Side	A	a	62	144	Undercooked
Green Beans	3	Side	A	a	52*	125*	Undercooked
Breads							
Roll (dinner)	1	Insert	A		46	115	Soft on top
Roll (dinner)	1	Insert	C		50	122	Slightly hard on bottom
Roll (dinner)	1	Insert	C		56	132	Hard on bottom
Roll (dinner)	1	Soup	C		55	131	Hard on bottom
Roll (dinner)	1	Insert	A		33	91	Hard on bottom
Roll (dinner)	1	Side	A		38	100	Hard on bottom

*Under recommended temperatures

a – plated uncooked

Table 5. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Breads (cont'd)							
Roll (dinner)	1	Soup	C		41	106	Hard on bottom
Roll (dinner)	1	Side	A		38	100	Hard on bottom
Roll (dinner)	1	Insert	A		32	90	Slightly hard on bottom
Roll (dinner)	1	Insert	C		40	104	Slightly hard on bottom
Bread w/Butter	1	Side	A		45	113	Butter melted
Desserts							
Pie, Apple	1 Slice	Insert	C		37	98	Very slightly warm
Pie, Apple	1 Slice	Side	A		28	83	Very slightly warm
Pie, Apple	1 Slice	Side	A		54	130	Warm
Pie, Apple	1 Slice	Insert	C		38	101	Slightly warm
Pie, Apple	1 Slice	Soup	C		48	119	Slightly warm
Applesauce	4	Soup	C		58	137	Warm
COLD							
Entrees							
Egg Salad Sandwich	1	Entree	D–E		21	69	
Egg Salad Sandwich	1	Entree	D–E		13	55	
Egg Salad Sandwich	1	Entree	D–E	Open faced	17	63	
Egg Salad, Scoop	4	Entree	D–E		7	45	
Chicken	6	Entree	D–E		17	62	
Breads							
Roll	1	Side	D		32	89	
Roll	1	Side	D		32	89	
Roll	1	Side	E		23	74	
Bread w/Butter	1 Slice	Side	E		17	63	

Table 5. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Salads							
Tossed Salad w/Dressing	2	Soup	D		18	65	
Tossed Salad w/Dressing	3	Side	D		22	72	
Tossed Salad w/Dressing	3	Side	D		12	53	
Tossed Salad w/Dressing	3	Side	E		14	58	
Tossed Salad w/Dressing	2	Side	E		9	49	
Tossed Salad wo/Dressing	2	Side	D		14	57	
Tossed Salad wo/Dressing	3	Side	D		14	58	
Tossed Salad wo/Dressing	3	Side	D		15	59	
Tossed Salad wo/Dressing	3	Side	E		8	47	
Tossed Salad wo/Dressing	3	Side	D		21	69	
Beverages							
Milk	3	Cup	F	Covered	8	47	
Milk	8	Carton	Wing		7	45	
Milk	8	Carton	Wing		9	48	
Milk	8	Carton	Wing		8	47	
Milk	8	Carton	Wing		13	56	
Milk	8	Carton	Wing		11	52	
Milk	8	Carton	Wing		10	50	
Milk	8	Carton	Wing		9	48	
Milk	3	Cup	F	Covered	12	54	
Pineapple Juice	3	Cup	F	Covered	13	55	
Pineapple Juice	3	Cup	E		15	59	
Pineapple Juice	4	Cup	E		10	50	

Table 5. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Beverages (cont'd)							
Pineapple Juice	4	Cup	E		11	51	
Pineapple Juice	4	Cup	F		10	50	
Pineapple Juice	4	Cup	F		14	57	
Pineapple Juice	4	Cup	F	Covered	13	57	
Pineapple Juice	4	Cup	F	Covered	17	63	
Pineapple Juice	4	Cup	F	Covered	16	61	
Pineapple Juice	4	Cup	F	Covered	14	57	
Pineapple Juice	4	Cup	F	Covered	17	63	
Pineapple Juice	3	Cup	F	Covered	11	53	
Apple Juice	3.5	Cup	E	Covered	17	62	
Desserts							
Applesauce	4	Side	E		8	46	
Applesauce	4	Side	E		7	45	
Applesauce	4	Side	D		9	49	
Applesauce	4	Side	E		13	55	
Applesauce	4	Side	E		16	61	
Applesauce	4	Side	E		12	54	
Cake	1 Slice	Side	D		9	49	
Cake	1 Slice	Side	E		13	56	
Cake	1 Slice	Side	D		12	53	
Cake	1 Slice	Side	E		13	55	
Cake	1 Slice	Side	E		17	62	Slight softening of frosting

Table 5. (cont'd)

	Portion Size (oz)	Dish	Position	Special Handling	Final Rethermalization Temperatures (°C)	(°F)	Comments on Rethermalization
Desserts (cont'd)							
Crushed Pineapple	3	Side	E		16	60	
Crushed Pineapple	3	Side	E		15	59	
Crushed Pineapple	3	Side	F		14	57	
Jello	4	Side	E		8	46	
Jello	4	Side	D		16	60	
Jello	4	Side	E		17	62	
Jello	4	Side	E		18	65	
Jello	4	Side	E		17	62	
Jello	4	Side	E		20	68	
Pudding	4	Side	E		16	60	
Pudding	4	Side	E		10	50	
Pudding	4	Side	E		11	51	
Pudding	4	Side	E		9	48	
Pie	1 Slice	Side	E		16	61	

(24°C to 47°C) was desirable. Leaving individual plastic wrap on the doughnuts before plating was also satisfactory. English muffins were acceptable as were corn muffins, either plain or left in the cupcake paper. Toast was not satisfactory when tried in various positions and on various dishes. It became soft and soggy in all tests but was best when placed on an insert dish in the entree position. Use of insert dishes for a slight warming of bread products seemed generally most desirable.

Starches. Grits, like the oatmeal, were stiff after reheating, even though thin when plated. The final temperatures in three out of four trials were satisfactory. With strict adherence to proper preparation procedures, these could be adapted to the system. Hash-browned potatoes are listed under luncheon dinner products.

D. Breakfast Foods – Cold

Juices. The temperature of orange juice (4 oz) ranged from 5°C to 13°C (41°F to 55°F) after other products were rethermalized.

E. Luncheon/Dinner Items – Hot

Soups. Soups rethermalized well in all tests. Final temperatures ranged from 66°C to 79°C (151°F to 174°F).

Entrees. Hamburgers and cheeseburgers heated to fairly low final temperatures. No scorching was evident in cheeseburgers even when the cheese was melted. Rolls for hamburgers and cheeseburgers were very difficult to handle. When placed on the dish directly, they became quite hard, and if placed over the meat they became soft. Tenting the roll over the meat seemed the best method, although using an insert or china dish for the roll might be considered, if enough room on the tray is available. Steaks cooked to slightly different end points were all considered "well done" after rethermalization. Deep-fat fried fish and other deep-fried foods were slightly soft and lacked the crispness desired in fried foods. Chicken breasts were too thick to rethermalize adequately; chicken legs heated better, but generally not to recommended temperatures. Pork chops and ham slices heated well. Spareribs, as might be expected, reached slightly lower temperatures than desired. Salisbury steak, veal parmesan, roast turkey and gravy, beef stew, and macaroni and cheese all heated well. Lasagna, when not too thick, reheated adequately. Chicken pot pie had a slightly soft crust on top. Stuffed peppers (whole) were tested three times and twice were slightly underheated, the third time they were satisfactory. A grilled cheese sandwich on the entree dish heated well, as did corned beef hash, pureed and thinned strained items. Frozen pizza generally had a good texture when heated without further cooking after tempering, although final temperatures were low.

Starches. A baked potato not wrapped in aluminum foil was hotter than those wrapped. Baked, stuffed potatoes did not reheat adequately. The temperature of mashed potatoes varied considerably, sometimes heating above 60°C (140°F), at other times lower. Glazed sweet potatoes heated well, but oven-browned potatoes tended to be slightly soft. Shoestring potatoes were soggy, but scalloped potatoes were satisfactory. Frozen, tempered, french fries were tried with no further cooking, but were raw and starchy tasting after rethermalization. With cooking

they were soft and limp. Hashed-browns, macaroni, and rice generally heated satisfactorily but some low temperatures were noted.

Vegetables. Vegetables were tried with no further cooking after the frozen products were tempered. Carrots and green beans were very undercooked after rethermalization without recooking after tempering, but broccoli, brussel sprouts, cauliflower, and corn could be served in this manner if slightly crisp, undercooked vegetables are acceptable to the patient population. Most of the vegetables rethermalized well, although the larger sized pieces such as broccoli spears, whole cauliflower, and brussel sprouts did not heat as well as those items with more surface area in contact with the dish, such as corn, chopped broccoli, carrots, and green beans. Thus, vegetables with poor surface contact with the dish or with a high volume configuration should be avoided or be plated with additional liquid to intensify heat transfer.

Breads. Dinner rolls heated best when placed on an insert dish although the rolls were somewhat hard on the bottom with all methods.

Desserts. Apple pie warmed nicely during the rethermalization cycle when placed directly on a disposable dish and to a lesser extent when placed on an insert dish.

F. Luncheon/Dinner Items – Cold

Entrees. Cold entrees, such as chicken, sandwiches, and egg salad ranged from 7°C to 21°C (45°F to 69°F) after rethermalization of other items in the cart.

Breads. Breads placed on unheated positions ranged from 17°C to 32°C (63°F to 89°F) after reheating.

Salads. Tossed salads ranged from 9°C to 22°C (49°F to 72°F) after reheating. However, the appearance of all salads was good and little wilting was noticed even when salad dressing was added during the salad making.

Beverages. Milk in 8-oz cartons in the wing area generally remained cooler, 7°C to 13°C (45°F to 56°F), than juices or milk in the juice cup under the insulated cover, 10°C to 17°C (50°F to 63°F). Most of the milk in the wing area reamined under 10°C (50°F), while that in the juice cup generally rose above 10°C (50°F).

Desserts. Cold desserts ranged in temperature from 7°C to 20°C (45°F to 68°F) after rethermalization, but generally looked attractive and had good flavor and texture attributes.

COMMENT

The panel board (Figure 6) on the outside of the refrigerator unit generally provided very helpful information. The power light indicated power was being generated to the heating units; the heating light indicated rethermalization was occurring; the time display indicated how many minutes until rethermalization was completed; and the rethermalization completion light showed when reheating was finished. The test button when pushed with the on/off button

allowed checking of each tray in the cart to determine which were in the heating position. The start button pushed with the on/off button in the on position started rethermalization. An audible alarm that was designed to sound at the completion of the rethermalization cycle did not always sound when anticipated. However, when it did sound, the silence button turned it off. The systems power indicator showed the power for the refrigeration unit and the digital temperature display was quite accurate in displaying the internal refrigerator temperature. The alarm light, which was supposed to flash if the unit went above 18°C (65°F), was inoperative in the unit tested.

The disposable dishes used with the system were generally adequate for the intended purpose. However, many hospitals prefer to use permanent dishware, which is not compatible with the system except when very mild heating is desired and a china dish is placed on a disposable dish to reduce the amount of heat. Some of the dishes were too small for their stated portions; it would be impossible in most cases to place the entree, starch, and vegetable, for example, on the entree dish. The plastic lids for the juice and soup containers were not tight enough to prevent spillage, which can easily occur when the cart is being rolled into the refrigerator units. Although a few disposable dishes showed slight bubbling after rethermalization, no melting of the dishes was evident. Almost no scorching or sticking of food to the dishes was noted. Little moisture condensation was noted dripping onto food products after rethermalization. The trays showed some adverse effects after the testing, done over a 30-day period. Of the 20 trays used in testing, 1 showed some bubbling or distortion after the 30-day test period.

An inconvenient feature of the system was the need to remove the entire cart from the refrigeration unit if one tray were to be added, removed, or checked. Gentle handling was required to insert the cart correctly in the unit without spillage and also to push the cart into position so that the door would shut properly. However, the "floating receiver" that connects the cart to the refrigeration usually connected without difficulty.

CONCLUSIONS

The Aladdin rethermalization system is a new food system with several advantages over other systems now available. However, certain design features detract from its capabilities. Most easy-to-heat food, such as soups and casseroles, heat very well in this system. Items that have good surface contact with the dish and are not too thick also heat well. Thick or bone-in items are more difficult to heat and somewhat erratic results are obtained with many products. Unlike some other systems, scorching or sticking of food to the dishes is no problem. Probably because of the insulated cover, there is almost no noticeable condensation dripping onto the food products. Breakfast items are difficult to rethermalize well.

The most serious problem noticed in this study was the difficulty in maintaining products at properly chilled temperatures prior to rethermalization. Once products are plated into the tray and covered with the insulated cover, the temperatures of those products will not significantly decrease under refrigerator temperatures in a reasonable amount of time. Therefore, extreme care must be taken to plate chilled foods in a chilled environment, to load them into prechilled carts, and to transfer them to the refrigerated unit very quickly. Unless food

enters the refrigerator unit at 7°C (45°F) or below, rethermalization should be started as soon as possible.

The principal advantages and disadvantages of the Aladdin rethermalization system found in this test are summarized as follows.

Advantages	Disadvantages
1. Good heating capabilities with many food items.	1. The inability of the refrigeration unit to chill food adequately inside the insulated tray.
2. Lack of scorching under almost all conditions.	2. The inability of the cart to heat certain types of food successfully.
3. Lack of large amounts of moisture condensation dripping onto food products.	3. The inability of the cart to heat all foods consistently to temperatures mandated by U.S. Public Health and AR 40–5 standards.
4. Adequate chill retention during rethermalization but only if food is thoroughly chilled at start of rethermalization.	4. The difficulty in plating, storing, and transporting food at sufficiently low temperatures to comply with U.S. Public Health and AR 40–5 standards.
5. Good heat and chill retention in insulated trays after rethermalization.	5. The need to remove the whole cart from refrigeration to adjust one tray.
6. A generally convenient and informational panel board.	6. Distortion of the trays after continued use.

APPENDIX

Foods Used in Energy Study

Tray	Food Item	Portion Size	Position
2	carrots	3 oz	A
2	fish	3 oz	B
2	french fries	4 oz	B
2	chicken broth	6 oz	C
2	jello	4 oz	D
2	juice	4 oz	E
3	egg salad sandwich	1 oz	D + E
3	soup	6 oz	C
3	corn	3 oz	A
3	beef stew	6 oz	B
4	steak	4 oz	B
4	candied sweet potatoes	4 oz	B
4	soup, vegetable	6 oz	C
4	applesauce	4 oz	E
4	salad	3 oz	D
4	carrots	3 oz	A
5	steak	3 oz	B
5	glazed sweet potatoes	4 oz	B
5	soup, vegetable	6 oz	C
5	cake, chocolate	4 oz	E
5	juice, pineapple	4 oz	F
6	steak	3 oz	B
6	potato, baked	2 oz	B
6	roll	1	C
6	chocolate cake	1 piece	D
6	juice, pineapple	4 oz	E
7	corn	4 oz	A
7	cheeseburger	1 oz	B
7	roll	1 oz	B
7	applesauce	4 oz	D
7	salad	2 oz	E
7	apple juice	4 oz	F
8	grilled cheese	1	B
8	egg salad	4 oz	D + E
8	applesauce	4 oz	F
8	milk	8 oz carton	wing
9	broccoli	3 oz	A
9	hamburger and roll	1	B
9	beef stew	3 oz	C
9	egg salad sandwich	1	D + E

Tray	Food Item	Portion Size	Position
10	corn	3 oz	A
10	chicken leg	1	B
10	oven-browned potato	3 oz	B
10	jello	4 oz	D
10	salad, green	3 oz	E
10	milk	8 oz carton	wing
11	fried chicken breast	6 oz	B
11	brussels sprouts	2 oz	A
11	hamburger, roll on top	1	C
11	cake, chocolate	1 slice	D
11	salad	3 oz	E
12	chopped broccoli	3 oz	A
12	fried chicken breast	6 oz	B
12	rice	3 oz	B
12	roll	1	C
12	cake	1	D
12	applesauce	4 oz	E
12	milk	8 oz	wing
13	hash-browned potatoes	4 oz	B
13	macaroni & cheese	6 oz	B
13	hash-browned potatoes	4 oz	A
13	grilled cheese sandwich	1	D–E
13	hash-browned potatoes	4 oz	C
14	fried fish	4 oz	B
14	mashed potatoes	4 oz	B
14	hash-browned potatoes	3 oz	A
14	fried chicken leg	4 oz	C
14	apple juice	3.5 oz	D
15	corned beef hash	6 oz	B
15	fried chicken leg	3 oz	A
15	roll	1	D
15	hamburger	4 oz	C
16	baked chicken leg	4 oz	B
16	rice	3 oz	B
16	juice, apple	3 oz	D
16	fried chicken breast	6 oz	E–F
16	applesauce	4 oz	C
17	pureed blend beef	8 oz	B
17	pureed vegetable	3 oz	A
17	soup, chicken broth	6 oz	C
17	pureed vegetable	3 oz	A
18	cold fried chicken leg	6 oz	D–E
18	applesauce	3 oz	A

Tray	Food Item	Portion Size	Position
18	lasagna	6 oz	B
18	black olives	4 oz	F
19	beef stew	6 oz	B
19	chicken breast	6 oz	D–E
19	crushed pineapple	3 oz	F
19	roll	1	A
19	roll	1	C
20	cheeseburger	4 oz	B
20	salad, green	2 oz	D
20	french fried potatoes	3 oz	A
20	crushed pineapple	3 oz	E
21	hamburg with roll	1	B
21	salad	2 oz	D
21	french fried potatoes	3 oz	A
21	crushed pineapple	3 oz	E
22	pork chop	1	B
22	stuffed baked potato	1	B
22	broth, chicken	6 oz	C
22	salad	3 oz	D
22	chicken breast	6 oz	E
23	dental liquid	3 oz	A
23	dental liquid	8 oz	B
23	dental liquid	6 oz	C
23	dental liquid	6 oz	D
23	dental liquid	3 oz	E
24	grilled cheese sandwich	1	B
24	soup, chicken broth	6 oz	C
24	salad, green	3 oz	D
24	jello	4 oz	E

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