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AIR FORCE FLIGHT FEEDING
VOLUME I:
EVALUATION OF CURRENT SYSTEM AND ALTERNATIVE CONCEPTS

BY

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This report covers the initial phase of the project, during which the current Air Force flight feeding system was evaluated via an extensive data collection and analysis effort. Project objectives included development of a new flight feeding system concept to meet the needs of current flight missions as well as those of the coming decade, improved flight meal customer acceptance, and increased operating efficiency of flight kitchens.

Crew opinions were obtained through 2,811 mail survey and 146 on-site surveys. Feedback was received on availability and acceptability of menu items, adequacy of galley equipment on board the aircraft, and flight feeding issues in general. Project team members visited several Air Force bases to observe flight kitchens in operation, to collect technical data on selected aircraft, and to meet with key personnel (crew members, food service personnel, aircraft maintenance representatives) to determine

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current flight feeding deficiencies and to identify possible solutions. Structured telephone surveys of 40 Air Force flight kitchens were conducted to determine equipment inventories, work space, storage space, and personnel resources.

The following observations, were made concerning current Air Force flight feeding systems: 1. Existing aircraft (C-141, C-5, C-130, KC-135, KC-10, B-52) do not provide adequate refrigeration and heating capabilities to deliver high quality hot and cold meals to crews and passengers; 2. Available heating methods no not permit crews to heat their own meals in such a manner that meals are hot when they choose to eat without running the risk of having these meals overcooked if flight duties interfere with the consumption of the meal at the anticipated time; 3. Galley components often are not modular in design to facilitate maintenance; 4. Overall, menus lack variety and more care is needed in menu item preparation and selection of ingredients; 5. Flight kitchen facilities and equipment range from inadequate to ample for the job at hand, and it appears no defined set of criteria is followed to provided adequate resources across the board to avoid the "feast or famine" situation that currently exists; and 6. In general, it does not appear that mission requirements, customer preferences, or food service expertise were taken into consideration when the current systems were designed, particularly the onboard galley systems.

In addition, a contract effort was completed to evaluate current and future planned commercial systems and to investigate potential application to the Air Force. It was found that civilian flight feeding management system has the authority to control their assets. Also, they are closely involved and can influence the selection of galley equipment installed on the airplanes. Civilian carriers predominantly board meals in a chilled state and reheat the hot portions in convection ovens. A state-of-the-art cart system which reheats meals in a chilled environment was identified as promising for Air Force flight feeding.

Based on analysis of both the current Air Force flight feeding system and observation of commercial practices, three alternative flight feeding system concepts were presented to the Air Force: 1. insulated containers for maintaining proper chilled temperature; 2. a microwave galley concept for chilling and reheating; and 3. the food service module system to reheat meals in a refrigerated environment. The food service module system was selected by the Air Force for development and field testing.

PREFACE

The work outlined in this report was performed under Joint Service Requirement AFN 79-2(I), Design of USAF/USN Flight Feeding Systems. DA Project Number 1L162724AH99, Joint Services Food/Nutrition Technology, during the period of October 1982 to January 1985.

The authors wish to acknowledge the following individuals for their support: Dr. Guy Livingston and Dr. Charlotte Chang of Food Science Associates, who contributed in a large way to the data collection efforts and development and analysis of galley alternatives; Ms. Janice Rosado, Advanced Systems Concepts Directorate, Natick, for her editorial support and technical expertise provided in review of final drafts; the many personnel at McChord, Travis, Barksdale, Robbins, Griffiss, Offutt, and Scott Air Force Bases for their guidance and assistance during the data collection phase of this project; and Mrs. Diane Sears and Ms. Maura Severance, Advanced Systems Concepts Directorate, Natick for secretarial support.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (cont'd)

LIST OF TABLES (cont'd)

LIST OF TABLES (cont'd)

LIST OF TABLES (cont'd)

AIR FORCE FLIGHT FEEDING VOLUME I: EVALUATION OF CURRENT SYSTEM AND ALTERNATIVE CONCEPTS

I. INTRODUCTION

Original Requirement

This project was undertaken as part of the DOD Food and Nutrition, Research and Engineering Program. The statement of requirement for the research to be conducted was submitted by the Air Force (AF 79-2) and given first priority over all other Air Force food-related projects at the U.S. Army Natick Research, Development and Engineering Center (Natick). The original technical plan stated:

> Existing flight feeding systems currently in use are modifications of systems developed for the needs of the 1960's. Changes since then in mission requirements, flight duration, and aircraft design impact upon food service operations as well as on the physiological and psychological well-being of the consumers. Therefore, a flight feeding system which is attuned to current mission requirements and equipment inventories as well as those of the coming decade, and which will provide improved acceptability and operational efficiency, is required.

Of these needs expressed by the Air Force, increased user acceptance emerged clearly as the highest priority. Therefore, it was paramount that all roads taken to design better equipment systems and to discover new food products must lead to more satisfied customers. If this were not the end result, then any other benefits of efforts expended would be less valuable. The well-being of the customer is certainly recognized by the Air Force. The unpleasant aspects of flying on a mission, for example, close quarters, extreme environments, stress, boredom, and long, arduous flights only heighten the need for a food service system which provides the highest level of consumer acceptance.

Although satisfying the customer was the primary goal in designing a new inflight food service system for the Air Force, improvements in the operational performance of galley equipment were high on the list of priorities for this project. As the project evolved during the early stages, the following began to emerge as essential characteristics of the proposed work effort:

> (1) The system design must take into consideration configuration of the aircraft itself, such as space limitations and other equipment on board.
>
> (2) The effort involved during flight to perform self-service food handling tasks required for the new system must not interfere with normal mission duties.
>
> (3) The system must provide meals which are comparable to commercial inflight feeding, and be more acceptable to crews than meals currently served.

(4) A systems analysis of current flight feeding operations must investigate the changes needed in the method of storing finished meals in both the flight kitchen and the aircraft.

(5) Descriptions of new food items tested with the new system must be provided.

It should be noted that the specific type of food service system to be provided was not defined by the Air Force. The alternative presented and ultimately tested came about as a result of the investigation of commercial systems, data collected on customer opinion of the current Air Force system, and hardware compatibility requirements with the specified aircraft.

Revised Requirement

The original needs of the Air Force were, out of necessity, expressed in very general terms. Two decisions were subsequently made to further define the scope of the project.

First, it was directed by the Air Force, based on discussions between Natick project team members and staff personnel at major command headquarters, that efforts should focus on systems which would be particularly applicable to the heavy aircraft in the Air Force inventory. These are bomber, tanker, and cargo aircraft. Since these aircraft carry the bulk of all crews and passengers and fly the longest missions, it was determined that the greatest improvement to the current Air Force flight feeding system could be achieved by concentrating on these aircraft.

As an extension of this decision, Natick proposed that the preferred alternative be designed and tested on board the aircraft of this group which offered the greatest constraints on space and crew mobility. Thus, a system which was successfully operated on aircraft with more compact space and other facility constraints would be more easily transferrable to other aircraft and ultimately lead to a DOD-wide system.

Testing of the preferred alternative on a new, space-abundant aircraft might, however, not result in easy transfer to other aircraft and could lead to the development of different systems which could be used only on certain planes. This latter possibility was particularly undesirable since it would probably involve extensive and diverse spare parts inventories, several galley equipment vendors, and, a host of logistics and support problems for flight kitchens.

Second, the decision was made to channel the effort into two major phases. During Phase I, activities would concentrate on designing and testing a system for crew feeding, carefully taking note that the system must have strong application possibilities toward passenger feeding. Phase II of the project would deal with refinement of the crew system based on results of the inflight tests, and adaptation of the crew system for expansion into passenger feeding.

Technical Approach

In this study of Air Force flight feeding, the overall project was broken down into major activities. The specific tasks required for successful completion of these activities were divided into distinct work functions assigned to certain project team members/groups. This report, Volume I, documents results of the project leading up to the selection of new galley systems for onboard testing. The major activities of this initial phase of the project are included in Figure 1.

Problem Definition

At the onset of the project, the first major goal was to know as much as possible about the existing flight feeding system, its good and bad points and the types of customers who used the system. The goal was pursued via visits to Air Force bases where the heavy aircraft (Figure 2) were stationed. Activities conducted during each visit included:

- Tours of the project aircraft were given by crew members of the aircraft (i.e., pilots, boom operators, load masters, crew chiefs, etc.), and personnel from the major maintenance squadrons. The research team learned during these visits that flight feeding is very important to the crews, and was impressed at how interested the crews were in the project. They candidly expressed their views on the current system and provided firsthand expert knowledge as to where new galley equipment could be located on the aircraft and not inhibit their ability to complete their mission-related tasks. Maintenance personnel also accompanied the investigative teams on these tours and elaborated on crew suggestions from an engineering point of view.

- Round table discussions were conducted with crews who could not join in on the tours to further discuss inflight feeding.

- Tours were taken of the flight kitchen facilities. Also, extensive discussions were held with food service personnel concerning menus, food handling equipment, and system alternatives.

- Commercial flight catering operations were examined and discussions were held with management personnel about menus, food products designed for the commercial industry, and sources of such products.

- Several commercial aircraft and the associated galley systems were observed.

- A contract effort was initiated to research state-of-the-art commercial flight feeding systems having application to military conditions.

- A customer survey was conducted through the mail to 55 bases worldwide.

- Formal customer interviews were conducted with active crews at three bases.

- Flight kitchen facility and equipment surveys were conducted by telephone to 40 bases worldwide.

DEFINITION OF AIR FORCE REQUIREMENTS

PROBLEM DEFINITION

DATA COLLECTION OUTLINE

EVALUATION OF THE CURRENT AIR FORCE SYSTEM

- Ground Support Network
- Management Roles
- Onboard Equipment
- Aircraft Profile
- Consumer Opinions

EVALUATION OF COMMERCIAL SYSTEMS

ANALYSIS OF ALTERNATIVE ONBOARD SYSTEMS

Figure 1. Major project activities.

	Principle Contractor	Aircraft Type	Commercial Airframe	Current Strength
B-52 Stratofortress	Rockwell International	Long Range Strategic Bomber	N/A	264
KC-10A Extender	McDonnell Douglas Corp.	Advanced Tanker/Cargo	DC-10	27*
KC-135 Stratotanker	Boeing Military Aircraft Co.	Tanker Transport	Boeing 707	619
C-5A Galaxy	Lockheed Georgia Co.	Heavy Logistics Transport	N/A	77*
C-141 Starlifter	Lockheed Georgia Co.	Cargo/Troop Transport	N/A	271
C-130 Hercules	Lockheed Aircraft Corp.	Medium/Long-Range Combat Transport	N/A	360

*45 KC-10 and 50 C-5B to be procured

Figure 2. Primary aircraft studied.

Systems Analysis

As part of the systems analysis, more detailed data were collected from earlier project phases. When the aircraft were studied more closely and mission characteristics considered, it became apparent that two aircraft most in need of galley improvements, the B-52 and KC-135, were also well suited to test the preferred alternatives (which were still only preliminary proposals at the time). The types of data collected at this stage of the project are presented in Figure 3.

It should be noted at this time no consensus had been reached in terms of what changes were needed to improve customer acceptance and menu variety, increase flexibility to the on board food service system, and other areas of concern which were brought up in crew discussions.

The information collected to define the current flight feeding methodology was done so from a systems point of view. In addition to information usually available from food service records, several types of surveys were used to gain knowledge about the flight feeding customer and the facilities from which the customer is served. The aircraft were technically examined in conjunction with individuals in the maintenance squadrons having expertise in vital areas, such as electrical requirements, environmental factors, stress analysis, and electromagnetic interference. These same aircraft were also looked at from the users' point of view through discussions with the crews who fly the aircraft.

Feasible alternative concepts were conceptually designed and aircraft locations proposed according to feedback received from actual crew members. These concepts were then presented to Air Force services personnel to ensure that the alternatives could be integrated into existing ground support networks.

System Design and Aircraft Modification

On advice from Headquarters, Strategic Air Command (HQ SAC), Natick planned to perform a Class II Modification on one B-52 aircraft. Appropriate points of contact were established with HQ SAC LGME individuals and MMRE technical personnel at OC-ALC/Tinker AFB, OK to coordinate the Class II Mod paperwork. Due to its proximity to Natick, Griffiss AFB, NY was selected as the location to make preliminary aircraft modification plans. The exceptional cooperation of the service and maintenance squadrons convinced Natick to work at Griffiss throughout the entire effort and ultimately complete inflight tests at that location. Results of these inflight tests are documented in Natick Technical Report, Air Force Flight Feeding Volume II: Test and Evaluation of a New Concept.

Operations	Aircraft	Food Service	Facilities	Customers
Crew Strength	Elec Power Characteristics	Menus	Storage Capacity	Crew Surveys
Mission Duration	Thermal Environments	Food Products	Meal Volume	Crew Interviews
Take-Off Times	Equipment Requirements	Food Costs	Equipment Inventories	
Landing Times	Vibration Test Requirements	Food Preferences	Staffing	
	Load Factors			
	Class II Modification Requirements			

Figure 3. Data collected in the systems analysis phase.

II. DESCRIPTION AND EVALUATION OF THE CURRENT SYSTEM

Based on guidance received from formal meetings with staff level personnel at the Strategic, Military Airlift and Tactical Air Commands, it was decided to focus this study on the six aircraft types listed in Figure 2.

In order to collect data relative to the existing system of aircraft and flight kitchens, shortcomings of the system, and specific areas of improvement needed for each of these six types of aircraft, trips were made to Robbins, Barksdale, McChord, Travis, and Griffiss Air Force bases.

During the preliminary stages of the project, most of the data collected were oral in nature and obtained by interviewing officers and enlisted personnel involved with Base Operations, and personnel working in maintenance squadrons involved with the various aircraft types. This information was corroborated by visits to the aircraft on the ground, and by securing appropriate pages from technical orders pertaining to the individual aircraft. For all aircraft types, project team members were accompanied on the aircraft with appropriate crew members. In addition, at each base visited, frank and informal round table discussions were conducted with crews, where subjects such as mission objectives and duration, crew size, menu preferences, likes and dislikes of the current system, and galley equipment requirements were discussed. Furthermore, a worldwide customer mail survey and a personnel interview survey at three air bases (to be discussed in subsequent sections) were conducted to obtain a large sample of customer opinion.

This active involvement, technical advice and opinions of crews proved to be invaluable when project members began formulating ideas for new flight feeding system alternatives. Thus, the needs, preferences, and observations of the ultimate users, Air Force crew members, have played an important and integral role in all aspects of this effort.

The existing flight feeding system in the Air Force consists of three major components:

1. The ground support subsystem
2. The management subsystem
3. The on board subsystem

The Air Force Regulation No. 146-15, dated 19 November 1981, titled "Foodservice Flight Feeding" adequately describes the ground support and management subsystems of the overall Air Force inflight feeding system.

This report will not reiterate information already in AF Regulation 146-15, but will instead supplement that information with appropriate observations and comments based upon the visits made to the various Air Force bases by project personnel.

Ground Support Subsystem

The flight feeding ground support subsystem of the Air Force consists primarily of flight kitchens located at the various Air Force bases, supplemented (in the case of those installations operating under the Military Airlift

Command) by Fleet Service facilities. Flight kitchens can be free-standing facilities or part of a base dining facility. In either event, the flight kitchens generally operate as part of the overall base food service program, but with their own dedicated supervisory staffs and labor forces.

In contrast to civilian flight kitchens, all Air Force flight kitchens were found to be rudimentary, both in facilities and in staffing. To a large extent, this is a consequence of the fairly simple flight feeding system currently in use by the Air Force which does not mandate extensive space, equipment, or personnel for food preparation, meal assembly, and warewashing.

Generally, the Air Force's ground support system is intended to order, receive, and store frozen, chilled, and shelf stable food products; carry out a minimum of food preparation; and ready the food for pick up by aircraft crews or Fleet Service, where applicable. Ground meals are also served by most flight kitchens.

Food preparation is limited to such simple tasks as frying chicken, roasting beef for sandwiches, preparing the sandwiches, and washing and preparing a few raw vegetable products such as tomatoes, lettuce, carrot sticks, and celery sticks.

Air Force flight kitchens do not carry out any tray assembly of meals. Some assembly work is involved in packing sandwiches and snacks into cardboard boxes. Other than sandwiches and vegetable sticks, most lunch box components are commercially packaged goods, such as chips, pastries or puddings. In MAC flight kitchens, components for passenger meals, including frozen meals, were observed to be simply removed from storage and readied as bulk items for pick up and delivery to the aircraft. The items are assembled on board the aircraft for customer service (crew and/or passenger).

Flight kitchen menus consist of those items described in Chapter 4 of Air Force Regulation 146-15. Primarily, these are the sandwich meals and snack meals (which are packed in lunch boxes), frozen cooked meals (which are used on some type of aircraft from certain flight kitchens, but not necessarily in use even where feasible), and shelf stable meals such as the Meal, Ready-to-Eat (MRE).

In general, meal orders are received from either aircraft crews or Passenger Service personnel, where applicable. Lead times reported in our study ranged from 15 minutes to overnight but seem to involve in most cases notification 24 hours in advance of meal pick-up. Flight kitchen personnel log in the date and time of meal order calls and the types of meals ordered. Meal orders are based upon the individual menus prepared by each flight kitchen, usually posted at the entrance of these kitchens and made available to relevant personnel. In one instance, a flight kitchen also maintained a file of individual menu preferences provided by crew members permanently stationed at the installation. These meal preferences were predicated upon the available menu components and the allowable costs. Thus, a crew member had the ability to order his or her preferred menu rather than the stock menus available from the flight kitchen. Most kitchens prepare minimum quantities of various menu components such as sandwiches, fried chicken, vegetable stick packets, or lettuce and tomato packets in advance and are thus able to assemble meals quickly when orders are received. Some kitchens also set up lunch boxes in advance with the nonperishable items so that only the perishable items (i.e., sandwiches, chicken, fruit, milk, etc.) need to be added to finish the orders. The completed meal orders are grouped per aircraft, along with hot cups, square jugs, and insulated containers for beverages and made for pickup by crew or Fleet Service as the case may be.

However, in the case of at least one base visited, the configuration and equipment inventory of the flight kitchen were extremely austere. This flight kitchen, combined with a crash kitchen operation for feeding firefighting personnel, had minimal space, equipment, work counters, and cold storage. There was neither room nor equipment for any advanced preparation or assembly. Consequently, flight kitchen personnel had to pack and assemble meal orders almost immediately prior to pickup, primarily because there was little refrigeration space to store meal orders after preparation. Thus, the production schedule was one of rushed frenzy followed by relative inactivity. Such a situation does not allow for smooth, orderly production schedules, attentive customer service, nor a varied menu.

Where MAC passengers are involved, frozen meals are shipped by the carton along with bulk packages of the supplemental items such as chips, puddings, bread, butter, etc. For non-MAC planes, crew members (such as boom operators) pick up the food supplies and deliver them to the aircraft. In the case of MAC flights, this function is performed by Fleet Service. Fleet Service personnel have the responsibility of bringing the food to the galleys of the aircraft where the food is stored in the appropriate compartments by the loadmasters. Meal service trays are sometimes used. These are removed from the aircraft and brought back to the aircraft by Fleet Service personnel. The warewashing of these trays, however, is the responsibility of the flight kitchen.

<u>Survey of Flight Kitchen Equipment and Facilities</u>

Even though the focus of the project was to design a more efficient onboard subsystem, a concentrated effort was devoted to research and analysis of the existing ground support subsystem, particularly the flight kitchen. Because the time and cost involved with extensive travel to several Air Force bases was prohibitive, a telephone survey (see Figure 4) was conducted to collect data on the physical setup of the day-to-day operation of the typical flight kitchen. For the most part, information was collected from bases that participated in the original customer mail surveys.

The purpose of the survey was to identify physical characteristics of selected flight kitchen, volume of meals served, hours of operation, equipment, area allotted to storage, and other operational factors.

<u>Methodology and Data Analysis</u>. To collect the required data, the Food Service Superintendents at 40 bases were contacted. Project team members provided a brief overview of Natick's mission, described the objectives of the project and the purpose of the survey, and asked whether the individual would like to participate in the survey. If a positive response was received, the survey was then conducted over the telephone.

After the data collection was completed, the surveys were divided into major command groups (MAC, TAC, SAC). A data base was then designed to categorize the information (Table 1) and facilitate analysis. Whenever possible, floor plan blueprints of flight kitchens were sent to Natick to aid in verifying responses received over the phone.

FLIGHT KITCHEN SURVEY

Base: ______________________________ Date: ______________

Telephone Number: ______________________

Food Service Superintendent (Name): ____________________ Rank: ________

Other Personnel Contacted:

Name: ______________________________ Rank: ________

Name: ______________________________ Rank: ________

1. What is the average number of meals prepared and picked up for flight feeding:

per day? __________ maximum? __________ minimum? __________

per week? __________ maximum? __________ minimum? __________

2. What is the approximate amount of time, prior to pickup, that notice is given by a crew for meals? ______________________________

____

____

____

3. How does 'show time'; (the time between actual pickup of meals and aircraft departure), affect flight kitchen food processing? ______________

____

____

____

4. What is the area, (in square feet), of the flight kitchen? ____________

____

5. How many employees work in the flight kitchen?

Full time: Military________ Civilian________

Part time: Military________ Civilian________

6. What are the hours of operation at the flight kitchen? ______________

____

7. How far is the flight kitchen from the flight line?______________

____

8. How far is the flight kitchen from the dining hall?______________

____

9. How far is the dining hall from the flight line?______________

____

10. What kind of utilities are located at the flight kitchen?

Gas:__________ Electric:__________ Voltage:______________

Figure 4. Telephone survey.

11. What kind of food service equipment is located at the flight kitchen?

a. Cooking Equipment? ______________________________

b. Warming Equipment? ______________________________

c. Preparation Equipment (meat slicer, vegetable slicer...)? __________

d. Packaging Equipment? ______________________________

e. Sanitation Equipment/Areas?

- Dry: ______________________________
- Refrigeration, (size)? ______________________________
- Freezer, (size)? ______________________________

12. What types of equipment/containers are used for transporting food and beverage from the flight kitchen to the aircraft? ______________________________

13. What type of equipment is used to serve food on the aircraft? (e.g., trays, utensils.....) ______________________________

14. Concerning Fleet Service:

a. Number of Employees? ______________________________

b. Equipment? ______________________________

15. Would you send us a drawing or a print of the food service equipment layout in your flight kitchen? ______________________________

16. Would you also send us a copy of your menus? ______________

Figure 4. Telephone survey (cont'd).

TABLE 1. Key to Telephone Survey Data Base

KEY TO DATA BASE CATEGORIES FOR FLIGHT KITCHEN SURVEY

COM	Command		
BASE	Base		
ST	State or country		
MAV	Avg meals/day (estimated or classified in some cases)		
MMX	Max meals/day		
MMN	Min meals/day		
NX	Max notice given, hours		
NN	Min notice given, hours		
AREA	Area of Flight Kitchen, square feet		
PE	Number of personnel in flight kitchen		
S	Number of hours/day of operation		
D	Number of days/week in operation		
KL	Distance from flight kitchen to flight line, miles		
KD	Distance from flight kitchen to dining hall, miles		
DL	Distance from dining hall to flight line, miles		
UT	Utilities:	G	Gas
		E	Electric
EQUIPMENT	Equipment	R	Range
		O	Oven
		OC	Oven, convection
		OM	Oven, microwave
		OD	Oven, dutch (Only reported at Robbins AFB)
		F	Fryer
		G	Grill or Griddle
		CH	Charcoal broiler
		K	Steam kettle
		C	Coffee maker
		MS	Meat slicer
		VS	Vegetable slicer
		SE	Sealer for sandwiches
		ICE	Ice maker
DRY	Dry storage space, square feet (estimated in some cases)		
FRIG	Refrigerated storage space, cubic feet (estimated in many cases)		
FREZ	Frozen storage space, cubic feet (estimated in many cases)		
TRANS	Transportation of meals to the aircraft:		
		BX	Box
		BG	Bag
		JS	Jug, square
		JR	Jug, round
		J	Jug (unspecified)
		I	Insulated container (size unspecified)
		1G	One gallon insulated container
		2G	Two gallon insulated container
		5G	Five gallon insulated container
		THERM	Thermos
		COF	Coffee carrier
		IG	Igloo

TABLE 1. Key to Telephone Survey Data Base (cont'd)

SERVE	Serving of meals on the aircraft:		
		FTPKG	Dining Packet (Inflight) NSN 7360-00-660-0526
		TRAY	Tray
		SPOON	Spoon
		BULK	Bulk serve
FT	Number of Fleet Service personnel		
FTEQUIP	Fleet Service equipment:		
		T	Truck
		PU	Pick-up truck
		V	Van
		WT	Water truck
		LAV	Lavatory truck
		FL	Fork lift
		CP	Comfort pallet
		IG	Igloo

The data base was queried in many various ways in order to demonstrate or identify relationships between selected data base parameters. The diverse queries into the data base each resulted in a report. These reports, referred to in the following discussion, are titled with reference to the parameters described.

<u>The Data Base Listing</u>. Table 2 shows the entire set of responses obtained from the individuals at each flight kitchen who participated in the survey. A zero ("0") indicates one of several things: the individual did not know the answer to the question; elected not to answer the question; stated the answer to the question was not available; or felt the question was not applicable to the particular flight kitchen operation in question.

Of note in these first two reports are the types of food service equipment found in the flight kitchens as reported by the survey participants (Table 3). The predominant equipment items listed are meat slicer and deep fat fryer. This finding is consistent with the type of menu found at most flight kitchens, which often serve cold box lunches consisting of deli sandwiches and fried chicken. Other types of cooking equipment are found much less often.

<u>Labor Distribution</u>. Table 4 shows the distribution of staff levels in the flight kitchens surveyed, which peaks at approximately five people. Most bases employ four to seven individuals. Hours of operation vary. Some bases operate the flight kitchen 24 hours per day, 7 days per week. Others are open only 5 days, while some are on standby on weekends.

<u>Meal Distribution</u>. Table 5 attempts to show if a similar distribution exists for the average number of meals per day. The distribution is skewed and less obvious, but appears to peak between 25 and 35 meals per day.

<u>Square Footage</u>. Table 6 attempts to show if a similar distribution exists for the area (square feet) in the flight kitchen. From an examination of the report, it appears as if such a distribution does not exist. Perhaps this indicates that the flight kitchens are actually located in whatever space is available, and little consideration is given to how much space is required for the numbers of meals served.

TABLE 2. Data Base Listing

COM	BASE	ST	MAV	MMX	MMN	NX	NN	AREA	PE	OP	S	D	KL	DK	DL	UT	EQUIPMENT
MAC	Altus	OK	45	0	0	24	1	950	5	24	4	7	0.00	0.20	0.25	GE	R O F MS
	Andrews	DC	45	0	0	2	0	950	7	24	3	7	0.05	0.50	0.50	E	O F MS
	Charleston	SC	0	0	0	2	1	850	8	24	3	7	0.00	0.05	0.10	E	O F C MS SE
	Clark	PH	80	100	75	2	1	9999	7	24	4	7	0.00	2.00	2.00	E	O F G C MS
	Dover	DE	465	0	0	2	1	700	6	24	3	7	0.00	0.25	0.25	E	OC F C ICE
	Elmendorf	AK	0	0	0	2	0	2050	7	24	2	7	0.25	2.50	2.00	E	R F MS
	Kirtland	NM	10	25	0	2	0	100	4	24	3	7	0.75	0.00	0.75	E	OC F MS ICE
	Little Rock	AR	35	0	0	2	1	400	7	24	3	7	0.00	2.00	2.00	E	OC F C MS
	McChord	WA	70	80	60	2	0	2400	9	24	3	7	0.00	1.00	1.00	E	OC F C MS
	McGuire	NJ	75	0	0	2	0	100	6	24	3	7	0.00	1.50	1.50	E	O MS
	Norton	CA	30	0	0	2	0	2000	6	24	2	7	0.05	0.25	0.25	E	R O MS SE
	Pope	NC	130	150	100	2	0	1000	7	24	2	7	0.00	0.00	0.00	E	O OM F MS VS
	Rhein Main	GE	450	0	0	1	0	0	9	24	3	7	2.00	0.00	2.00	E	R F G C MS
	Scott	IL	30	40	2	1	0	2200	10	24	2	7	0.00	0.25	0.25	E	R O F C MS
	Travis	CA	50	0	0	1	0	500	10	24	3	7	1.00	0.25	1.50	GE	R O C MS
SAC	Anderson	GM	15	30	3	12	3	900	6	24	2	7	0.25	0.25	0.25	GE	OC F C MS
	Barksdale	LA	65	120	15	24	2	200	5	24	0	7	0.00	0.00	0.00	GE	R O F MS
	Blake	CA	15	44	4	20	2	100	5	24	2	7	0.00	0.50	0.50	E	R OM MS
	Blythville	AR	75	80	60	24	2	100	3	24	3	5	0.25	0.00	0.25	E	C
	Carswell	TX	30	60	2	24	2	100	4	24	3	5	0.00	0.20	0.15	G	R O F MS
	Castle	CA	75	90	60	18	2	200	5	24	3	5	0.00	1.00	1.00	G	O F MS
	Dyess	TX	0	0	0	72	2	1000	5	24	2	5	0.00	0.50	0.50	G	O OM F MS
	Ellsworth	SD	30	0	0	0	2	900	5	24	2	7	0.00	1.00	1.00	E	O F G C MS
	Eielson	AK	25	35	10	1	0	2000	5	24	4	7	0.00	0.50	0.10	E	R O OM F C MS
	Fairchild	WA	50	55	10	24	2	550	5	24	2	7	0.00	0.25	0.25	E	F G C MS
	Grand Forks	ND	15	0	0	24	3	900	4	24	0	7	1.00	0.50	1.50	E	O OM CH C MS SE
	Griffiss	NY	30	40	20	24	8	720	5	24	3	7	0.50	1.00	1.00	E	R O OM F G C MS
	Grissom	IN	25	50	0	24	2	350	4	18	2	7	0.00	0.20	0.25	E	R O OM F C MS
	K.I. Sawyer	MI	25	80	9	10	0	300	6	24	3	6	0.00	1.00	1.00	E	R O OM F C MS
	Loring	ME	20	30	10	12	2	800	4	24	2	5	0.00	0.50	0.50	E	R O F C MS ICE
	March	CA	80	200	15	48	2	3200	5	24	3	7	0.00	1.00	1.00	GE	O C MS
	Mather	CA	100	0	0	24	0	2400	5	18	0	0	0.00	0.20	0.25	GE	R O F MS
	McConnell	KS		0	0	0	0	0	0	0	0	0	0.00	0.00	0.00		
	Minot	ND	20	0	0	24	0	0	5	24	2	7	0.25	0.20	0.25	E	R F K C MS
	Offutt	NE	35	50	15	24	12	450	15	24	2	7	0.05	0.05	0.15	GE	R F C MS
	Pease	NH	15	20	5	24	0	500	5	24	2	7	0.50	0.25	0.75	E	OC F MS
	Plattsburg	NY	75	136	50	0	2	300	5	24	2	7	0.00	0.25	0.25	E	R MS
	Robins	GA	90	150	25	0	2	400	4	24	3	7	5.00	0.00	5.00	E	R OC OD F MS VS
	Wurtsmith	MI	25	30	20	24	0	2300	5	24	3	7	0.00	0.25	0.25	E	R F C MS SE
TAC	Maxwell	AL	35	0	0	1	0	1050	4	10	0	7	0.00	1.00	1.00	GE	R F C MS

TABLE 2. Data Base Listing (Cont'd)

COM	BASE	ST	DRY	FRIG	FREX	FT	FTEQUIP	TRANS	SERVE	
MAC	Altus	OK	100	150	50	0		BX JS JR THERM	FTPKG	
	Andrews	DC	250	1100	1550	5	V WT FL CP	IG	FTPKG	
	Charleston	SC	100	150	600	40	T WT FL CP	BX BG COF IG	FTPKG	
	Clark	PH	100	850	475	15	V WT LAV FL	BX BG	FTPKG	
	Dover	DE	1225	750	725	40	T V LAV FL CP	J 5G IG	FTPKG	TRAY
	Elmendorf	AK	250	800	25	15	PU V WT IG	BX BG JS	FTPKG	
	Kirtland	NM	50	100	0	0		BX JS	FTPKG	
	Little Rock	AR	25	600	25	0		BX BG J	FTPKG	TRAY
	McChord	WA	400	150	1200	15	V WT FL CP	BG J IG	FTPKG	BULK
	McGuire	NJ	100	300	275	30	T WT LAV FL CP		FTPKG	TRAY
	Norton	CA	900	1900	450	25	PU LAV FL CP	BG JS 2G 5G IG	FTPKG	
	Pope	NC	0	150	0	0	PU V FL CP	BX J IG	FTPKG	
	Rhein Main	GE	300	200	100	0		BX BG JS 5G IG	FTPKG	TRAY
	Scott	IL	100	250	50	5	PU V FL CP	JS 2G	FTPKG	TRAY
	Travis	CA	500	300	375	40	T V WT FL CP	BX BG JS IG	FTPKG	
SAC	Anderson	GM	150	200	150	5	PU V	BX BG	FTPKG	
	Barksdale	LA	50	450	75	0		I		
	Blake	CA	25	100	175	0		BX		
	Blythville	AR	25	300	0	0				
	Carswell	TX	50	250	50	0		J	FTPKG	
	Castle	CA	50	100	25	0		JS	FTPKG	
	Dyess	TX	50	200	50	0		JS JR	FTPKG	
	Ellsworth	SD	900	1900	375	0		JS JR	FTPKG	
	Eielson	AK	100	200	50	0		BG JS JR	FTPKG	
	Fairchild	WA	75	150	300	0		BX BG JS JR	FTPKG	
	Grand Forks	ND	100	300	600	0		JS JR	FTPKG	
	Griffiss	NY	32	100	25	0		BX BG JS JR	FTPKG	
	Grissom	IN	25	100	25	0		JS	FTPKG	
	K.I. Sawyer	MI	200	100	25	0		JS JR I	FTPKG	
	Loring	ME	25	200	50	0		I		
	March	CA	100	750	25	0		BX BG JS	FTPKG	
	Mather	CA	150	600	25	0		JS JR I	FTPKG	SPOON
	McConnell	KS	0	0	0	0				
	Minot	ND	75	300	100	0		BX BG JS JR	FTPKG	OVEN
	Offutt	NE	150	350	50	0		BX JS	FTPKG	
	Pease	NH	25	100	200	0		BG JS JR	FTPKG	
	Plattsburg	NY	300	200	50	0		BX JS JR	FTPKG	
	Robins	GA	850	100	800	0		BX JS JR	FTPKG	
	Wurtsmith	MI	75	150	50	0		BX JS JR	FTPKG	
TAC	Maxwell	AL	125	200	25	0				

TABLE 3. Food Equipment Distribution

Equipment Item	Number of Bases Responding
Meat Slicer	37
Deep Fat Fryer	30
Coffee Maker	25
Range	21
Oven	21
Convection Oven	7
Microwave Oven	8
Steam Kettle	1
Ice Maker	3
Vegetable Slicer	2
Charcoal Broiler	1

TABLE 4. Labor Distribution

Number of Flight Kitchen Personnel	Number of Bases Responding
0	1
3	1
4	6
5	15
6	5
7	6
8	1
9	2
0	2
5	1
	40

TABLE 5. Meal Distribution

Average Number of Meals/Day	Number of Bases Responding
0	3
10	1
15	4
20	2
25	4
30	5
35	3
45	2
50	2
65	1
70	1
75	4
80	2
90	1
100	2
130	1
450	1
465	1
	40

TABLE 6. Square Footage

Area of Flight Kitchen (Ft^2)	Number of Bases Responding
0	3
100	5
200	2
300	2
350	1
400	2
450	1
500	2
550	1
700	1
720	1
800	1
850	1
900	3
950	2
1000	2
1050	1
2000	2
2050	1
2200	1
2300	1
2400	2
3200	1
9999	1
	40

Flight Line Proximity. Table 7 shows the distribution of the distances that the flight kitchens are away from the flight line, and illustrates that approximately three-fourths of the kitchens are either on the flight line or are within one-twentieth (0.05) of a mile. In other words, most are very close.

Dining Hall Proximity. Table 8 shows the distribution of the distances that the flight kitchens are away from the main dining hall, and illustrates that one-fifth are adjacent to the dining hall. Most of the others are located approximately one-fourth to one-half mile away.

TABLE 7. Flight Line Proximity

Flight Kitchen: Flight Line Distance in Miles	Number of Bases Responding
0.00	26
0.05	3
0.25	4
0.50	2
0.75	1
1.00	2
2.00	1
5.00	1
	40

TABLE 8. Dining Hall Proximity

Flight Kitchen: Dining Hall Distance in Miles	Number of Bases Responding
0.00	7
0.05	2
0.20	5
0.25	9
0.50	6
1.00	7
1.50	1
2.00	2
2.50	1
	40

Dry Storage. Table 9 attempts to show a distribution of dry storage space (square feet) for each flight kitchen. The distribution is not extremely obvious, but appears to be skewed and to peak between 25 to 100 square feet. Perhaps this indicates that the dry storage space allotted is whatever space that is available, and little consideration is given to how much space is required.

TABLE 9. Dry Storage

Dry Storage Space Ft^2	Number of Bases Responding
0	2
25	6
32	1
50	5
75	3
100	8
125	1
150	3
200	1
250	2
300	2
400	1
500	1
850	1
900	2
1225	1
	40

Refrigerated Storage. Table 10 shows the distribution of refrigeration space (cubic feet) for each flight kitchen. The distribution is skewed and not too obvious, but appears to peak at approximately 150 cubic feet, with a tail up to much larger spaces.

Frozen Storage. Table 11 shows the distribution of freezer space (cubic feet) for each flight kitchen. The distribution is skewed, but appears to peak between 25 to 50 cubic feet, with a tail up to much larger spaces. Perhaps this indicates that some flight kitchens are allocated unusually large freezer capacity when the space is available.

TABLE 10. Refrigerated Storage

Refrigerated Space Ft^3	Number of Bases Responding
0	1
100	8
150	6
200	7
250	2
300	5
350	1
450	1
600	2
750	2
800	1
850	1
1100	1
1900	2
	40

TABLE 11. Frozen Storage

Frozen Storage Ft^3	Number of Bases Responding
0	4
25	9
50	9
75	1
100	2
150	1
175	1
200	1
275	1
300	1
375	2
450	1
475	1
600	2
725	1
800	1
1200	1
1550	1
	40

Meals Served: Square Footage. Table 12 attempts to show a relationship between the average number of meals per day for each flight kitchen and the area of that flight kitchen. There does not appear to be any correlation. Perhaps, as suggested previously, the area of most flight kitchens is determined by available space and not by workload.

TABLE 12. Meals Served: Square Footage

Avg. No Meals/Day	Area of Flight Kitchen Ft^2	Number of Bases Responding	Avg. No Meals/Day	Area of Flight Kitchen Ft^2	Number of Bases Responding
0	850	1	0	20	1
	1000	1		100	1
	2050	1		450	1
10	100	1	100	10	1
15	100	1		15	1
	500	1		30	1
	900	2		75	2
20	0	1	200	65	1
	800	1		75	1
25	300	1	300	25	1
	350	1		75	1
	2000	1	350	25	1
	2300	1	400	35	1
30	100	1		90	1
	720	1	450	35	1
	900	1	500	15	1
	2000	1		50	1
	2200	1	550	50	1
35	400	1	700	465	1
	450	1	720	30	1
	1050	1	800	20	1
45	950	2	850	0	1
50	500	1	900	15	2
	550	1		30	1
65	200	1	950	45	2
70	2400	1	1000	0	1
75	100	2		130	1
	200	1	1050	35	1
	300	1	2000	25	1
80	3200	1		30	1
	9999	1	2050	0	1
90	400	1	2200	30	1
100	0	1	2300	25	1
	2400	1	2400	70	1
130	1000	1		100	1
450	0	1	3200	80	1
465	700	1	9999	80	1
		40			40

Meals Served: Labor Distribution. Table 13 attempts to show a correlation between the average number of meals per day for each flight kitchen and the number of personnel in that flight kitchen. There does not appear to be any obvious correlation. Perhaps the workload is not considered when the personnel are assigned. This would appear to be supported by the observation that most kitchens have five people.

Meals Served: Dry Storage. Table 14 shows no obvious correlation between the distribution of dry storage space for each flight kitchen and the average number of meals per day of that flight kitchen. Perhaps, as stated previously, the dry storge space is not allocated according to the workload.

Meals Served: Refrigerated Storage. Table 15 attempts to show a correlation between the distribution of refrigeration space for each flight kitchen and the average number of meals per day served by that flight kitchen. There does not appear to be any obvious correlation.

Meals Served: Frozen Storage. Table 16 attempts to show a correlation between the distribution of freezer space for each flight kitchen and the average number of meals per day of that flight kitchen. There does not appear to be any obvious correlation.

Meals Served: Frozen Storage -- Dining Hall Proximity. Table 17 attempts to show a correlation between the distribution of freezer space of each flight kitchen, the average number of meals of each flight kitchen, and that flight kitchen's distance to the dining hall. This survey was attempting to investigate the theory that if a flight kitchen was located near a dining hall, the flight kitchen might use the dining hall freezers, and have smaller freezers in the flight kitchen itself. The reports do not appear to support this theory.

Meals Served: Flight Line Proximity. Table 18 attempts to show a correlation between the average number of meals from a flight kitchen and that flight kitchen's distance to the flight line. This survey was attempting to investigate a theory that flight kitchens with a larger workload would be located nearer to the flight line. The reports do not appear to support this theory. Perhaps the flight kitchen is not located according to the workload, but rather according to whatever space is available on base.

Meals Served: Dining Hall Proximity. Table 19 attempts to show a correlation between the average number of meals served from a flight kitchen and that flight kitchen's distance from the dining hall. This survey was attempting to investigate a theory that the flight kitchens with a larger workload would be located nearer dining halls, where additional resources would be available. There exists some support for this theory.

Meals Served: Flight Kitchen Location. Table 20 attempts to show a correlation between the average number of meals served from a flight kitchen and either or both of the following: that flight kitchen's distance to the flight line; and that flight kitchen's distance to the dining hall. This survey was attempting to investigate a theory that the flight kitchens with a larger workload would be located nearer the flight line (where transportation would be easier) and nearer the dining halls (where additional resources would be available). Some support for this theory is suggested. Also, reports in this series show that one flight kitchen with a big workload (450 meals average) and which is far (2 miles) from the flight line does turn out to be adjacent to the dining hall.

TABLE 13. Meals Served: Labor Distribution

Avg. No. Meals/Day	Personnel	Number of Bases Responding	Avg. No. Meals/Day	Personnel	Number of Bases Responding
0	5	1	100	0	1
	7	1	75	3	1
	8	1	10	4	1
10	4	1	20		1
15	5	2	25		1
	6	1	30		1
	7	1	35		1
20	4	1	90		1
	5	1	0	5	1
25	4	1	15		2
	5	2	20		1
	6	1	25		2
30	4	1	30		2
	5	2	45		1
	6	1	50		1
	10	1	65		1
35	4	1	75		2
	7	1	80		1
	15	1	100		1
45	5	1	15	6	1
	7	1	25		1
50	5	1	30		1
	10	1	75		1
65	5	1	465		1
70	9	1	0	7	1
75	3	1	15		1
	5	2	35		1
	6	1	45		1
80	5	1	80		1
	7	1	130		1
90	4	1	0	8	1
100	0	1	70	9	1
	5	1	450		1
130	7	1	30	10	1
450	9	1	50		1
465	6	1	35	15	1
		40			40

TABLE 14. Meals Served: Dry Storage

Avg. No Meals/Day	Dry Storage Ft^2	Number of Bases Responding	Avg. No Meals/Day	Dry Storage Ft^2	Number of Bases Responding
0	50	1	100	0	1
	100	1	130		1
	250	1	15	25	2
10	50	1	20		1
15	25	2	25		1
	100	1	35		1
	150	1	75		1
20	25	1	30	32	1
	75	1	0	50	1
25	25	1	10		1
	75	1	30		1
	100	1	65		1
	200	1	75		1
30	32	1	20	75	1
	50	1	25		1
	100	1	50		1
	900	2	0	100	1
35	25	1	15		1
	125	1	25		1
	150	1	30		1
45	100	1	45		1
	250	1	75		1
50	75	1	80		2
	500	1	35	125	1
65	50	1	15	150	1
70	400	1	35		1
75	25	1	100		1
	50	1	25	200	1
	100	1	0	250	1
	300	1	45		1
80	100	2	75	300	1
90	850	1	450		1
100	0	1	70	400	1
	150	1	50	500	1
130	0	1	90	850	1
450	300	1	30	900	2
465	1225	1	465	1225	1
		40			40

TABLE 15: Meals Served: Refrigerated Storage

Avg. No. Meals/Day	Refrig Ft^3	Number of Bases Responding	Avg. No. Meals/Day	Refrig Ft^3	Number of Bases Responding
0	150	1	100	0	1
	200	1	10	100	1
	800	1	15		2
10	100	1	25		2
15	100	2	30		1
	200	1	75		1
	300	1	90		1
20	200	1	0	150	1
	300	1	25		1
25	100	2	45		1
	150	1	50		1
	200	1	70		1
30	100	1	130		1
	250	2	0	200	1
	1900	2	15		1
35	200	1	20		1
	350	1	25		1
	600	1	35		1
45	150	1	75		1
	1100	1	450		1
50	150	1	30	250	2
	300	1	15	300	1
65	450	1	20		1
70	150	1	50		1
75	100	1	75		2
	200	1	35	350	1
	300	2	65	450	1
80	750	1	35	600	1
	850	1	100		1
90	100	1	80	750	1
100	0	1	465		1
	600	1	0	800	1
130	150	1	80	850	1
450	200	1	45	1100	1
465	750	1	30	1900	2
		40			40

TABLE 16. Meals Served: Frozen Storage

Avg. No. Meals/Day	Frozen Storage Ft^3	Number of Bases Responding
0	25	1
	50	1
	600	1
10	0	1
15	150	1
	175	1
	200	1
	600	1
20	50	1
	100	1
25	25	2
	50	2
30	25	1
	50	2
	375	1
	450	1
35	25	2
	50	1
45	50	1
	1550	1
50	300	1
	375	1
65	75	1
70	1200	1
75	0	1
	25	1
	50	1
	275	1
80	25	1
	475	1
90	800	1
100	0	1
	25	1
130	0	1
450	100	1
465	725	1
		40

TABLE 17. Meals Served: Frozen Storage/Dining Hall Proximity

Avg No Meals/Day	Frozen Storage Ft^3	Distance Flt Kitchen/ Dining Hall	Number of Bases Responding	Frozen Storage Ft^3	Distance Flt Kitchen/ Dining Hall	Number of Bases Responding	Frozen Storage Ft^3	Distance Flt Kitchen/ Dining Hall	Number of Bases Responding
0	25	2.50	1	0	0.00	4	0	0.00	4
	50	0.50	1	75		1	25	0.20	2
	600	0.05	1	100		1		1.00	5
10	0	0.00	1	800		1		2.00	1
15	150	0.25	1	50	0.05	1		2.50	1
	175	0.50	1	600		1	50	0.05	1
	200	0.25	1	25	0.20	2		0.20	2
	600	0.50	1	50		2		0.25	3
20	50	0.50	1	100		1		0.50	3
	100	0.20	1	50	0.25	3	75	0.00	1
25	25	0.20	1	150		1	100	0.00	1
		1.00	1	200		1		0.20	1
	50	0.25	1	300		1	150	0.25	1
		0.50	1	375		1	175	0.50	1
30	25	1.00	1	450		1	200	0.25	1
	50	0.20	1	725		1	275	1.50	1
		0.25	1	50	0.50	3	300	0.25	1
	375	1.00	1	175		1	375	0.25	1
	450	0.25	1	600		1		1.00	1
35	25	1.00	1	1550		1	450	0.25	1
		2.00	1	25	1.00	5	475	2.00	1
	50	0.05	1	375		1	600	0.05	1
45	50	0.20	1	1200		1		0.50	1
	1550	0.50	1	275	1.50	1	725	0.25	1
50	300	0.25	1	25	2.00	1	800	0.00	1
	375	0.25	1	475		1	1200	1.00	1
65	75	0.00	1	25	2.50	1	1550	0.50	1
70	1200	1.00	1						
75	0	0.00	1			40			40
	25	1.00	1						
	50	0.25	1						
	275	1.50	1						
80	25	1.00	1						
	475	2.00	1						
90	800	0.00	1						
100	0	0.00	1						
	25	0.20	1						
130	0	0.00	1						
450	100	0.00	1						
465	725	0.25	1						
			40						

TABLE 18. Meals Served: Flight Line Proximity

Avg No. Meals/Day	Distance Flight Line/ Flight Kitchen	Number of Bases Responding	Avg No. Meals/Day	Distance Flight Line/ Flight Kitchen	Number of Bases Responding
0	0.00	2	0	0.00	2
	0.25	1	15		1
10	0.75	1	20		1
15	0.00	1	25		4
	0.25	1	30		3
	0.50	1	35		2
	1.00	1	45		1
20	0.00	1	50		1
	0.25	1	65		1
25	0.00	4	70		1
30	0.00	3	75		3
	0.05	1	80		2
	0.50	1	100		2
35	0.00	2	130		1
	0.05	1	465		1
45	0.00	1	30	0.05	1
	0.05	1	35		1
50	0.00	1	45		1
	1.00	1	0	0.25	1
65	0.00	1	15		1
70	0.00	1	20		1
75	0.00	3	75		1
	0.25	1	15	0.50	1
80	0.00	2	30		1
90	5.00	1	10	0.75	1
100	0.00	2	15	1.00	1
130	0.00	1	50		1
450	2.00	1	450	2.00	1
465	0.00	1	90	5.00	1
		40			40

TABLE 19. Meals Served: Dining Hall Proximity

Avg No. Meals/Day	Distance Flight Kitchen/ Dining Hall	Number of Bases Responding	Avg No. Meals/Day	Distance Flight Kitchen/ Dining Hall	Number of Bases Responding
0	0.05	1	10	0.00	1
	0.50	1	65		1
	2.50	1	75		1
10	0.00	1	90		1
15	0.25	2	100		1
	0.50	2	130		1
20	0.20	1	450		1
	0.50	1	0	0.05	1
25	0.20	1	35		1
	0.25	1	20	0.20	1
	0.50	1	25		1
	1.00	1	30		1
30	0.20	1	45		1
	0.25	2	100		1
	1.00	2	15	0.25	2
35	0.05	1	25		1
	1.00	1	30		2
	2.00	1	50		2
45	0.20	1	75		1
	0.50	1	465		1
50	0.25	2	0	0.50	1
65	0.00	1	15		2
70	1.00	1	20		1
75	0.00	1	25		1
	0.25	1	45		1
	1.00	1	25	1.00	1
	1.50	1	30		2
80	1.00	1	35		1
	2.00	1	70		1
90	0.00	1	75		1
100	0.00	1	80		1
	0.20	1	75	1.50	1
130	0.00	1	35	2.00	1
450	0.00	1	80		1
465	0.25	1	0	2.50	1
		40			40

TABLE 20. Meals Served: Flight Kitchen Location

Ave No. Meals/Day	Distance Flight Kitchen/ Flight Line	Distance Flight Kitchen/ Dining Hall	Number of Bases Responding	Ave No. Meals/Day	Distance Flight Kitchen/ Flight Line	Distance Flight Kitchen/ Dining Hall	Number of Bases Responding
0	0.00	0.05	1	65	0.00	0.00	1
		0.50	1	100			1
	0.25	2.50	1	130			1
10	0.75	0.00	1	0		0.05	1
15	0.00	0.50	1	25		0.20	1
	0.25	0.25	1	30			1
	0.50	0.25	1	45			1
	1.00	0.50	1	100			1
20	0.00	0.50	1	25		0.25	1
	0.25	0.20	1	30			1
25	0.00	0.20	1	50			1
		0.25	1	75			1
		0.50	1	465			1
		1.00	1	0		0.50	1
30	0.00	0.20	1	15			1
		0.25	1	20			1
		1.00	1	25			1
	0.05	0.25	1	25		1.00	1
	0.50	1.00	1	30			1
35	0.00	1.00	1	35			1
		2.00	1	70			1
	0.05	0.05	1	75			1
45	0.00	0.20	1	80			1
	0.05	0.50	1	75		1.50	1
50	0.00	0.25	1	35		2.00	1
	1.00	0.25	1	80			1
65	0.00	0.00	1	35	0.05	0.05	1
70	0.00	1.00	1	30		0.25	1
75	0.00	0.25	1	45		0.50	1
		1.00	1	75	0.25	0.00	1
		1.50	1	20		[illegible]	1
	0.25	0.00	1	15		0.25	1
80	0.00	1.00	1	0		2.50	1
		2.00	1	15	0.50	0.25	1
90	5.00	0.00	1	30		1.00	1
100	0.00	0.00	1	10	0.75	0.00	1
		0.20	1	50	1.00	0.25	1
130	0.00	0.00	1	15		0.50	1
450	2.00	0.00	1	450	2.00	0.00	1
465	0.00	0.25	1	90	5.00	0.00	1
			40				40

In summary, some flight kitchen factors, such as staffing levels and flight kitchen proximity to the flight line, appear to have been established according to logic, tradition, or need. However, other important factors, most notably space allocation, appear to have been established according to what was available or convenient at the specific base at the specific time. The regulation establishing flight kitchen size and equipment appears to be observed as the exception and not as the rule. This deviation from levels recommended severely limits the services many flight kitchens can provide to flight crews, and suggests that resource allocation for flight feeding holds a very low priority at many Air Force bases.

Management Subsystem

A detailed description of the management subsystem can be found in Air Force Regulation 146-15. One aspect of the management subsystem addressed in this regulation is the area of customer acceptance. Air Force Form 468, Flight Meal Questionnaire, is used to evaluate the acceptability of the meals prepared by the flight kitchen. These questionnaires are used at the rate of 1 per meal to 1 out of every 10 meals, depending upon the flight kitchen visited. Completed cards are returned to the food service officer at the installation who reviews them. Some of the installations visited indicated the customer evaluations were not taken seriously enough to modify its menu on the basis of the complaints or suggestions received. Conversely, one food service officer required the flight kitchen supervisor to hold periodic menu meetings with the crews, based on the comments contained on the survey cards.

As opposed to civilian flight kitchens, where a minimum percentage of the total labor force time is expended on record keeping tasks, it appeared from visitations to the United States Air Force flight kitchens that a considerable percentage of personnel time was required for the proper fulfillment of these tasks.

The most striking difference between the Air Force's management subsystem and that of civilian carriers is the lack of centralized responsibility for inflight food service in the Air Force. Civilian carriers centralize authority over food service in the person of a Director of Food Service (or similar designation) whose responsibilities include menu planning, meal costs, food safety, food preparation, galley equipment and handling methods, food serving and presentation, and transporting needs to the aircraft. This ensures that all efforts relating to passenger and crew feeding are coordinated for optimal results.

In the Air Force, on the other hand, food service officers do not have the responsibility or authority -- in the pursuit of their food service management responsibilities -- to supervise the transport of food to the aircraft, the meal assembly (if any) on board the aircraft, or to observe the quality of food inflight at the time of meal consumption. Most inflight food service personnel have little knowledge of the equipment configuration on board, or the condition of the equipment. This lack of responsibility for food service once meals are taken from the flight kitchen is a serious shortcoming of the system.

However, it is not suggested food service officers staff missions with flight attendants, but the involvement of flight kitchen personnel should be far more encompassing, at least to the extent of periodically observing food transportation to, and initial handling of meals on board the aircraft. Involvement in the near-term would not only motivate flight kitchen personnel to improve the current system but also to spark new ideas which would continually lead to better service for the customer. In the long-term, the expertise of food service could be brought in to help engineers design galleys which would allow for an improved climate of inflight feeding.

The Air Force might consider broadening the authority of food service officers in order to improve the overall management of the inflight feeding system.

Onboard Subsystem

There are major differences in the on board feeding subsystems in use in the United States Air Force at the present time. The present study was concerned primarily with the B-52, KC-10, KC-135, C-5A, C-130 and C-141 aircraft of the active Air Force fleet. However, with an eye toward the future, the B-1 and C-17 aircraft have also been researched.

A summary of the information collected relative to the active on board subsystems is presented in Table 21, and a more detailed analysis in the Primary Aircraft Profile, Appendix A. However, the following additional comments should be made.

B-52G

The B-52 bomber presents probably the most challenging inflight crew feeding problem of the aircraft types studied. This aircraft carries from 6 to 12 crew members on missions which can be quite extended in duration.

This aircraft has the most stringent space limitations encountered. However, space was identified on the plane that could accommodate some type of a food service unit. At present, crew feeding on board the B-52 is normally limited to box lunches or snack meals which have to be consumed within the first 5 hours of the mission, with shelf stable rations, such as MRE's being used beyond that. Hot cups are available aboard the aircraft for heating water for coffee, tea, or soup. Some aircraft have a small conduction oven, in which one meal can be reheated at a time (Figure 5).

KC-10

The KC-10 carries a minimum crew of 5, but can accommodate up to 20 additional crew and support personnel in track mounted seats forward of fuselage station 560. Installation of an increased accommodation kit provides seating for an additional 55 support personnel. Food service on board the KC-10 is provided by means of a G-1 galley unit (Figures 6 and 7) which consists of 2 convection ovens (6 meal capacity each), a coffee maker, a beverage container, a refrigerator, and a refrigerator-freezer. The boom operator is responsible for the food service, but generally crew members or passengers will reheat their own meals using the available convection ovens.

TABLE 21. Summary of Existing Onboard Feeding Subsystems

AIRCRAFT	CREW SIZE RANGE	MAX. PAX	NO. GALLEYS (PERMANENT)	OVEN(S)	REFRIGERATION	CAPABILITIES CREW	CAPABILITIES PAX
B-52	6-12	0	0	0	0	Box Lunch Snack	NA
KC-10	5-25	75	1	2 convection for crew & pax	1 Refrig/Freez for crew	Box Lunch Snack Frozen Meal	Box Lunch Snack Frozen Meal
KC-135	5-10	72	1	1 conduction for crew	0	Box Lunch Snack	Box Lunch Snack
C-5A	8-22	73	2	1 convection-crew 2 convection-pax	1 Refrig 1 Freez for crew 2 Refrig Pax	Frozen Meal Box Lunch Snack	Frozen Meal Box Lunch Snack
C-130	5-8	92	1	1 convection for crew	0 (Insulated compartment for crew)	Box Lunch Snack Frozen Meal	Box Lunch Snack
C-141	5-8	60	1	1 convection for crew	0 (Insulated compartment for crew	Frozen Meal Box Lunch Snack	Frozen Meal (w/Comfort Pallet) Box Lunch

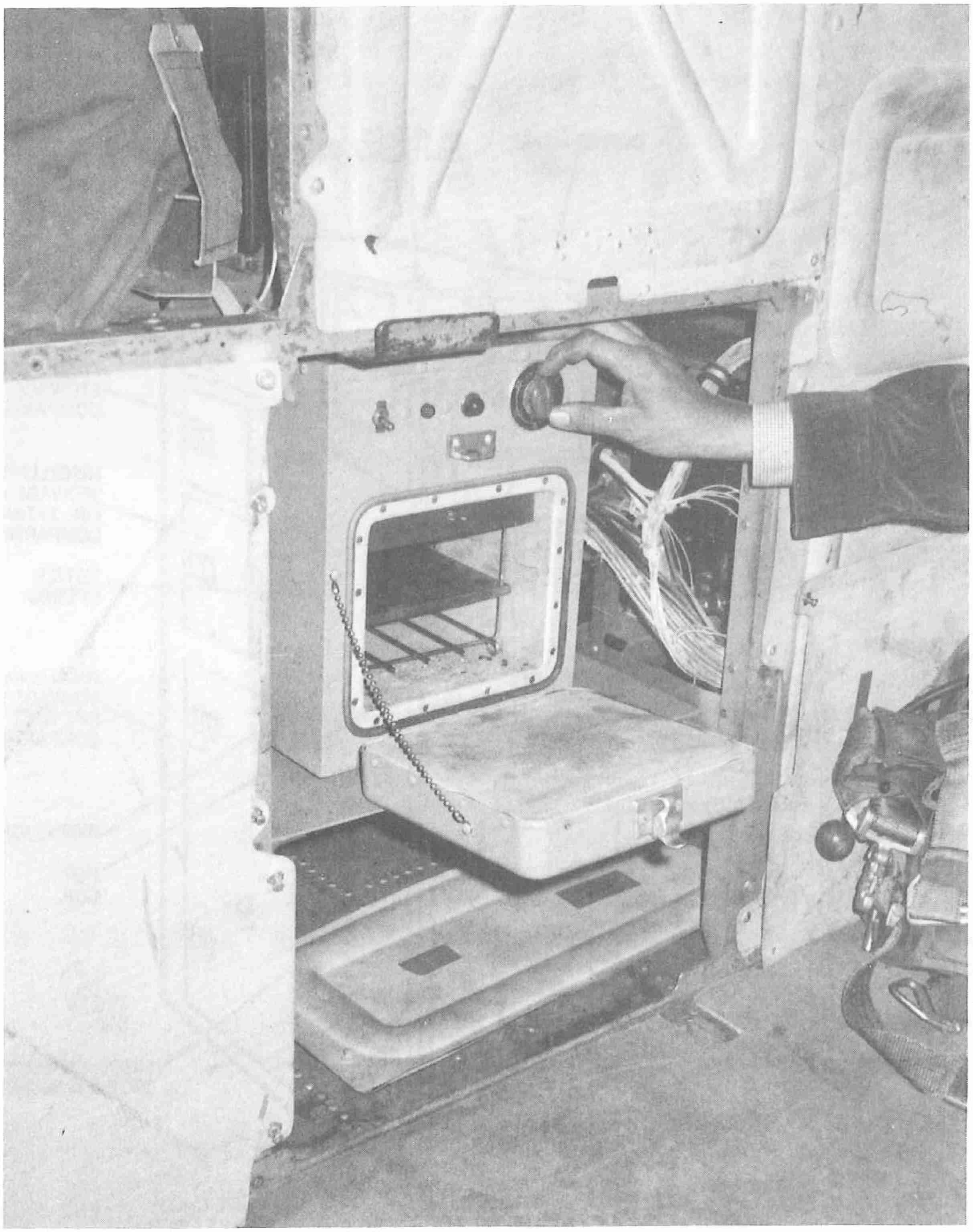

Figure 5. B-52 conduction oven.

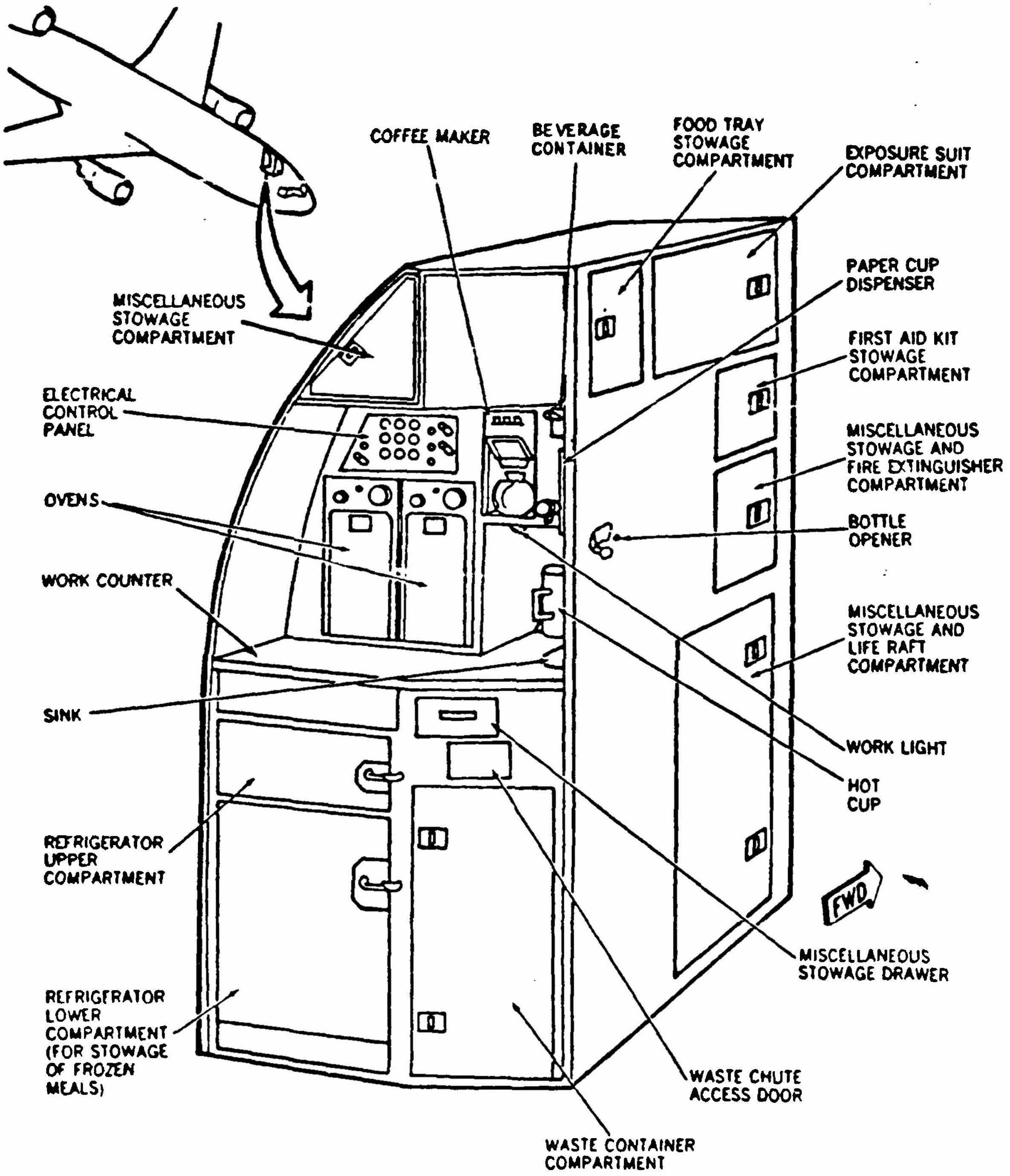

Figure 6. Galley drawing KC-10.

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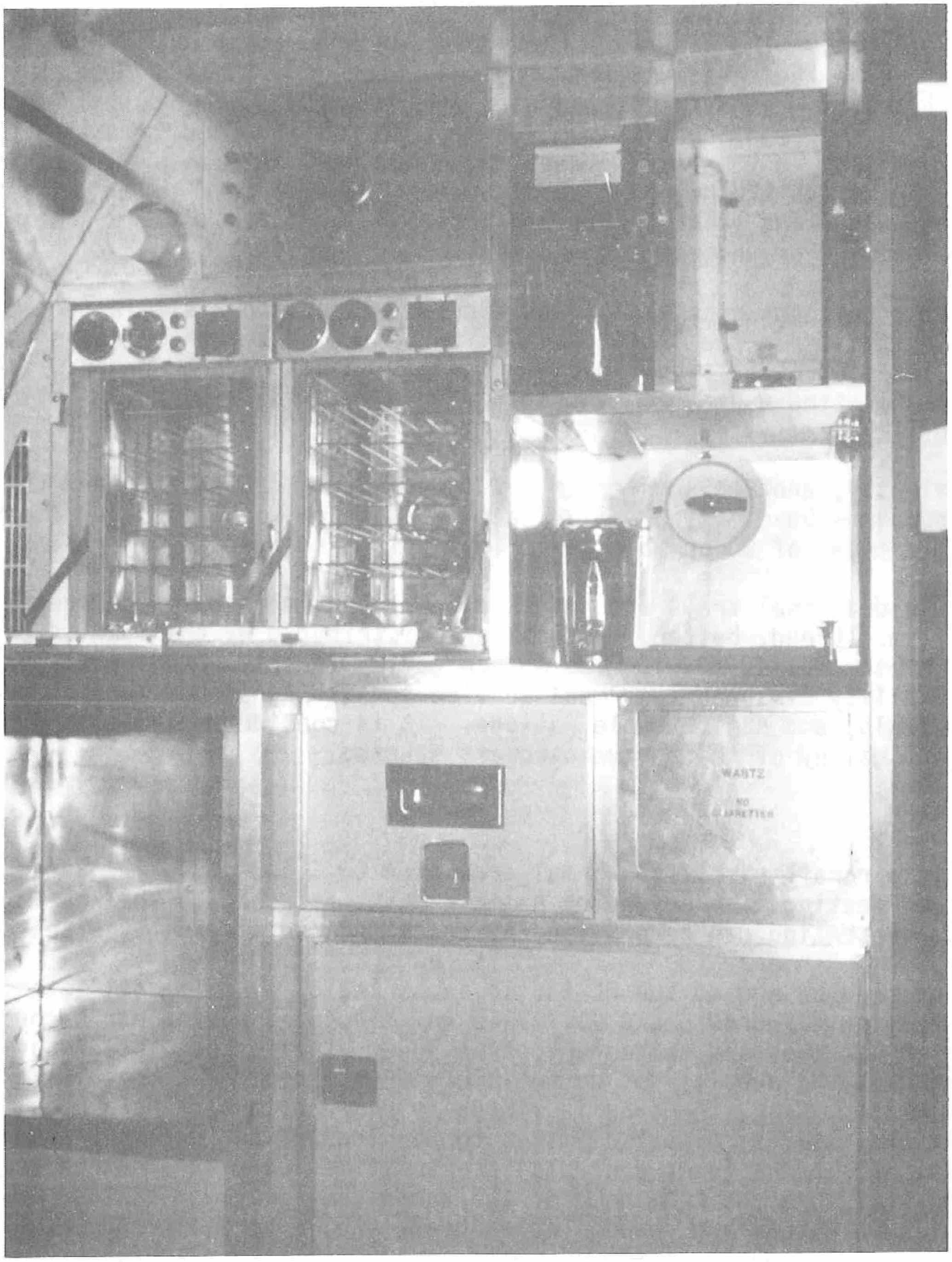

Figure 7. KC-10 galley.

A major flaw of the present food service system on board the KC-10 is the relatively inflexible meal heating process offered through use of convection ovens to reheat the frozen meals. Through discussions with active duty personnel it was discovered that frequently a crew member will begin heating a meal and subsequently find that they are called upon to carry out flight tasks which interfere with the consumption of the meal when it is ready. Consequently, the residual heat in the oven often causes the meal to become overheated and undesirable. Also, if other crew members want to reheat a meal, they must wait until the first is completed or put their own meal into an oven which is already partially through the heat cycle. They then must go back to the oven to reset the timer after the initial heat cycle is finished. Invariably, the result is a meal overcooked or undercooked - often not quite right.

All crews, but especially tanker crews, expressed a similar urgent need for more flexibility in the flight feeding system; a system where meals could be heated independently, simultaneously, and/or on a staggered basis. Tanker crews further expressed a need for a system with quick reheating capability in addition to flexibility.

Obviously, another shortcoming of the existing galley on board the KC-10 is that the ovens have only 6 shelves each, but there may be a requirement for heating a total of 80 or more meals in a full passenger configuration.

Individual meal trays are not used for crew members or passengers, and bulk items (i.e., bread, butter, dessert) are distributed by the loadmaster. Nevertheless, the KC-10 with its modern galley (despite the shortcomings) has the capability of supporting meal service consisting of box lunches or snacks, frozen meals, and shelf stable rations. It is considered the most functionally efficient galley of the active aircraft studied.

KC-135

This aircraft carries a normal crew of 4 to 5 and up to 72 passengers. Passenger seating is provided by hammock seats attached to the fuselage, but additional seating can be provided by track mounted airline type seats.

Food service aboard the KC-135 is supported by a small, self-standing antiquated galley (Figures 8 and 9). This unit includes a single B-4 conduction oven, two hot cups and space for coffee jugs. It does not include any refrigeration, and the oven is not compatible with the typical commercial 7 x 9 inch frozen meals. Thus, the oven is virtually nonfunctional. As a result of these limitations, meal service is limited to box lunches and snacks or shelf stable rations. The ovens (when operable) are sometimes used by creative crews for heating items brought from home or the sandwiches provided in the box lunches or snacks, such as ham and cheese, roast beef, etc. There also appears to be a problem with the availability of spare parts to maintain the oven. In essence, they are useless.

The need for flexible eating times described for the KC-10 applies also to the KC-135 due to the similarity of mission. A major distinction between the two types of aircraft is that KC-135, unlike the KC-10, has no capability for providing hot meals to passengers. Needless to say, even though KC-135 crews are better off than B-52 crews because the B-4 galley does provide for odds n' ends storage and square jugs for beverages, the aircraft sorely needs an updated galley system.

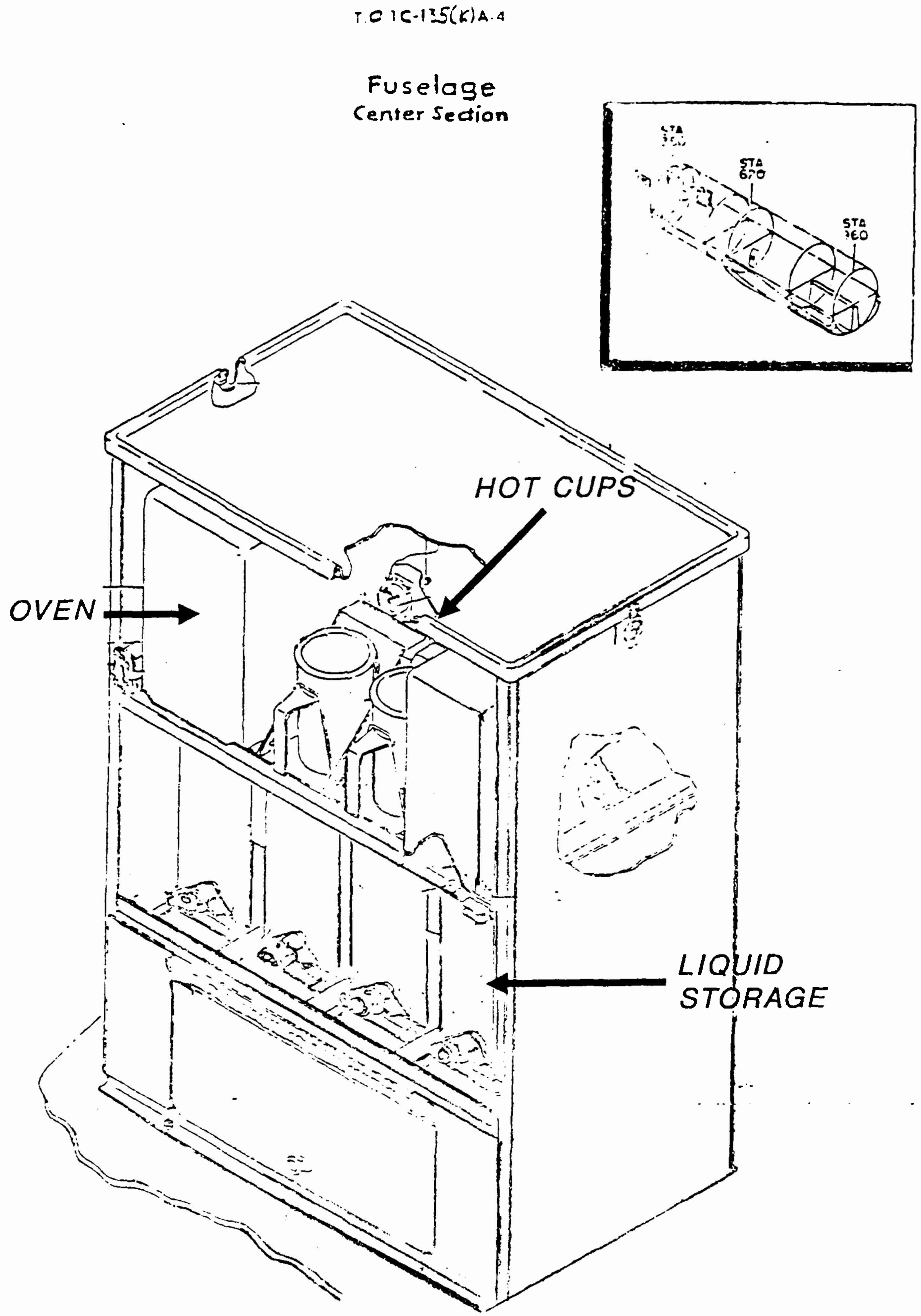

Figure 8. Galley drawing KC-135.

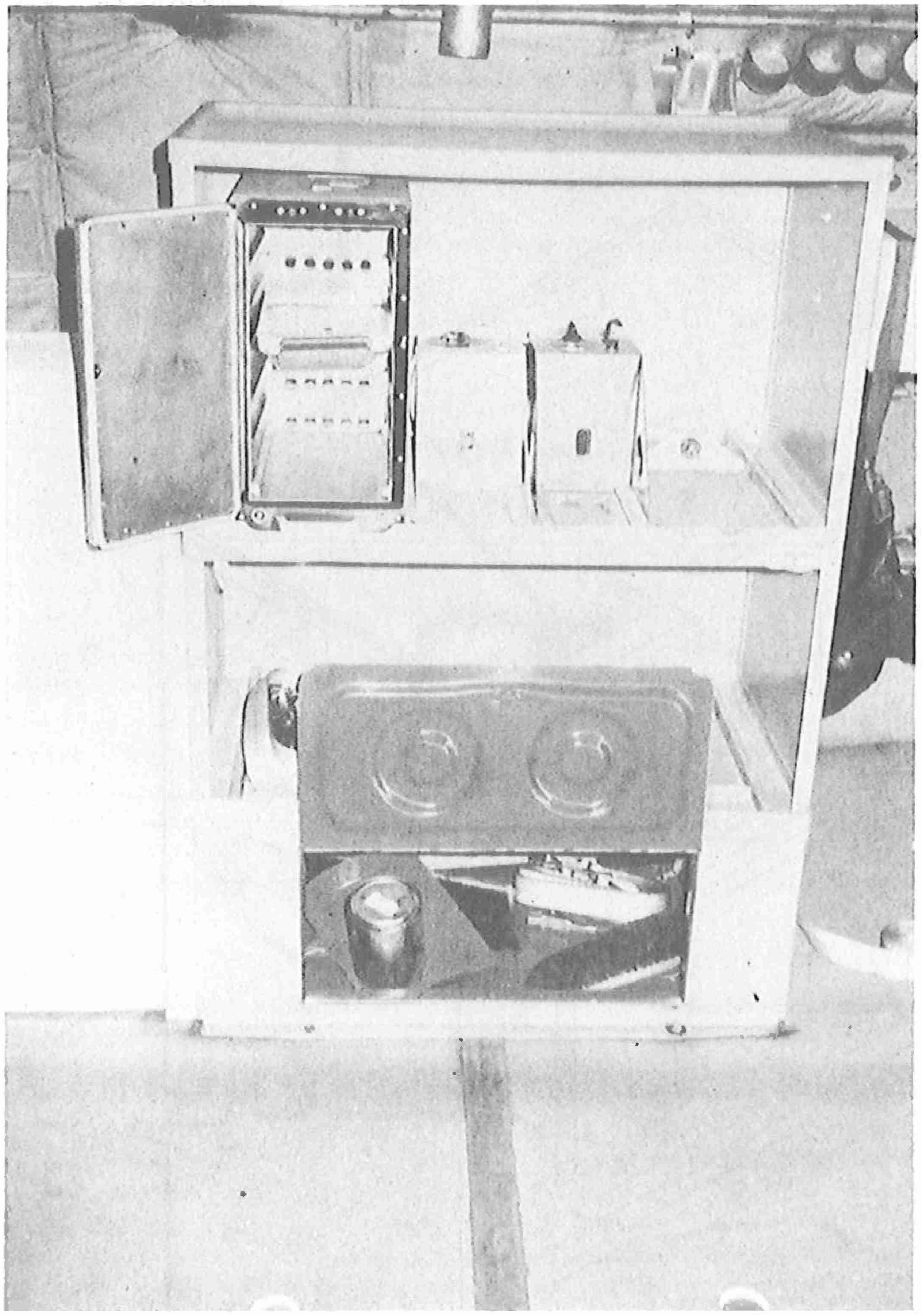

Figure 9. KC-135 galley.

C-5A

The C-5A aircraft carries a basic crew of 8, but usually 12 to 15 and more. In the forward section of the aircraft there is a crew/courier compartment which provides seating for additional crew members and seats a maximum of 22. The passenger section of the aircraft is separate and can carry up to 73 passengers. The large cargo area can accommodate hundreds of troops, if necessary.

The crew/courier compartment has its own separate galley (Figure 10) consisting of a refrigerator, freezer, convection oven (12 meal capacity), coffee brewer, hot beverage unit, water cooler, a sink, and ancillary facilities.

Individual crew members usually prepare their own meals, sometimes with the assistance of a loadmaster. Refrigerator space is limited but manageable, but the main problems are water supply and the coffee maker. The water stored on board the aircraft is generally of such poor quality that it cannot be consumed. The coffee maker unit cannot be drained. Water in pipes causes ruptures when the aircraft is kept on the ground in sub-zero weather. In addition, there is a problem of air entrapment in the coffee making unit which prevents the proper water flow.

The troop compartment galley (aft of the aircraft) has, as basic components, two refrigerators, two ovens (12 meals each) and ancillary equipment (Figure 11). Even though this galley is physically larger than the one in the forward section of the aircraft, there is an extreme lack of work space. The space available on the galley counter top is limited in actual operation because of the need to constantly open the oven doors which drop down upon the counter surface. It was suggested by several loadmasters that a drop leaf shelf should be made part of the troop compartment galley to provide a work surface for meal assembly during meal periods.

A further problem in the troop compartment galley is the limited heating capacity of the convection ovens. Since the loadmasters prefer to have all meals ready at the same time, they now sometimes heat frozen meals and store the heated meals in the storage compartments while they proceed to heat additional meals. However, since these storage compartments are not insulated, the first meals lose temperature and must be boosted for about 5 minutes before being served to the passengers. This last step could be eliminated if the storage compartments were insulated.

Despite this prospective improvement, multiple handling, lost time, and increased frustration are the rule due to the less than adequate oven capacity. The C-5A meal service does utilize meal trays for passengers and crew. Some of the above problems (although oven capacity is not being addressed) are being solved through the new galley design for the C-5B.

C-130

C-130 transport aircraft normally carries five crew members, sometimes eight for rescue missions. The maximum number of passengers which this aircraft may carry would be 92, but 60 are carried when airborne troops are flown.

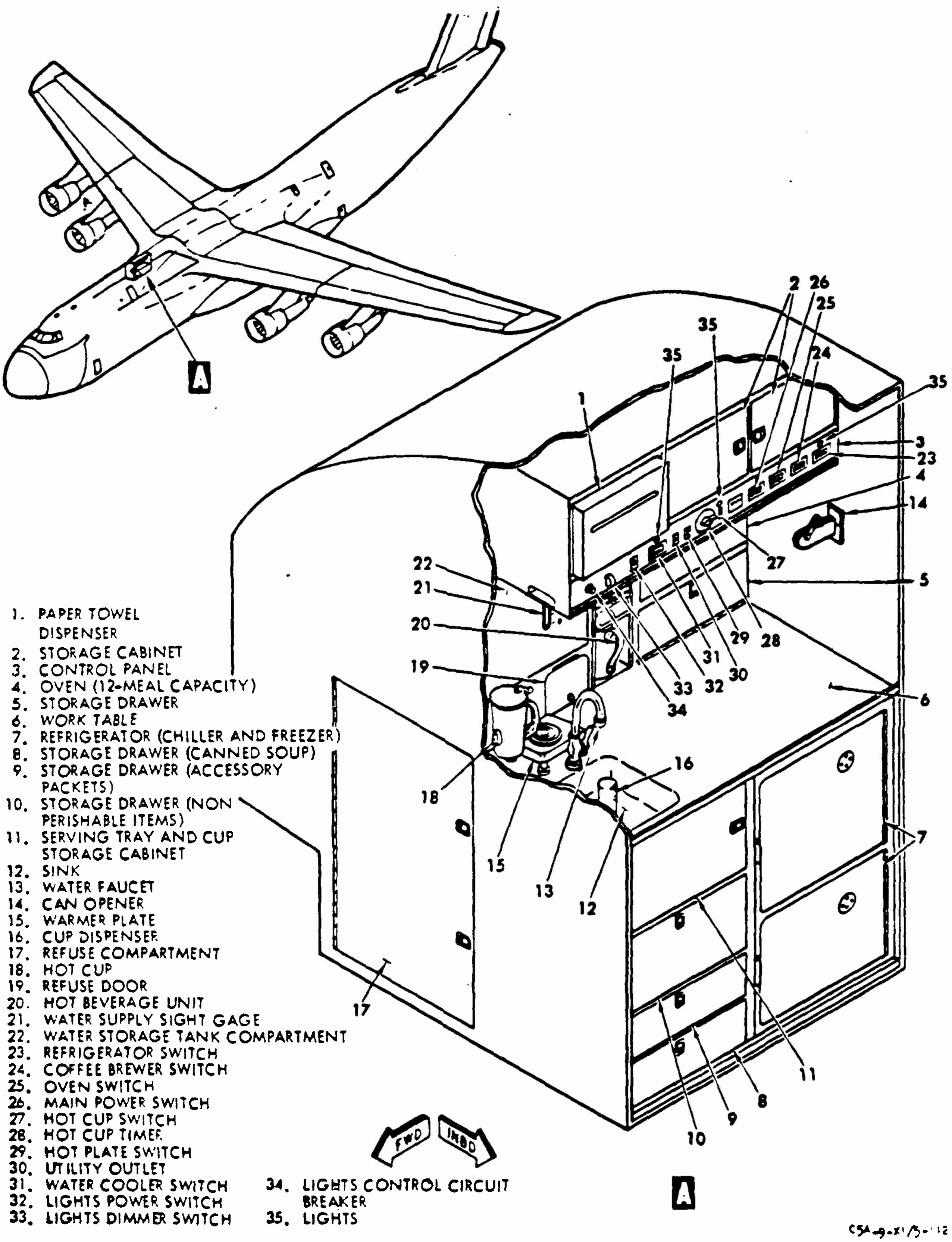

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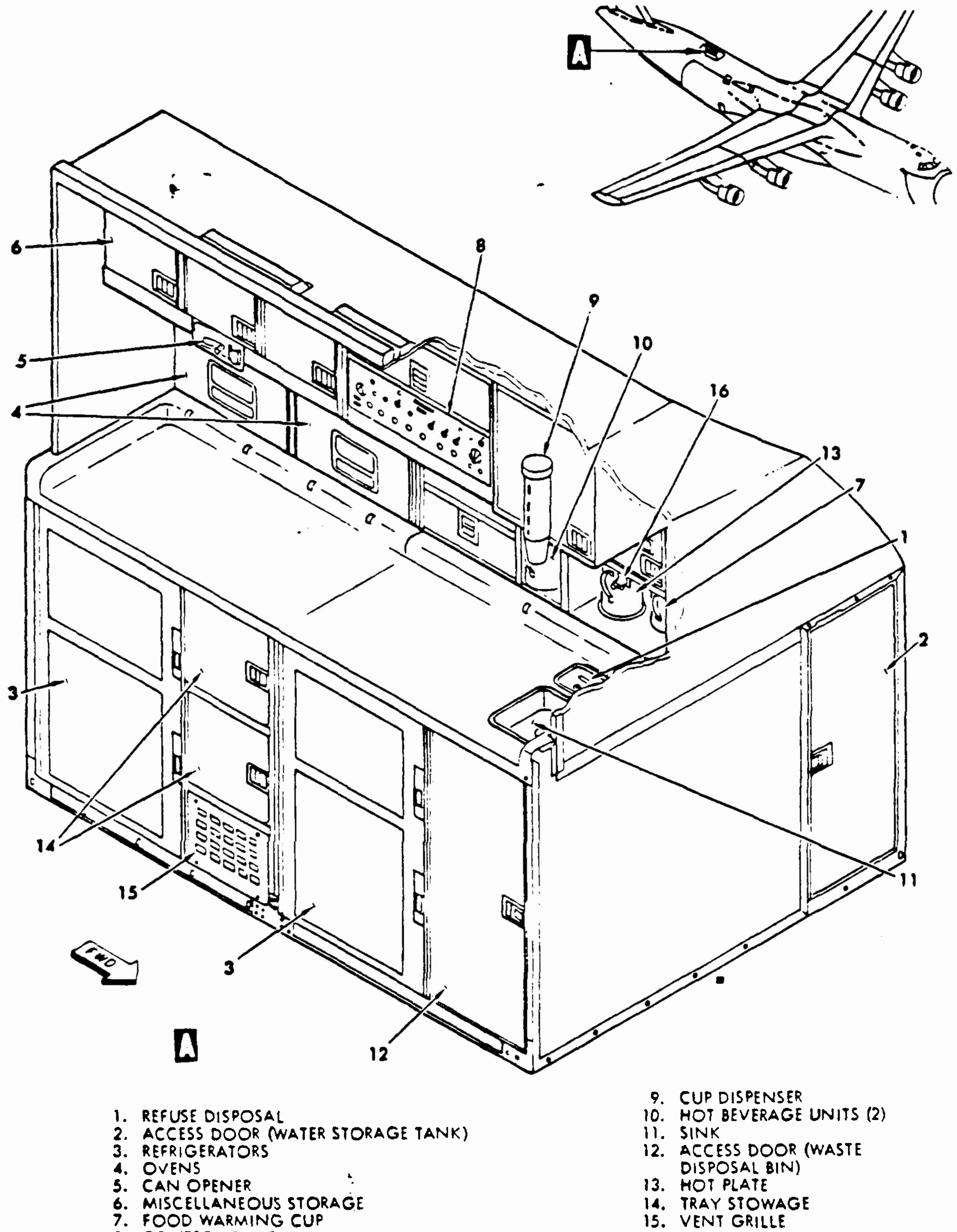
Figure 10. C-5A forward galley.



1. REFUSE DISPOSAL
2. ACCESS DOOR (WATER STORAGE TANK)
3. REFRIGERATORS
4. OVENS
5. CAN OPENER
6. MISCELLANEOUS STORAGE
7. FOOD WARMING CUP
8. CONTROL PANEL
9. CUP DISPENSER
10. HOT BEVERAGE UNITS (2)
11. SINK
12. ACCESS DOOR (WASTE DISPOSAL BIN)
13. HOT PLATE
14. TRAY STOWAGE
15. VENT GRILLE
16. WATER FAUCET

C5A-9-3-096

Figure 11. C-5A aft galley.

The food service on board the C-130 aircraft is provided by a crew galley adjacent to the cockpit (Figures 12 and 13). This galley consists of two liquid containers, two hot cups, a convection oven (6 meal capacity), an insulated compartment for chilled foods, a sink, and ancillary equipment. The insulated compartment is not large enough for the food requirements for crew feeding. Consequently, the greatest shortcoming of the existing on board system is the lack of refrigeration. The convection oven has seven shelves and can hold frozen meals up to standard size commercial frozen dinners.

The galley is not intended to, nor does it support, any food service for passengers on board this aircraft. In addition, the galley is of the one-piece construction type. None of the components are modular, meaning none can be removed for maintenance. Thus, any service to this galley must be performed on the aircraft. Since galley maintenance is a low priority, problems are not regularly corrected and these galleys often are inoperative. Consequently, even though crews prefer hot meals, they do not order them often because of the uncertainty of galley conditions. Because of its irregular configuration, there is a lot of wasted space in this galley.

C-141

This aircraft carries a normal crew of 5 and up to 60 passengers. It is equipped with a small galley on the cargo deck, (Figures 14 and 15), consisting of a convection oven (7 meal capacity), an insulated compartment for chilled foods, a hot cup, and space for insulated liquid containers.

This galley suffers from the same lack of refrigeration as the C-130, one-piece construction, and also does not support any meal service for passengers. With a comfort pallet on board the C-141, frozen meals can, however, be served to passengers.

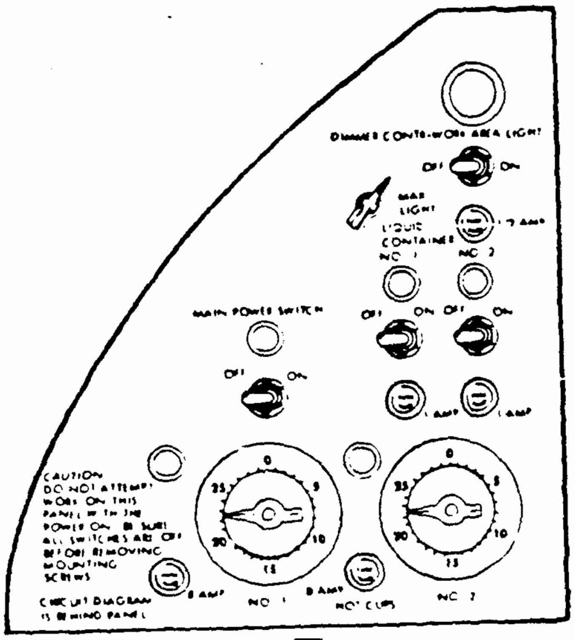
Consumer Opinion of the Present System

Concurrent with research conducted concerning on board subsystem alternatives, considerable attention was given to the flight feeding customer. The twofold goal of the data collection efforts was to determine customer opinions of the current Air Force inflight feeding system, and to use this information to implement a system with which to improve their satisfaction. This effort was centered on current problems with the existing system and on specific preferences of the crew members.

Two types of questionnaires were used to assess the current situation (Appendix B). Customer opinions were obtained through mail surveys collected from 2,621 air crews of 30 Strategic Air (SAC) and 21 Military Airlift (MAC) Command bases worldwide. An additional 146 questionnaires were obtained from personnel on site at 3 (2 SAC and 1 MAC) stateside installations.

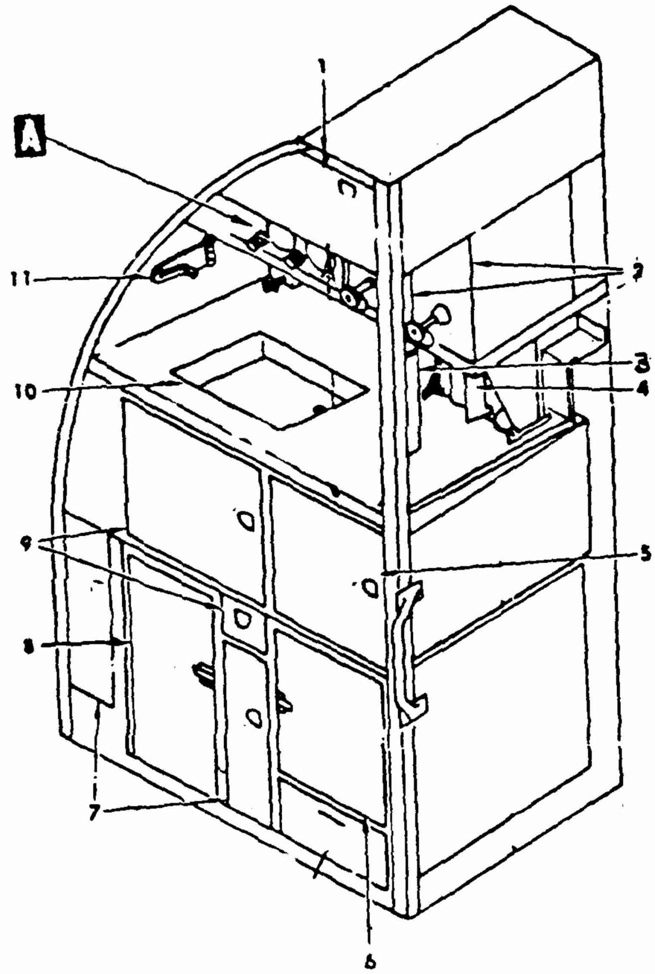
T.O. 1C-130B-1

galley



A

GALLEY CONTROL PANEL



1. WATER TANK
2. LIQUID CONTAINERS
3. CUP DISPENSER
4. FOOD WARMING CUPS
5. REFUSE CONTAINER
6. REFRIGERATOR
7. STORAGE COMPARTMENTS
8. OVEN
9. FOOD STORAGE COMPARTMENTS
10. SINK
11. CAN OPENER

Figure 12. C-130 galley drawing.

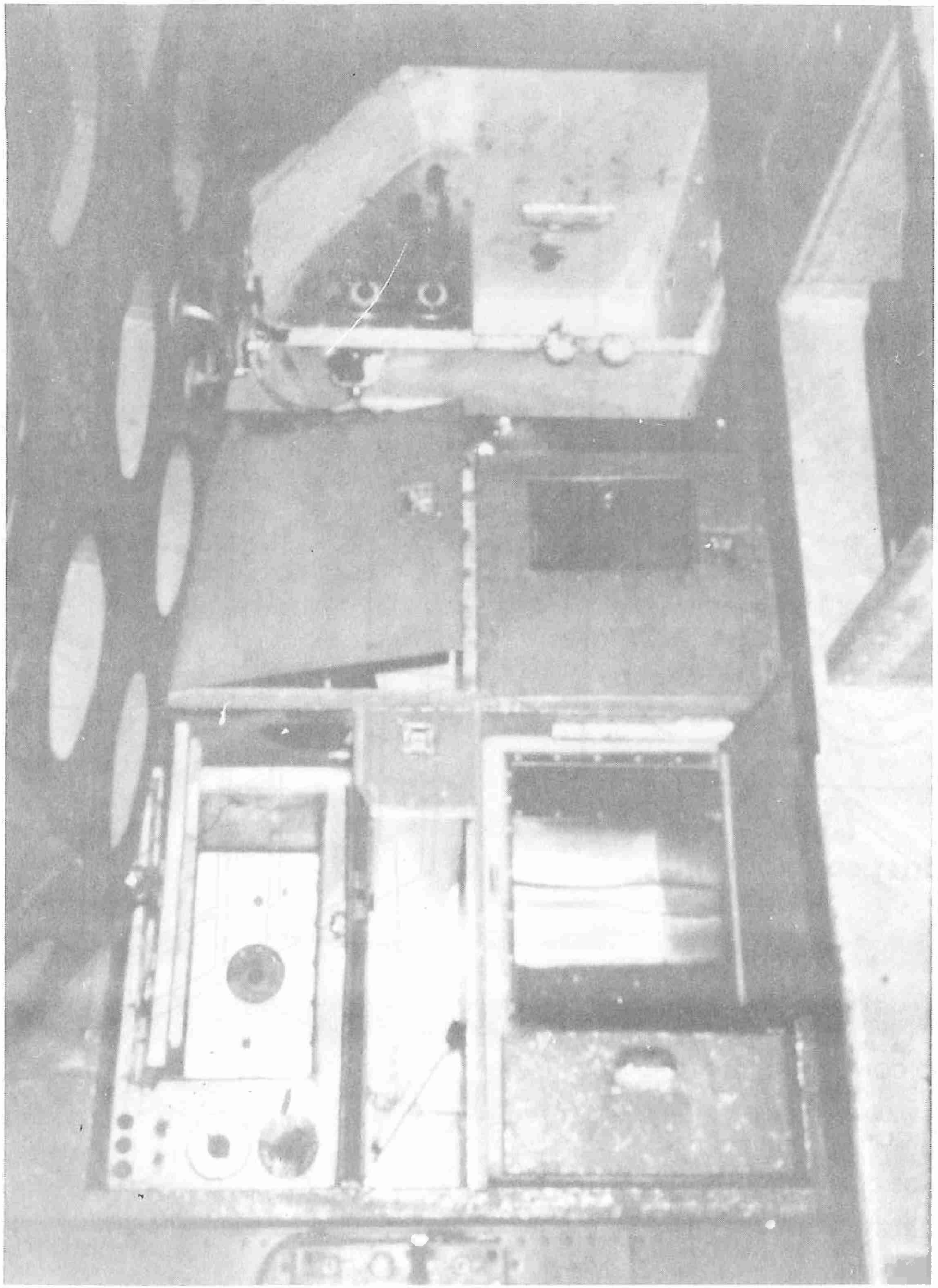
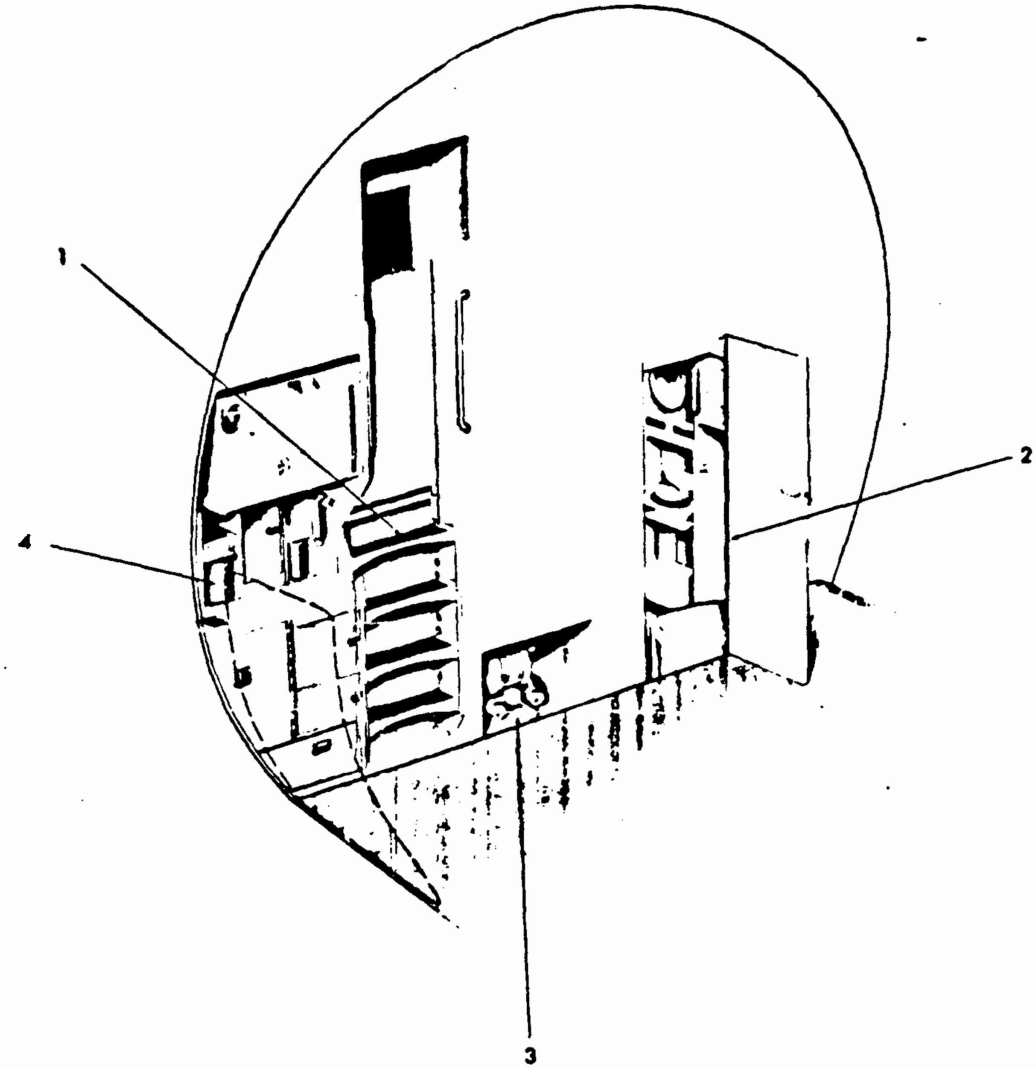


Figure 13. C-130 galley.

FORWARD CARGO COMPARTMENT FACILITIES



1. FLIGHT STATION LADDER
2. LAVATORY
3. CARGO WINCH
4. GALLEY

Figure 14. C-141 galley drawing.

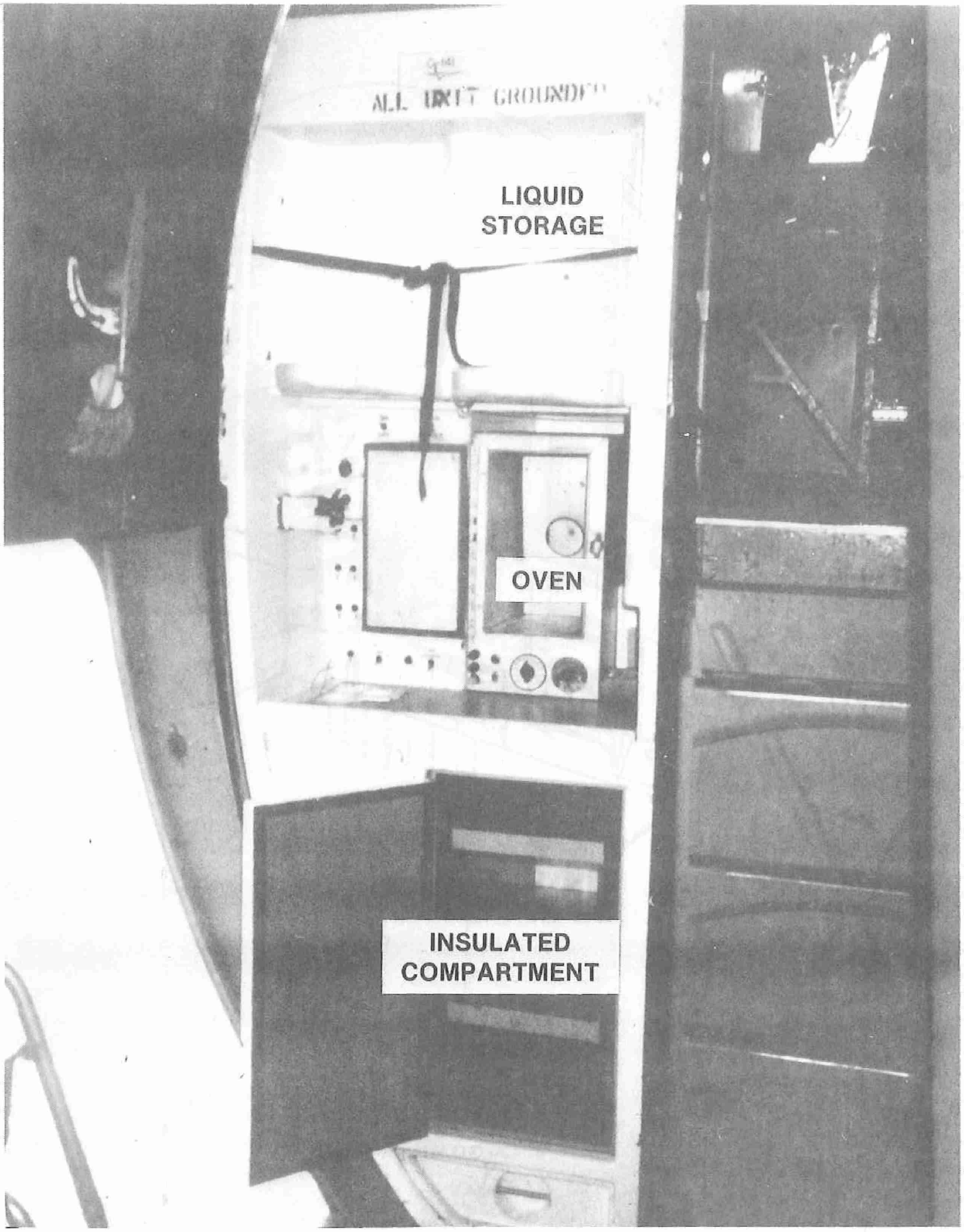


Figure 15. C-141 galley.

Crews of the following aircraft were surveyed:

TABLE 22. Air Crew Surveys Returned

	MAIL SURVEY RETURNS (N=2,621)	ON-SITE SURVEY RETURNS (N=146)
B-52 bomber	419	34
KC-135 Tanker	865	15
C-5	367	34
C-130	551	0
C-141	419	63

The mail survey sample consisted of a higher percentage of officers (60%) than enlisted personnel (40%). Ranks of the participants were not requested.

The 2,621 crew members responding to the mail survey averaged 1.8 flights per week, as may be seen in Table 23. Of these, MAC averaged 2.0 flights, significantly more ($p<0.05$) than SAC which averaged 1.6 flights per week.

TABLE 23. Mean Number of Flights and Flight Durations

	SAC		MAC		Overall
	Mail	On Site	Mail	On Site	Mean
Average # Flights:					
Per week	1.6	1.2	2.0*	1.1	1.4
Average Flight Duration:	6.4	7.8	13.2*	7.2	9.9

*Significantly more than SAC $p<0.05$.

The average air time (flight duration) of these flights was 9.9 hours overall. For the mail survey, SAC averaged 6.4 hours while MAC averaged 13.2 hours, which was again significantly greater ($p<0.05$).

The 146 crew members responding to the on-site survey averaged 4.5 flights per month. There were no significant differences between bases (Griffiss, Travis, McGuire) for mean number of flights or for flight duration. There were, however, differences among aircraft types as seen in Table 24.

TABLE 24. Mean Number of Flights and Flight Durations by Aircraft Type*

Aircraft Type	C-141	B-52	KC-135	C-5	Overall
Average Flight/Month	5.4	4.7	4.7	2.5[a]	4.5
Average Flight Duration (hr)	6.1[c]	9.5	3.9[b]	9.4	7.4

*P<0.05
[a] Significantly fewer than C-141
[b] Significantly less than B-52, C-5, C-141
[c] Significantly less than B-52, C-5

The MAC on-site respondents were asked to recall the maximum number of passengers carried recently aboard their aircraft. Table 25 indicates their responses for the three aircraft types. The C-5 and the C-141 respondents reported carrying the most passengers, with 58% and 51% respectively, responding "20 or more". Conversely, only 25% of the C-130 crew reported that they had carried "20 or more" passengers.

TABLE 25. Maximum Number of MAC Passengers Carried by Aircraft

	Percent Responding to Number of Passengers		
	None	5 or More	20 or More
C-130	60.1	15.1	24.8
C-141	36.9	12.1	51.0
C-5	32.2	9.6	58.1

Current Situation

Equipment. In order to put the current situation in the proper perspective, it was necessary to elicit from the crews the types of food-related equipment that were currently available on board their respective aircraft. Table 26 indicates their responses from the mail survey.

Generally, four types of food service equipment were common and three were not. Items for heating (i.e., hot pot/cup and oven) were standard. In contrast, however, items for cooling (refrigerator, freezer) were scarce. SAC respondents reported this scarcity to be more of a problem than did MAC respondents. Nevertheless, this limits the kinds of food items that both groups of respondents can currently handle during flights. Most aircraft also lack a coffee maker, although only a minority of crew members expressed a desire for means to make coffee inflight anyway.

TABLE 26. Food-Related Equipment Currently on Board

Item	SAC (N=1226)	MAC (N=1395)	TOTAL (N=2621)
	Percent Reporting		
Hot pot/cup	82.2	87.2	84.8
Oven	64.5	89.7	77.8
Insulated jug	65.7	73.0	69.6
Galley	44.6	75.9	61.2
Refrigerator	7.0	47.2	28.4
Coffee maker	8.9	41.3	26.1
Freezer	4.0	32.3	19.0
No food equipment	1.4	0.3	0.8

In the opinion of the majority of the on-site respondents (Table 27), the food service equipment is properly maintained so that it works much of the time. Over one-third of the respondents complained that it was not properly maintained. Respondents did not state if some types of equipment work better, or were better maintained than other types.

TABLE 27. Food Service Equipment Properly Maintained by Aircraft Type

Aircraft type	% of Responses NO	YES
C-141	44.1	55.9
B-52	37.0	63.0
KC-135	50.0	50.0
C-5A	27.3	72.7

Aircraft. The mail respondents were asked to rate how good or bad food service factors are on board their current aircraft type. Their opinions are shown in Table 28. From the results, it appears that the SAC respondents were more satisfied with aspects of their aircraft than were MAC respondents. Noted exceptions where MAC respondents were more satisfied are meal preparation ease and time and, unsurprisingly, equipment on board. These exceptions might easily be attributed to the kinds of equipment available on the MAC aircraft. Both commands agree on the "somewhat bad" rank of the shelf stable ration item. Fleet service, which is only available at MAC, is quite acceptable to these crew members.

Types of Meals. Box lunches and snacks are the most common meal types served on board the aircraft according to the mail respondents (Table 29). Less common are hot meals in the form of a heated frozen dinner which are only noted by about one-third of the respondents, the majority of which are MAC crew members on board the C-141 and C-5 (Table 30). Bite size and MREs were less prevalent overall. Bite size was more familiar aboard the KC-135 and B-52 aircraft, while MREs were more familiar to the C-130 and C-141 crews.

TABLE 28. Factors Good or Bad in Current Aircraft

	% Responding Somewhat Good or Higher	Mean Responses (S.D.) SAC	MAC	OVERALL
Quality - Frozen Meals	49.0	4.14	4.34	4.28(1.51)
- Sandwiches (box lunches)	42.0	4.32*	3.75	4.00(1.49)
- Snacks	39.6	4.38*	3.63	3.96(1.45)
- MREs	14.1	3.32*	2.77	2.93(1.54)
Quantity - Sandwiches (box lunches)	47.4	4.50*	4.00	4.23(1.44)
- Snacks	34.0	4.19*	3.51	3.80(1.45)
- Frozen Meals	31.7	3.92	3.82	3.85(1.39)
- MREs	21.6	3.73*	3.34	3.46(1.45)
Variety - Sandwiches (box lunches)	40.5	4.28*	3.88	4.06(1.53)
- Snacks	37.8	4.20*	3.84	4.00(1.41)
- Frozen Meals	24.0	3.71*	3.40	3.49(1.49)
- MREs	15.0	3.47*	3.12	3.22(1.41)
Meal Preparation - Ease	38.5	3.66	4.26*	4.06(1.53)
- Time	34.2	3.78	4.16*	4.03(1.42)
Service - Fleet	44.6	----	4.18	4.18
- Kitchen	38.4	4.20*	3.77	3.96(1.58)
Trash Disposal	38.7	4.38*	3.70	4.02(1.61)
Equipment On Board	35.8	3.02	4.28*	3.71(1.85)

SCALE: 0 - never tried, 1 - very bad, 2 - moderately bad, 3 - somewhat bad, 4 - neither bad nor good, 5 - somewhat good, 6 - moderately good, 7 - very good.

*Significant difference $p<0.05$

Where Meals are Consumed. Responses to some questions on the mail survey regarding where crews eat are seen in Table 31. As might be expected, flight meals are typically eaten at the individual's duty location, on board the aircraft, and during the flight. A distant second alternative location on board is in the galley area. Of the few that report eating on the ground, the squad building is, according to the mail respondents, used most often. Base operations and the aircraft are other ground locations used.

TABLE 29. Types of Meals Eaten While on Board Current Aircraft (97.0% Responding)

	SAC (N=1226)	MAC (N=1395)	% of Positive Responses	Number of Positive Responses
Sandwich (box lunch)	83.3	84.4	83.9	2158
Snack Meal	58.4	77.9	68.8	1768
Pre-cooked Frozen	21.2	53.2	38.5	981
Bite-Size	17.2	5.8	11.1	285
MRE	3.6	16.3	10.4	267

TABLE 30. Types of Meals Eaten on Board by Aircraft Type*

	KC-135	B-52	C-130	C-141	C-5
Precooked Frozen	22.4	18.9	36.6	64.6	64.2
Sandwich	83.7	82.6	82.8	87.1	83.7
Snack Meal	61.9	51.7	75.8	77.0	82.1
Bite-Size	16.0	19.3	7.7	6.3	2.4
MRE	3.4	3.9	17.8	23.0	6.3

*Numbers represent percent reporting meal type

TABLE 31. Where and When Meals Are Typically Eaten

Meals are Typically Eaten (88.4% Responding)

	On the Ground	On the Aircraft	Both
SAC	1.7	95.7	2.6
MAC	2.5	93.6	4.0

On Aircraft - Location (85% Responding)

	Duty Position	Wing	In Back Area	Galley	Walking	Position
SAC	87.4	0.3	0.3	2.0	0.1	0.2
MAC	77.5	0	2.7	5.5	0.2	0

On Aircraft - Meal Period (84% Responding)

	Before Flight	During Flight	After Flight
SAC	3.4	94.5	2.4
MAC	3.2	94.2	2.6

Menu Variety. More detailed results of the customers' opinions in the survey by mail of the current menu variety are shown in Table 32. Typically, very few (1.89% SAC, 1.49% MAC) thought there was too much variety. Over half thought it was adequate, but about one-third were dissatisfied.

TABLE 32. Ratings of Current Menu Variety
(96.9% Responding)

	Percent SAC	Agreeing MAC	Number of Responses
Much too many	0.5	0.4	12
Too many	1.3	1.0	29
Adequate	70.2	57.9	1615
Too few	22.3	30.8	684
Much too few	5.7	9.8	201

Junk Food. Of the mail survey respondents who answered the question is there was too much "junk food" in the flight meals and snacks, 30.1% responded that there was too much, while 69.9% indicated that there was not. Table 33 shows, however, that the percentages of "yes" responses from the MAC respondents were slightly higher than from the SAC respondents. It is therefore conceivable that, due to the nature of these two meal forms, the junk food issue might cause concern over the nutritional adequacy of the current diet which was expressed by one-third of the respondents (MAC especially). Whether the remaining respondents think that the diet is adequate or whether they just lack the nutritional knowledge to make an informed judgement remains indeterminate.

TABLE 33. Is There Too Much "Junk" Food in the Flight Meals and Snacks?

Response	Percentages of Responses SAC	MAC	Overall	Number of Responses
Yes	20.2	38.6	30.1	752
No	79.8	61.4	69.9	1744

Deciding What To Eat. When presented with a number of factors and asked to rate each in terms of how important it was in their decision of what to eat on their current aircraft, the mail respondents offered results shown in Table 34. Meal quality was reported as the most important single factor in the crew members' decision about what to eat, followed, in decreasing importance, by meal quantity, ease of eating, and meal cost.

TABLE 34. Factors Important in Deciding What To Eat
(*In Decreasing Importance)

Factor	Mean Rating SAC	MAC	Overall	% Responding Very Important or Higher*
Meal Quality	3.30	3.34	3.32	86.5
Meal Quantity	2.82	2.89	2.85	67.2
Ease in Eating	2.62*	2.28	2.43	50.2
Flight Boredom	1.22	2.47*	1.89	39.0
Meal Cost	1.98	2.16*	2.08	36.5
Time for Eating	1.97*	1.81	1.88	31.8
Flight Duration	--	1.58	--	28.8
Per Diem Status	1.11	1.78*	1.47	28.3
Clean Up	1.64	1.59	1.61	24.1
Low Calorie Meal	1.06	1.62*	1.36	22.2
Time Night or Day	1.43	1.38	1.41	20.3
Place to Eat	1.28	1.38	1.33	15.8

SCALE: 0 = not important, 1 = slightly important, 2 = moderately important, 3 = very important, 4 = extremely important

*Significant Difference p<0.01

TABLE 35. Factors Important in Deciding What To Eat by Aircraft Type

Factor	B-52	KC-135	C-5	C-130	C-141
Meal Quality	3.35	3.27	3.38	3.27	3.39
Meal Quantity	2.89	2.78	2.84	2.94	2.87
Ease in Eating	2.65	2.60	2.17	2.39	2.22
Time - Night or Day	1.21	1.55	1.32	1.44	1.36
Time for Eating	1.87	2.03	1.77	1.84	1.81
Place to Eat	1.18	1.32	1.43	1.35	1.39
Clean Up	1.58	1.68	1.52	1.64	1.57
Meal Cost	1.94	2.01	2.08	2.19	2.18
Per Diem Status	0.93	1.20	1.84	1.66	1.88
Flight Boredom	1.08	1.30	2.22	2.53	2.59
Low Calorie	1.00	1.09	1.55	1.65	1.63
Flight Duration	--	--	1.78	1.50	1.51

SCALE: 0 = not important, 1 = slightly important, 2 = moderately important, 3 = very important, 4 = extremely important.

This ranking suggests that the respondents want a good meal that is easily consumed and at a fair and reasonable cost. Any improvement in these factors might, in turn, improve the perceived factor of flight boredom (for MAC especially). Time for eating was a moderately important consideration. In spite of the significantly more air time (Table 24), flight duration for the MAC respondents was rated only slightly to moderately important when making their meal decision. Other factors (clean up, time of day, and caloric content) were "slightly important" when deciding what to eat. Rated as the least important factor was a place to eat. Looking back at Table 7, it would appear that this factor is of minor importance because the majority of the respondents eat on the aircraft and at their duty location.

Meal Purchase Preference. In Table 36, over half of the mail respondents (55.9%) would prefer to purchase the individual meal components rather than prepackaged meals (44.1%). This would enable them to purchase just the items they wanted to consume. It is surprising, however, that fewer MAC respondents (47.3%) preferred to have the ability to purchase individual meal components.

TABLE 36. Meal Purchase Preference
(95% Responding)

			Percent Responding
	SAC	MAC	Total
Individual Components of Meal	66.4	47.3	55.9
Complete Prepackaged Meals	33.6	52.7	44.1

Meal Preferences. Mail respondents were asked to rank their preferences for six different meal-type items during flights. The results in Table 37 are the means listed in declining rank order where "1" refers to the meal desired most and "6" refers to the meal desired least (lower numbers indicate higher preference). The crew members want complete hot meals and hot sandwiches most. Cold sandwiches combined with snacks and frozen meals follow. The traditional hamburger and fries are wanted least.

Meal Types. Since about one-third of the mail respondents expressed some concern regarding the nutritional content (specifically junk food) of their meals, it follows that the on-site question of "How much do you like the following types of meals?" produced the results in Table 38. Among the three choices, low calorie meals are most preferred. Sixty-five percent of those responding rated them positively. Fewer (54%) rated low sodium meals on the positive side of the 9-point scale.

The implementation of frozen breakfast meals on board the aircraft would, in the opinion of 50% of the on-site respondents who responded positively, be only marginally acceptable. Respondent preference for hot meals does not appear to extend to the breakfast meal.

TABLE 37. Meal Preference (92.6% Responding)

Most Preferred Meals

	Category Percent	Mean Rating
Complete Hot Meals	59.4	2.44
Hot Sandwiches	57.5	2.56
Cold Sandwiches	30.2	3.51
Frozen Flight Meal	25.8	3.99
Snack Meal	19.5	3.92

Least Preferred Meal

	Category Percent	Mean Rating
Hamburger/Fries	48.3	4.22

TABLE 38. How Much Do You Like the Following Types of Food? (98.6% Responding)

Item	% Responding Like Slightly - Like Extremely	Mean Rating*
Low Calorie Meals	65.0	6.33
Low Sodium Meals	54.0	5.79
Frozen Breakfast Meals	50.0	5.34

* SCALE: 1 - dislike extremely, 2 - dislike very much, 3 - dislike moderately, 4 - dislike slightly, 5 - neither like nor dislike, 6 - like slightly, 7 - like moderately, 8 - like very much, 9 - like extremely

The Flight Kitchen. Problems with the flight kitchen were specifically addressed by asking the mail respondents to indicate the problems they were having in getting meals (Table 39). The problems reported most frequently were the pre-order time, the wait at the flight kitchen, and the attitude of flight kitchen personnel. Flight kitchen wait was the single problem not reported by a considerably higher percentage of the MAC respondents.

To sum up the crew evaluation of the current system, the majority of the respondents reported insufficient equipment for keeping foods and beverages cold (to temperatures below 45°F). Menu limitations as well as lowered food quality are direct results of the lack of a means for safe storage of perishable products during flights. Crews rely on sandwiches and snack meals which cause about one-third of them concern about the adequacy of the nutritional content of the inflight diet.

TABLE 39. Problems in Getting Meals From the Flight Kitchen

Problems	Percent Reporting SAC	MAC	Total
Pre-Order Time	23.2	39.5	32.2
Flight Kitchen Wait	24.4	5.9	24.1
Attitude of Kitchen Personnel	18.1	27.3	22.6
Others	13.7	25.7	19.9
Amount of Paperwork	6.8	20.5	14.3
Flight Kitchen Transportation Time	8.8	23.5	9.1
Lack of Transport Vehicle	3.0	23.5	3.4

Future Needs

Flight Kitchen Deli Concept. When presented with the concept of deli-style foods being displayed at the flight kitchen, the respondents indicated the frequency with which they would go there for a meal (Table 40). They reported that sometimes they would select their meal from the deli-style display at the flight kitchen. Perhaps the change-of-pace as well as the increased variety from the usual box lunch might be attractive to these mail respondents of whom, according to Table 37, 30% prefer cold sandwiches anyway.

TABLE 40. Would Visit Flight Kitchen for Deli-Style Foods (90% Responding)

	% Responding	Mean Rating*
SAC	47.0	2.87
MAC	53.0	3.13
Total:	100.0	2.99

*SCALE: 1 - almost always, 2 - often, 3 - sometimes, 4 - seldom, 5 - never

Preferences. The on-site respondents rated on a 9-point hedonic scale how much they liked the food and beverage items that are listed in Table 41.

A popular item, hot sandwiches, preferred by 57% of the mail respondents (Table 37), was also well-liked by 93% of the on-site crew members (Table 41). Pizza (82.8%), usually served hot and often as a meal, was also a favorite of the on-site respondents. Overall preference for hot items, whether a sandwich as above or a complete meal as in Table 37, is not inconsistent with the low percentage of SAC respondents who report eating frozen (hot) dinners regularly (Table 29). The less than desirable condition of galley equipment, particularly on board SAC planes, precludes selection of hot meals, in the form of frozen meals.

The inclusion of carrots/celery sticks and tossed salad are indicative of the respondents' desire for fresh items as will be seen later (in Tables 43 and 50).

TABLE 41. How Much Do You Like the Following Foods and Beverages? (99.3% Responding)

Item	Like Slightly - Like Extremely	Mean Rating*
Natural Fruit Juices	94.3	7.85
Hot Sandwich	93.1	7.61
Resealable Beverages	80.4	7.25
Pizza	82.8	7.11
Carrot/Celery Sticks	84.6	7.08
Tossed Salad	79.7	7.04
Condiments	75.9	6.67
Hamburger	78.5	6.66
Meat Pot Pies	75.2	6.61
Tea	69.0	6.60
Chicken Salad Sandwich	72.8	6.54
Fruit Flavored Drinks	73.8	6.42
Granola/Nutty Snacks	73.2	6.30
Tuna Salad Sandwich	67.6	6.21
Coffee	67.1	6.15
French Fries	68.7	6.09
Puddings	63.7	6.01
Potato Chips	63.5	5.78
Yogurt	59.4	5.58
Candy	50.7	5.13

*SCALE: 1 - dislike extremely, 2 - dislike very much, 3 - dislike moderately, 4 - dislike slightly, 5 - neither like nor dislike, 6 - like slightly, 7 - like moderately, 8 - like very much, 9 - like extremely

The results are arranged in descending order by the mean hedonic ratings. Natural fruit juices and beverages in resealable containers lead the list of desired beverages. Similar results were obtained from the mail questionnaire.

Beverages. Table 42 shows that soda (39.9%), fruit juices (38.3%), and fruit-flavored drinks (28.5%) are the most wanted beverages.

TABLE 42. Types of Beverages Desired (90.9% Responding)

Beverages	% of Responses
Soda	39.9
Fruit Juices	38.3
Lemonade, Kool-aid, Fruit Punch	28.5
Iced Tea, Hot Tea	23.3
Milk	23.0
Coffee	21.5
Water	13.3
Diet, Decaffeinated Drinks	5.0

At the low end are water (13.3%) and diet or decaffeinated drinks (5.0%). Note that no single drink was called for by a majority. Of the five beverages listed in Table 41, coffee is the least perferred, and only a few (21.5%) desire it on flights (Table 42). Consequently, the lack of a coffee maker on aircraft is less of a problem than the lack of refrigeration equipment to furnish drinks and foods requiring cold storage. Coffee requirements can be met by use of insulated beverage containers. These results suggest that a wider variety of beverages should be made available in order to satisfy the different beverage preferences of Air Force personnel during flights.

Equipment. The availability of a reliable refrigerator/freezer would provide a wider choice of cold foods and beverages. The on-site crew members reported beverage preferences are shown in Table 43.

TABLE 43. Given a Dependable Refrigerator/Freezer, What Cold Foods and/or Beverages Would You Prefer? (86.3% Responding)

Response	% of Responses
Soft Drinks	51.6
Fruit Juices	38.1
Milk	26.2
Fresh Fruits & Vegetables	19.0
Sandwiches w/Cold Cuts	17.5
Iced Tea	16.8
Salads	11.1
Ice Cream	10.3
Frozen Meals	9.5
Other Dairy Products	7.9

Soft drinks, fruit juices, and milk were the most popular cold beverage items, and iced tea was the least popular. Fresh fruits and vegetables (19.0%) followed by cold cut sandwiches (17.5%) and salads (11.1%) were the food items they favored the most.

Customer satisfaction could be increased somewhat by improving the menu variety. Given the availability of a reliable oven, the on-site respondents listed the foods they would like to eat. Table 44 shows the types and Table 45 the specific foods they listed.

TABLE 44. Given a Dependable Oven, What Foods During Flight Would You Prefer (Food Types)? (52.7% Responding)*

Responses	% of Responses
Frozen Dinner	75.0
Box Lunch	13.3
Non-Frozen	11.7

*Percentage of Respondents who listed specific meal types

TABLE 45. Given a Dependable Oven, What Foods During Flight Would You Prefer (Specific Foods)? (65.8% Responding)*

Responses	% of Responses
Beef/Steak	60.4
Chicken	39.6
Hot Sandwich	20.9
Pizza	20.8
Fish	12.5
Turkey	12.5
Potatoes	8.3
Frankfurters	7.3
Veal	3.1

*Percentage of respondents who listed specific food items

Of those who specified meal types, frozen dinners (75%) were preferable to the other meal choices. Of the specific foods listed by the on-site respondents (Table 45), their choices clearly correspond with results given previously. For example, two of their favorite foods listed in Table 41 were hot sandwiches and pizza. Other specific selections listed: beef/steak, chicken, fish, and turkey lend themselves well as ingredients for frozen dinners, their first meal-type choice, if given a dependable oven (Table 44). Further agreement is even evident with their second choice. The box lunch (13.3%), which consists mainly of cold sandwiches, agrees with their rated satisfaction of chicken and tuna salad sandwiches in Table 41. Although chopped filling sandwiches are prohibited by regulation, research at Natick suggests there are prepared chopped sandwich filling products which could be served inflight.

Results in Table 46 further indicate how often the respondents would eat frozen meals. Over 78% say they would eat them from between "every flight" to and including "every third flight", as opposed to 13.5% who say they would never eat frozen meals.

TABLE 46. Given a Dependable Oven, How Often Would You Eat Frozen Meals? (96.9% Responding)

Response	% of Responses
Every Flight	39.7
Every 2nd Flight	28.4
Every 3rd Flight	10.6
Every 4th Flight	4.3
Every 5th Flight	1.4
Every 6th Flight	2.1
Never	13.5

Table 47 shows that for the majority (63.6% or two-thirds) of the respondents the availability of a microwave oven would not alter their responses to the oven availability questions as shown in Tables 44 and 45. A sizeable percent, however, (36.4% or one-third) answered that they would select different items. Table 48 shows that in addition to choosing specific entree-type items similar to those in Table 45 as their first choices (18.9%), their second choice was to furnish their own meals (13.5%). Soups and desserts (8.1%) completed their choices.

TABLE 47. Given a Microwave Oven, Would You Choose To Eat Different Foods Inflight? (83% Responding)

Responses	% Responding
No	63.6
Yes	36.4

TABLE 48. Given a Microwave Oven, What Service Suggestions Would You Make?

Responses	% Responding
More Meats	18.9
Bring Own Meals	13.5
Soups	5.4
Desserts, pastries	2.7

The importance of the availability of properly working food service equipment inflight cannot be overly stressed. Accordingly, the suggestions offered by the on-site respondents for the improvement of inflight feeding are not surprising. The majority of the suggestions shown in Table 49 are for a refrigerator (52.9%). The main reason cited is to prevent food spoilage. The second suggestion, a microwave oven (47.6%), is needed for faster and more efficient food preparation. Third, an oven (39.2%) to replace the present malfunctioning one was suggested. This would afford the crew better, more diverse menu selections. Finally, an area alloted for storage (5.0%) would permit them to bring their own food. Tables 50 and 51 show the same results by aircraft type. Note that KC-135 crews differ somewhat in their reasons for siting microwave. They more often suggest this oven type as offering better menu selection, as opposed to other crews who view this option as one that provides faster service.

TABLE 49. Equipment Suggested To Improve Flight Feeding (69.9% Responding)

Item	% of Responses	Reason For Suggestion	
Refrigerator	52.9	Prevent spoilage	(33.3%)*
Microwave Oven	47.6	Faster/more efficient	(50.0%)
Oven	39.2	Better selection/present equipment broken	(21.2%)
Storage Facility	5.0	Store Own Food	(7.9%)

*Of the individuals responding, the percentage who stated this reason.

TABLE 50. Equipment Suggested To Improve Flight Feeding by Aircraft Type (69.9% Responding)

	C-141	B-52	KC-135	C-5A
Refrigerator	70.0	36.4	76.9	5.9
Microwave Oven	34.0	39.1	76.9	76.5
Oven	40.0	63.6	23.1	17.6
Storage Facility	4.0	9.5	0.0	5.9

TABLE 51. Equipment Suggested To Improve Flight Feeding: Reasons by Aircraft Type

	C-141	B-52	KC-135	C-5A
Refrigerator				
Better Selection	3.7	0.0	23.1	0.0
Prevent Spoilage	40.7	18.8	30.8	100.0
Store Own Food	14.8	12.5	0.0	0.0
Ice Box Not Reliable	25.9	0.0	0.0	0.0
Microwave Oven				
Better Selection	5.0	6.3	38.5	0.0
Present Equipment Broken	0.0	0.0	7.7	0.0
Faster, More Efficient	60.0	31.3	15.4	100.0
Oven				
Better Selection	11.1	44.4	7.7	0.0
Present Equipment Broken	44.4	0.0	15.4	33.3
Faster, More Efficient	11.1	0.0	0.0	66.7
Storage Facility				
Store Own Food	20.0	0.0	0.0	100.0

Likewise, mail survey results lend support to the crew's perception that better equipment is followed by better meal quality. Table 52 shows the equipment needed to improve their meals. Of those responding (51.0%), almost one-fourth feel the need for: a refrigerator (26.7%), a microwave (23.9%), and an oven (20.1%). Other items, while useful, were perceived as being less needed to improve meals.

Both groups of respondents agree on the importance of a refrigerator, microwave oven, and an operable oven in improving the meal quality on board their respective aircraft. Food and beverage variety which quite conceivably would be expanded with the installation of the above items would afford the crew members more satisfying inflight meals.

TABLE 52. Equipment Needed on the Aircraft for Better Meals: Mail Respondents (51.0% Responding)

Equipment	% of Responses
Refrigerator	26.7
Microwave	23.9
Oven	20.1
Freezer	5.5
Full Galley	4.1
Coffee Maker	3.5
Larger Hot Cups	3.0
Trash Containers	0.5
Sink	0.3

Menu Items to Remove. A list of the items that the on-site respondents would remove from the current menu in order to upgrade and improve it appears in Table 53. Junk food, including candy (24.7%) heads the list. This might be indicative of the crew members nutritional concerns. It is interesting to note that fried chicken, a traditional menu item, which appears on menus often with predictable frequency (21.6%) was second. Historically a popular item, it is possible that the frequency with which it appears is the reason that the respondents would remove it. The 75% who did not respond to having any items removed may have been concerned with any decrease in present variety, thus would agree with those mail respondents (See Table 32) who are dissatisfied with too few choices on the current menu.

TABLE 53. Foods To Be Removed From the Menu (66.4% Responding)

Item	% Responding to Remove
Junk Food - Candy	24.7
Fried Chicken	21.6
Box Lunch	19.6
Roast Beef - Too Fatty	18.6
Milk - Too Warm	11.3

It is speculated that Milk (11.3%) is included in this list as a result of the lack of cooling equipment (comment: too warm). It is strongly suspected that with the availability of refrigeration capabilities milk would then be removed from this list.

While the items in Table 53 may be rated unfavorably, it might be even more unfavorable to decrease present variety. For some of the respondents, items such as candy and junk food may be desirable for snacks, if not in fact appreciated with the meal. Although, since a sizeable percentage of respondents feel there is too much "junk food", some alternatives should be offered.

Menu Items to Add. The on-site respondents felt that the menu would be improved by adding those items listed in Table 54, which would require refrigeration (except for dried fruit) to ensure the best quality. These items would expand the present menu to include a larger variety and provide nutritionally acceptable alternatives to replace the snacks for those who expressed concern.

TABLE 54. Foods To Be Added to the Menu
(61.6% Responding)

Item	% Responding to Add
Fresh or Dried Fruit	22.2
Salads with Dressing	18.9
Fresh Vegetables	17.8
Juice, Soda and Cold Drinks	14.4
Yogurt	7.9

Summary Observations on the Existing System

In evaluating the existing Air Force inflight feeding system, the following major deficiencies were observed:

1. Crew meals served are generally sandwich meals or snacks, both consisting in part of the same sandwich varieties. Since Air Force Regulation 146-15 prohibits use of ground or chopped fillings for sandwiches, the fillings in use consist primarily of ham, cheese, roast beef, bologna, salami, turkey, or peanut butter and jelly. There is no cyclical pattern to these menus, and often from year to year, very few changes are made.

2. Hot meals (in the form of frozen meals) cannot be used on many flights due to the lack of, or inoperativeness of heating equipment. For example, the B-52G has no means of storing frozen meals, and often no equipment to reheat frozen meals. The KC-135 has an antiquated oven which will not accommodate the current generation of commercially packaged frozen meals, and does not have any refrigerated storage space. The C-130 and C-141 have no refrigeration, only insulated compartments which are too small and require the use of dry ice or gel-ice packs.

3. Even where sound equipment is available it may not be ideally suited to the mission of the aircraft or the needs of the crew; for example, the KC-10. Although this aircraft has a modern galley, the limitations of the convection oven in the galley are incompatible with the inflight requirements of the crew. During a mission, it is very difficult for crews to forecast when they will be able to eat. Often a crew member will start heating a meal and get taken away for some unexpected inflight duty before the heating cycle for the meal is finished. If the crew member cannot return to remove the meal from the oven at the appropriate time, it becomes overcooked due to the inordinate amount of residual heat which remains in the convection oven after the heat cycle is finished. Furthermore, crew members often need to schedule their meal consumption breaks independently, but the ovens have only a single mechanical timer

which does not allow independent or staggered reheating. All crews, but especially those who fly on tanker aircraft, have stated the ability to eat hot meals independently is very important to them, but is something they cannot do on board their current aircraft without risk of ending up with an undercooked or overcooked meal.

4. With the single exception of the C-5A aircraft, which has a troop compartment galley, the galleys on the other aircraft that may transport troops seem to have been designed with little regard to the problems and demands of passenger feeding. The C-141 can be supported, however, by means of a comfort pallet.

5. The ground support subsystem presently in use by the Air Force today is a very uncomplicated operation which does not vary to any great extent from base to base. A wealth of space, equipment, and staff are not necessary for food production, meal assembly, or warewashing. However, it seems the facilities and food service equipment allocated to flight kitchens can be compared to a "feast or famine" situation. Some flight kitchens are lucky enough to be very adequately equipped while some must struggle along with less than the bare essentials. The production flow, physical set-up, equipment inventory, and general design do not appear to have been decided upon according to any particular criteria.

6. Food service management personnel have little knowledge of what happens to flight meals after they are picked up from the flight kitchen, or of the types of (or the lack of) galley systems that exist on board the aircraft at their respective bases.

7. In general, the menus observed at and received from various bases are limited in choice, unimaginative in design, and lacking in variety. For example, menus received from a particular base during March 1985 and March 1986 were essentially the same with the exception of one cold sandwich item which had been substituted. Thus, only one item had been changed over the period of one year, while all the others remained the same.

8. Overall, crews consider quality as the most important factor involved in the meal selection decision. However, common sense tells one that there certainly is a level of cost where meal price might become the dominant factor. Crews rate the current set of items offered at slightly higher than neutral with regard to quality.

9. Crews would prefer hot meals to cold lunches for flight missions. They rate cold lunches and the standard frozen meals about the same for quality. But, they order frozen dinners much less often than cold meals. It seems the reason for this is that aircraft galley equipment is unreliable, not compatible with the mission requirements, or not available.

10. Galleys on board the aircraft are often very difficult to repair and as a result do not get serviced as often as they should. For example, the C-130 and C-141 galley systems are single frame construction, meaning, for example, the oven cannot be removed from the airplane without the whole galley coming with it.

In evaluating the shortcomings of the existing system, the following conclusions are made:

1. The current menu limitations in part described by Air Force Regulation 146-15 are a result of the lack of a means for ensuring safe storage of perishable products at a temperature below 45°F. If refrigeration could be provided on board aircraft, it would be possible to broaden the existing menu considerably and cater to contemporary menu preferences, including the trend toward healthier foods such as salads and other fresh items. Also, in light of many new processes/products available today on the commercial food service market the prohibition on chopped filling sandwiches should be reexamined.

2. The issues concerning heating capabilities on board aircraft are really fourfold:

a. Ovens on board the aircraft must be sized so that commercially packed frozen meals can be heated during flight.

b. Individual crew members must be able to heat their own meals in such a manner that the meals are hot when they choose to eat, but without running a risk of having these meals overcooked if flight duties interfere with the consumption of the meal at the anticipated time.

c. Under all circumstances food must be kept cold (i.e., 45°F or below) until such time that it is consumed or reheated. A system which imposes time restrictions (e.g., 5 hours) is bound to result in menu constraints. This is precisely what the present system has done.

3. Any and all galleys must be modular in design to facilitate maintenance away from the aircraft. Components which are hard mounted to the aircraft to meet load requirements must be done in such a manner that slide-in, slide-out installation and removal is possible.

4. Design of new flight kitchens or upgrades for existing facilities must be accomplished according to a predetermined and a well defined set of criteria, i.e., Air Force Table of Allowances For Flight Kitchen Equipment (TA 504). Such undertakings should not be approached with a "space available" point of view. This type of action will only perpetuate the existing situation of flight kitchens with inconsistent and sometimes inadequate designs. Food service and services staff in general must do a better job of convincing base level operations command staff personnel of the importance of inflight food service and the need for adequate ground facilities to support this function.

5. Food service managers must be required to fully understand how inflight meals are handled after they leave the flight kitchen, and be aware of the galley/food service equipment systems on board the aircraft they are servicing. Managers cannot plan the best menus for a particular system or suggest ideas to improve a system if they do not understand a major element in that system.

Every individual involved with flight meal preparation should be given a tour of the aircraft, and in particular, have the galley system explained to them. Furthermore, these food service individuals should see how the meals are transported to and stored within the aircraft, and observe what the conditions are like in the aircraft shortly before take-off.

For instance, the B-52 cockpit area is very small to begin with. When crews board with all their gear needed for a flight the flight deck area becomes very crowded. Such conditions have a bearing on the types of food service equipment that can be used/stored on the aircraft. Food service managers should be aware of these types of considerations concerning all aircraft for which flight meals are offered.

6. It appears that many (NOTE: not all!) food service managers do not have the time and/or interest to plan and offer greater variety in the flight menus. Of interest is the response to the survey question of what items crews would like to see removed from the menu: a fairly large percentage of the respondents listed fried chicken and roast beef, two mainstays of any Air Force flight feeding menu. What could be the reason for such a reaction? Possibly the quality of these items needs to be improved. Or is it that the quality is adequate but the customer is simply tired of seeing these same items on the menu day after day, flight after flight?

Added variety must be incorporated into the existing menus, either by additional selections, weekly or monthly specials, and/or a cyclical process, to increase customer satisfaction and maintain the achieved higher level of satisfaction. This cannot be a "one shot deal". The Air Force Engineering and Services Center must actively and in a participatory fashion mandate adequate variety in and periodic revision of flight menus. These menus must be given the same attention that dining hall menus receive.

7. Quality is certainly a very important factor (as is quantity) in the mind of the flight feeding customer. It also appears that the customer feels the current flight meals are lacking in quality. A restaurant which receives a slightly better than neutral ratings for its products, as was given to flight meals, would certainly not be in business very long. The quality of ingredients used for flight meals MUST be closely examined. Given the BDFA cost constraints imposed on the meals served, possibly a trade-off of quantity for quality should be experimented with. Higher quality ingredients could be put in the meals, but with less overall quantity (or fewer separate items but comparable quantity) in each meal, and customer reaction measured.

8. Crews also desire hot meals for flights. In addition to galley equipment to make such inflight service possible, the Air Force should actively pursue procurement of meals prepared by caterers for the commercial airline industry. Many of these meals are equal to or higher in quality than the "upscale" retail frozen meals, come in greater variety, and are much less costly. Caterers which survive in the highly competitive commercial airline industry have done so by offering quality products at the right price and by keeping pace with new trends in consumer eating habits which have changed so drastically in the 1980s. These companies serve a whole nation of consumers (similar to the task of the Air Force), and perform this task very well, despite the old hat comments one always hears about "airline food". The Air Force should and must jump on the bandwagon and take advantage of the talents, resources, and products of this well-established industry.

9. Flight crews are no different than any other food service customer of this decade. Natural fruit juices and fresh products are higher on their list of preferred products. Concerted efforts should be made to include more of these types of products in flight feeding menus.

III. EVALUATION OF COMMERCIAL SYSTEMS

Ground Support Subsystems

Except for the five U.S. civilian air freight carriers whose route structure is such that beverage service alone is sufficient, it was found that civilian carriers utilize extensive ground support facilities to ensure the operation of their crew inflight food service. In most instances, these facilities are caterer owned and the carriers contract with the caterers to supply specified menus and beverages to their flights. In a minimum of instances, airlines were found to operate their own kitchens. In those cases, whether in the U.S. or in Europe, these kitchens were found to be very large. This is contrast with the Air Force system which is spartan when compared to its civilian counterpart. The ground support subsystem in use by the commercial sector is complex, sophisticated, and multifaceted.

Food Preparation

U.S. carriers serve freshly prepared items to crew members. But at least for economy class meals, U.S. carriers seem to have largely delegated the responsibility of main course preparation for passengers to specialized frozen prepared food manufacturers. In some instances, meals are made by these manufacturers to the precise specifications of the airline based upon menus developed by the airline (as in the case of United Airlines). In other instances, the manufacturers offer the same components to airlines at large.

Not withstanding the fact that the European airlines visited do not appear to utilize frozen meals purchased from commercial sources, it was found that the concept of frozen meals has been well-received among these airlines as a means of supplying standard, high quality, sanitary meals for passengers at remote catering points. Thus, Alitalia, Lufthansa, Air France, and Sabena all prepare frozen meals for use on remote parts of their network. Although there is considerable interest among some of the carriers in possible methods for extending the shelf life of cold meals, sandwiches, snacks, etc., preparation of these items was found to be quite traditional. In contrast with the restrictions placed by the U.S. Air Force on lunch box components, there appeared to be virtually no restrictions on the part of the civilian carriers, except for Alitalia and Lufthansa.

As compared to the fairly restrictive menu offered to its crews by the Air Force, the civilian airline industry offers its crews foods broad enough to satisfy virtually all menu preferences.

Mode of Shipment to Aircraft

In most instances, food is kept chilled by means of dry ice as it is transported to the aircraft. A few exceptions were found where tray setups were transported without such chilling. Generally, there would be little cause for alarm since the food was kept in walk-in refrigerators prior to shipment to the aircraft. For some types of aircraft, several airlines use rather extensive systems for maintaining the cold temperature of the chilled foods.

Of particular interest with respect to crew feeding was the ATLAS tray carrier utilized by the European airlines. This is a high impact plastic tray carrier, lightweight, but not insulated. It nevertheless retains cold foods at a safe temperature when utilized with dry ice. The carrier is a versatile modular unit in that it will hold individual meals in disposable trays; drawers holding bulk items; or insulated styrofoam inserts to maintain frozen meals or heated meals at their proper temperature. In some cases, a combination of individual meals and bulk items were observed to have been loaded in ATLAS tray carriers. Because a number of the European airlines have adopted this tray carrier for their crew meals (it was seen used in Rome, Paris, Brussels, and Frankfurt) and because it is manufactured by different suppliers in each of these counties, it can be assumed that the airlines are satisfied with it for their crew feeding.

In its present form, the ATLAS tray carrier requires dry ice as a refrigerant if food is to be kept on board the aircraft for several hours at refrigerated temperatures. Since it is not an insulated carrier, it is not likely that "blue ice" would be satisfactory as a substitute for dry ice. While the disposable, hinged, thermoformed trays used by the European carriers for their crew meals are attractive, they are likely to be too small for use with a conventional Air Force lunch box meal. These disposable hinged trays provide a capacity of approximately 132 cubic inches as compared to 240-256 cubic inches volume provided by the type of lunch boxes used in some of the flight kitchens visited.

On the other hand, the 11 x 16 inch disposable tray used by Flying Tigers would provide enough room for all of the meal components going into the Air Force meals and would also lend itself to use for frozen meals, cold meals, or other menu components.

Crew meals are in all instances provided by flight kitchens. Either carrier-operated or caterer-operated, high lift trucks are available for boarding the meals aboard the aircraft. In the case of U.S. Air Force bases, it appears that high lift trucks are available only for food service on MAC bases where Fleet Service is responsible for the servicing of the galleys of the aircraft prior to departure or in transit. For this reason, particular attention was paid to those methods used by civilian carriers that involved hand-portable equipment. The ATLAS carriers, or any other typical tray carrier, would be hand-portable even when fully loaded. Tray carts, on the other hand, would require the use of a lift truck.

Onboard Feeding Subsystems

A variety of onboard subsystems were found in the survey of the civilian sector. Figure 16 summarizes the crew meal delivery methods in use by the various carriers. It should be noted that the majority of carriers, whether they use fresh meals or meals that are frozen (either on their premises or by a commercial manufacturer) board these meals in a chilled state (shown in Figure 16 are several airlines that were not directly interviewed, such as British Airways or Air Afrique, but about whose practices information was received from caterers). A few of the carriers board frozen meals in a frozen state and keep them frozen until they are required for reheating on board the aircraft. Of the U.S. carriers, only TWA follows this practice and then only for its extended flights.

FROZEN MEALS BOARDED FROZEN	-	AIRLIFT INTL EVERGREEN UTA (except Paris) TWA (long haul)
FRESH/FROZEN MEALS BOARDED CHILLED	-	AIR AFRIQUE AIR FRANCE AIR INTER AMERICAN BRITISH AIRWAYS FLYING TIGERS PAN AM (except some 727) RICH INTERNATIONAL SABENA TWA (short haul) UNITED (wide bodies) UTA (Paris)
FRESH/FROZEN MEALS BOARDED HOT	-	PAN AM (some 727) UNITED (narrow bodies) USAIR
PASTEURIZED MEAL COMPONENTS BOARDED CHILLED	-	ALITALIA
CANNED MEAL COMPONENTS BOARDED AMBIENT	-	LUFTHANSA

Figure 16. Crew meal delivery methods in use - civilian carriers.

The practice of boarding meals hot and keeping them hot in transit and on the aircraft until served to passengers or crews has largely fallen out of favor and is being used only where galley equipment limitations or brief flight duration make any other alternative impractical. This is the case on some narrow-body planes not equipped with high heat ovens, or on flights where the time precludes the reheating of chilled meals. USAir, whose flight structure involves short hauls, has opted for insulated trays that retain hot menu components hot and cold menu components cold. Only pasteurized meal components are used by Alitalia for their crew meals, while Lufthansa cockpit crews are required to consume only sterilized (i.e., canned) meal components.

Hot Food/Insulated Trays

The Aladdin Insulated Tray System is currently used by USAir on its entire system and by several other airlines including Frontier, Piedmont, and United Airlines on some flights. It is a very demanding system because of the speed with which food must be plated in the kitchen so as to not lose its temperature, and the scheduling of this plating immediately prior to flight departure. It does not appear that the insulated tray system offers any useful potential to the Air Force for its crew feeding problems. In addition, a minimum of eight trays are required for temperature maintenance, and would have to be used on all flights, whether or not that many meals were needed. Even USAir, the major user of this system, has not found it feasible to utilize the insulated tray system for crew feeding because balancing equipment for crew meals among its various stations proved to be too bothersome.

Hot Food/Holding Ovens

The hot food system in which meals are boarded hot, kept hot, and served hot to passengers and crews is practical for civilian airlines which enjoy the benefit of well-equipped, well-staffed, well-managed flight kitchens, and where flight durations are relatively predictable and forecast by flight schedules. Such a system requires that all meals be consumed within a relatively short time and that no meals be kept hot from the time that they are plated until they are consumed for more than 2½ to 3 hours. Food quality deteriorates relatively rapidly at food holding temperatures. It is not deemed practical for the Air Force to employ such a system for crew feeding. The survey showed that the civilian sector has, on the whole, abandoned this practice.

Chilled Foods/Convection Ovens

Use of convection ovens in conjunction with chilled foods is predominant in the civilian airline industry for both passenger feeding and crew feeding. It is used, not only on board passenger carrying aircraft, but also among cargo carriers or on freighters operated by passenger airlines such as Pan Am or United. The chilled food must be kept refrigerated either by using dry ice or by mechanical refrigerators. The convection ovens provide a means for crew members to reheat meals at their convenience in a relatively short period of time (approximately 30-35 minutes). Food quality is usually acceptable, provided that meals are not overheated and have been properly designed for convection heating. One problem area arises when meals are not removed from the oven after the heating cycle has been completed because the residual oven heat will continue to heat the meal, eventually causing scorching and dehydration.

Chilled Food/Self-Heating Cart

This type of system, exemplified by the PTC Aerospace Singl Serv cart, is not only the most innovative encountered in the survey but offers the best potential for a major improvement in the Air Force crew feeding system. In its original civilian format, the utilization of the Singl Serv system would require plating of the meal in flight kitchens and transport of the cart on board the aircraft on high lift truck. However, it is deemed possible to develop a hand-portable version of this system for the the Air Force that would: 1) utilize the commercial precooked frozen meals in their 7 x 9 inch trays; 2) be adaptable to the transport of 8 to 10 meals (as opposed to 24 to 36); 3) provide individual operating controls so that each crew member could heat his or her meal individually when desired; and 4) be mechanically refrigerated rather than dependent upon the availability of dry ice.

Frozen Food/Convection Ovens

Convection ovens are being used also for the direct reheating of frozen meals by some of the carriers at least on certain flights. TWA uses this practice widely on long haul, wide body flights.

Frozen Food/Microwave Oven

Microwave ovens were not found in use by any of the carriers interviewed. TWA had used them in the past as an auxiliary heating device in first class. Obviously the civilian carriers, who are primarily concerned with feeding passengers, view microwave ovens as a relatively expensive and slow heating device for volume feeding as compared to convection ovens. While the microwave ovens can heat a single frozen meal in 6 to 8 minutes, this time is multiplied for each additional meal heated. Conversely, a convection oven can heat several dozen meals in the same 30-35 minutes that it would take to heat a single meal. Microwave ovens, however, do offer an interesting potential for crew feeding on board Air Force planes since they can heat meals individually as required and do so more rapidly than any other oven.

Management Subsystems

It is clear that a major difference between the civilian feeding systems studied and the U.S. Air Force's inflight feeding system lies in the sophistication and complexity of the management subsystems used by the civilian carriers. It must be recognized by the Air Force that any improvement in its crew feeding system will demand counterpart improvements in its management structure, currently geared entirely to the fairly simple menus offered.

Centralization of Decision-Making

The most significant difference observed between the civilian sector and the military sector in terms of inflight feeding is the centralization of authority that exists in the civilian sector. Civilian carriers have corporate food service staffs whose mission it is to plan and operate the total food system within the corporate goals of the organization. Even if a carrier relies on outside contract caterers to prepare and board the meals, the airline's food service executives plan menus, control costs, design the preparation and service of the food on board the aircrafts, and train cabin personnel involved in inflight food service. Thus, there is an ability to plan food service to accomplish specific corporate objectives and to provide all human and fiscal resources to achieve these objectives.

The visitations made to U.S. Air Force bases, on the other hand, revealed that there is considerable fragmentation of responsibility. Flight kitchens prepare meals ordered by passenger service (in the case of MAC bases) or by crew members (in other cases) but have no responsibility in getting the food to the aircraft or ensuring that it is handled in a manner that will result in optimum meal service for the customers.

Indeed, a philosophy seems to prevail that any "frills", such as preset trays, are not necessary requirements in the fulfillment of the Air Force's mission. This may be true. However, any substantial improvement in the flight feeding system on board Air Force planes will mandate a change in attitude and a genuine desire to improve the variety, quality, and attractiveness of the food being served. In addition, it is felt that Air Force crews should at least get a level of service comparable to coach class customers of civilian airlines. Indeed, civilian crews often get first class service.

When a civilian carrier plans a new menu or even new menu components, a considerable amount of testing is involved, including inflight testing and observation of customer reaction. This is feasible because the decision maker (i.e., the food service director and his staff) has the ability to plan the menus, source the ingredients, specify the preparation methods in the kitchens, design the presentation methods and the packaging methods, and specify the serving and handling procedures to be used on board the aircraft. The same degree of control would seem to be mandatory, to some extent, in the Air Force if a quantum improvement in food service were to be made. This would broaden the role of the food service officers and give them the ability to go on board the aircraft based at their installation and beyond the confines of their flight kitchens and ground feeding facilities. This can be done without requiring them to transport meals to the aircraft or perform inflight food service tasks.

Menu Planning

As in all other sectors of the food service industry, menu planning in airline food service must take into account the desires of the customer population, management's organizational objectives, and the constraints of facilities and equipment. In the civilian sector, the organizational objectives frequently reflect the marketing objectives of the carrier insofar as passenger meals are concerned. With respect to crew feeding, however, union contracts with the pilots' union, cabin attendants' union, etc. appear to dictate the level and type of meal service that is to be offered.

Most of the carriers interviewed place a great deal of emphasis on variety and quality of the crew meals. This emphasis may be a reflection of union concessions already negotiated or a pragmatic realization by the carriers of the importance of maintaining employee morale. Whatever the motivation, the results of the survey were very clear: civilian air carriers believe that their crew meals should be at par with the best of that they would offer their passengers. If an airline flies first class passengers, the crew meals are either first class meals or close to it. If an airline, such as the charter airlines, fly economy passengers only, the crew meals are of that quality or better. Hot meals are considered important by the civilian carriers and are used except on those short hauls where it would be impractical. In the case of USAir, which specializes in short hauls, hot crew meals are boarded even for flight segments where no passenger food service is involved.

It is clear from the foregoing that each carrier has a certain set of considerations that must be taken into account in the menu planning process. In no instance in the civilian sector study was it found that a local flight kitchen would, on its own, develop a menu to be offered to the aircraft that it is servicing. This responsibility resides with a central menu planner (who is generally the Director of Dining Services for the airline). This is true even where a basic set of menus and recipes has been developed by the airline for crew feeding.

The reason is that it is the Directors of Dining Services' responsibility to ensure that menus are properly rotated so that crew members are not subjected to repetitiousness in selections. Inevitably the civilian system also provides a means for responding to desires of its customer population (crew members). Through the crew flight reports, direct comments to the food service division, or through union representatives, food preferences of crew members are channeled to the menu planners.

It was observed that the food service management of the airlines interviewed seem to be very responsive to the desires of their crews. Printed menus obtained from several of the airlines showing crew meals were developed by processes that took these customer desires into account. Such a process is currently nonexistent in the Air Force since flight kitchens have very limited flexibility in varying the menu. Since dry ice or mechanical refrigeration and galley ovens are the rule rather than the exception on board civilian aircraft, the menu planning process among the civilian carriers can provide a wide choice of cold or hot meals. At present, the Air Force system does not allow this degree of flexibility because in many instances, even on aircraft that presumably have heating capabilities, there is a lack of refrigeration and ovens of questionable performance.

Logistical Control

Crew feeding for the civilian carriers is handled as an offshoot of passenger feeding. Therefore, the entire ordering, production scheduling, delivery process, and the machinery set-up to implement these functions for the passenger meals are utilized for crew meals as well. Generally, there is advance notice as to crew meal requirements, permitting orderly planning of the catering for crews whether on board passenger or cargo aircraft. The more advanced flight kitchens use computerized systems for the management information that is involved. Some of the airlines visited, particularly those in Europe, efficiently handle very diverse crew meal requirements for a large number of international carriers, many of which have very unique menu and equipment requirements.

It has already been pointed out that the Air Force system is very splintered as compared to the civilian system, but the point is important enough that it bears repeating. In a conventional civilian catering situation, after all of the necessary advance ordering, production, preparation and delivery by the catering truck to a galley, there is the interfacing of the catering personnel on that truck with crew members as they load the galley. At that point, any problems of meal shortages, equipment failures, lack of supplies can be resolved. At Air Force bases, even those that operate for MAC and are provided with Fleet Service organizations, there is no interfacing of the flight kitchen personnel with crew members on board the aircraft. Therefore, whatever corrective measures might be required are limited to what Fleet Service is able to do on its own. Most Air Force bases, however, do not have Fleet Service and it is entirely the responsibility then of the crew chief, boom operator, or other crew member (who are not food professionals) to take action to resolve the problems.

Cost Control

By and large, costs in civilian sectors are controlled much in the same manner as in the Air Force. In lieu of the BDFA and the percentages thereof which govern inflight meal costs, civilian carriers generally set up both percentage food cost budgets and total meal costs. For example, an airline carrier might negotiate a 40% food cost for the meals to be supplied to the airline by a caterer. In addition, the airline might indicate that a ceiling of $5.00 per crew meal is to apply. In this case, the caterer would have $2.00 in raw food cost allowed per meal. The caterer provides the airline with data on the current ingredient costs so that the airline can monitor the cost of the foods being supplied to them.

Quality Control

Quality control practices were found to vary extensively among the civilian carriers interviewed. In the majority of cases, reliance was primarily placed on flight crew reports. Some airlines, however, such as Air France, have staffs of full-time quality auditors who ensure that quality specifications for all meals are being followed, whether in the airlines' or caterers' kitchens.

More often, however, it was stated that it was the responsibility of the station manager at each location to ensure that the airlines' quality requirements were being met and this would be as true for a cargo airline as for a passenger airline.

It would appear that there is no similar, ongoing effort at the present time at work within the Air Force. Relatively little base-level-organized attention has been focused on the quality of meals for inflight feeding.

With regard to quality assurance and safety of frozen meals not consumed during a flight, it appears Environmental Health Officers spend a fair amount of time monitoring these returned meals. It seems rather inefficient, cost wise, for an officer to be checking whether a returned frozen meal has thawed or not, not to mention the cost of handling and re-issuing these meals. Perhaps the Air Force would be better served if efforts were made to make meal requirement forecasts more accurate. This would reduce the number of throw-aways, and greatly reduce the postflight handling (and expense) of inflight meals. Meals leftover after a flight should just be disposed of.

Conclusions on Commercial Systems

The study of commercial crew flight feeding systems has resulted in the following major conclusions:

1. Civilian flight feeding systems are structured upon well-planned, well-organized, and well-managed subsystems addressing ground support, on board feeding, and system management.

2. Civilian carriers give a high degree of priority to the quality, variety, and safety of their crew meals and, in a majority of instances, serve first-class-type meals to cockpit crews.

3. Hot meals are generally offered to crew members, except on short flights when only beverage, snack, sandwich, or cold meal service is practical. In no instance was it found that an airline limited its menu selection because of lack of availability (or unwillingness to make available) dry ice for refrigeration or galley ovens.

4. The civilian sector is able to use a total systems approach to its crew feeding requirements because decision-making is centralized within the food service department of the carrier. Thus, centralized menu planning, sourcing of meals, scheduling and planning of inflight equipment and procedures can be effectively planned, implemented, and supervised.

5. The preferred method of handling meals was found to be the boarding of meals in a chilled state and the reheating of the hot portion of the meal in convection ovens. This is generally the practice even where commercially manufactured frozen meals are being used.

6. The practice of boarding hot meals hot has largely been abandoned by the airlines, except for very short hauls and some narrow-body planes and is not recommended for consideration by the Air Force.

7. The utilization of insulated trays to retain the temperature of hot cold food was evaluated and found to be unsuitable for crew feeding on board civilian carriers. It is therefore, not recommended for consideration by the Air Force.

8. Microwave ovens are not in use for crew feeding by commercial carriers but offer certain advantages in terms of speed of heating and convenience, making them worthy of consideration for Air Force crew feeding.

9. A new system of transporting meals in carts that maintain meals under refrigeration, and reheat the hot portion of the meal without further handling, is being tested by several airlines and should be given serious consideration in connection with Air Force inflight crew feeding.

IV. ANALYSIS OF ALTERNATIVE ONBOARD SYSTEMS

System 1 - Insulated Carriers for Cold Foods

The simplest possible way of expanding the current inflight menu is through a method of safely keeping cold food cold. This is normally achieved in the air transport field through the use of dry ice. However, dry ice is not generally available to Air Force flight kitchens (except for the larger MAC bases) and therefore could not be depended on as means for cold temperature maintenance. Some Air Force bases do use insulated containers, but only on a limited basis.

As part of a contract work effort for this project, so-called "blue ice" was evaluated in conjunction with insulated carriers as a means of maintaining cold temperatures of inflight meals until consumed. The results of this evaluation are presented in Appendix C. This study concluded blue ice is a feasible method for use in insulated carriers to maintain chilled or frozen foods at 45°F or below for the 10- to 12-hour period that might be required by the Air Force for flight feeding.

The particular insulated carrier used was a Model 171 Thermosafe (Figure 17), front opening transporter, with 2 inches of insulation, manufactured by Polyfoam Packers Corporation of Wheeling, Illinois. This type of insulated carrier is rugged in construction, fully sanitary, and extensively used in the food service industry. It is a portable unit which could be easily handled in the ground support system much in the same manner as beverage jugs are currently used.

Figure 18 summarizes the alternative on board systems identified and their menu expansion capabilities. It will be noted that the insulated food carrier alternative would permit expansion of the existing menu to include items such as salad plates, chilled desserts, fresh fruit salad, and yogurt, and beverages served at appropriate cold temperatures.

Insofar as the ground support system would be involved in implementing this alternative, it is anticipated that the flight kitchens would be required to sanitize the carriers when they are turned in at the flight kitchen, store blue ice in the freezer, and load the carriers with crew meals for specific flights. Meals would no longer be transported loose or in paper bags as they are now, but would instead be transported to the aircraft under proper conditions of refrigeration, which could be maintained for a time period long enough to accommodate most Air Force flight missions. Maintenance of proper temperatures for cold storage of any menu item prolongs and enhances end product quality (vs. ambient storage) and thereby improves customer acceptance.

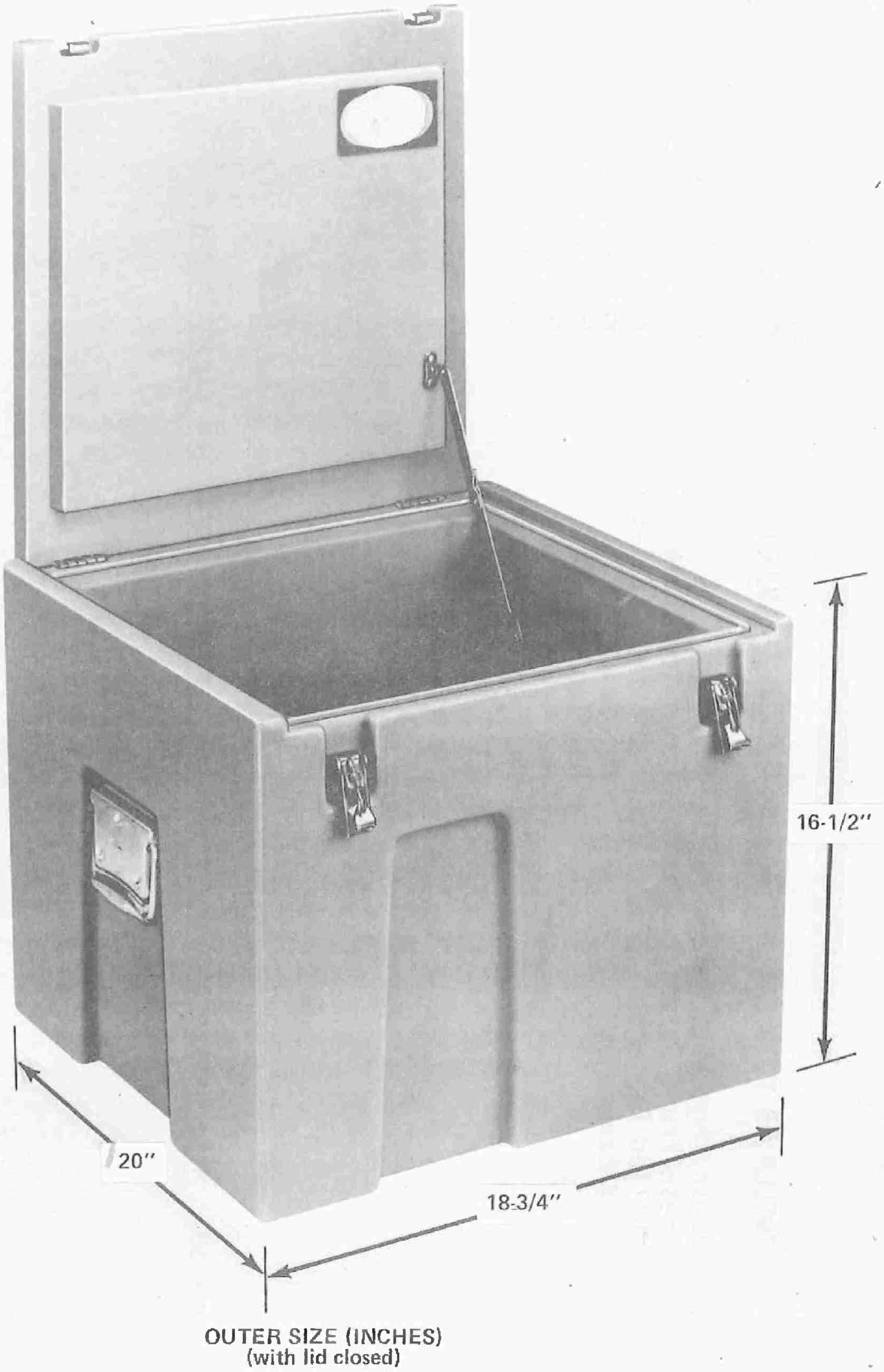


Figure 17. Model 171 Thermosafe (insulated carrier) polyfoam.

ALTERNATIVE	INSULATED FOOD CARRIER	MICROWAVE GALLEY	FOOD SERVICE MODULE SYSTEM
MENU EXPANSION CAPABILITIES	Fresh Vegetable Salads Fresh Fruit Salads Chilled Desserts Cold Beverages	Soup Fresh Vegetable Salad Fresh Fruit Salad Hot Snacks Hot Sandwiches Hot Meals Chilled Desserts Cold Beverages	Fresh Vegetable Salad Fresh Fruit Salad Hot Snacks Hot Sandwiches Hot Meals Chilled Desserts Cold Beverages

Figure 18. Alternative onboard subsystems and menu expansion capabilities.

System 2 - Microwave Galley

The interviews with crews of the KC-10 aircraft and KC-135 aircraft revealed a substantial need for flexible eating times due to the nature of the tanker mission and tasks which must be performed during flight. One available method of heating foods that would respond to this requirement is the microwave oven. Microwave ovens are in use by the Air Force on VIP aircraft and have met all the certification requirements for inflight use. If refrigeration capabilities are combined with the rapid heating capabilities of the microwave oven, it is clear that there exists a basis for a system (Figures 19 and 20) that would provide both the desired menu expansion capabilities and functional requirements which were identified as being desirable. It should be pointed out that the retail sector of the frozen food industry now manufactures a wide range of ready-to-eat microwavable snacks, casseroles, and complete dinner products. These are, however, in a higher price range than the frozen dinners currently used in the inflight feeding program. However, the use of microwave ovens on board Air Force aircraft would be fully compatible with the commercial availability of meals designed for microwave heating. Microwaves also allow quick reheating of meals for individual service.

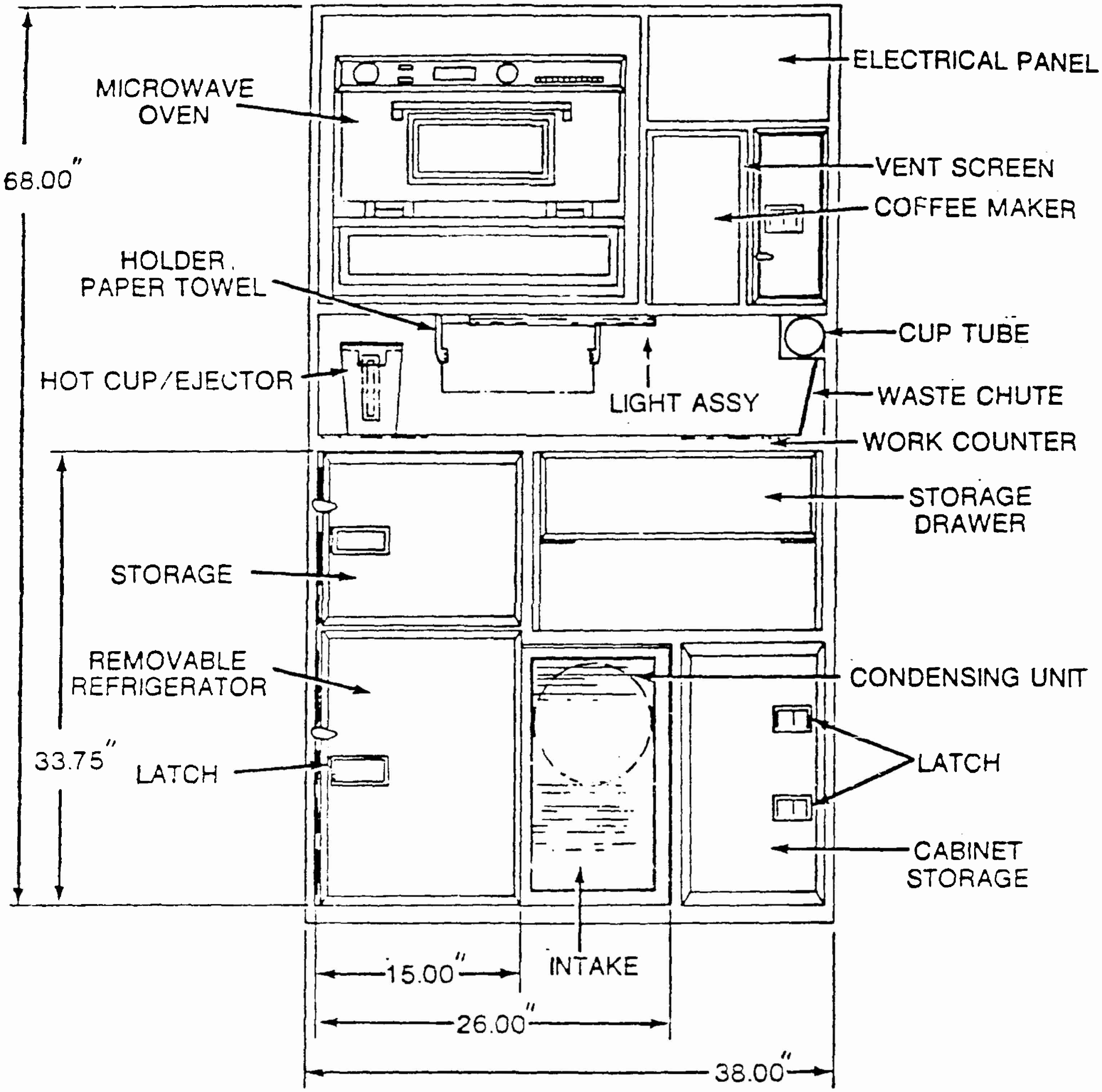
System 3 - Food Service Module System

The most innovative advance in inflight feeding uncovered in this study was the advent of self-heating carts for inflight use in the commercial sector. These carts have the ability to accept fully assembled tray meals, maintain the meal components chilled as long as may be required, and selectively reheat the hot meal components when desired without heating the cold meal components.

The Food Service Module System alternative is a modification of the commercial cart system. The unit would be modular in nature, have a capacity of 10 meals and could be used either by itself as a single unit for crew feeding or in multiple numbers for passenger feeding. Whereas the commercial version of this equipment utilizes dry ice as a refrigerant and/or mechanical refrigeration equipment built into the aircraft, the Air Force version would utilize a self-contained mechanical refrigeration system.

The rethermalization principle of both the commercial and military versions is conduction heating. The hot meal portion of the tray is positioned above a heating pad when a tray carrier (which holds the meal trays) is inserted into the Module unit. In the case of the Air Force version, the heating pad would be large enough to accommodate the 7 x 9 inch standard commercial frozen dinner, and just about any single serving frozen meal available from the commercial market.

In order to have a unit that is really portable it was important to keep the weight of the tray carriers down to a minimum. Accordingly, it was decided to separate the tray carriers from Module galley equipment, which would contain the necessary controls and reheating and refrigeration systems. Thus, the tray carriers would be used to transport meals to the aircraft and soiled materials back to the flight kitchen. On board the aircraft, the tray carriers would be inserted into the Module unit, which would be permanently installed on the aircraft.



MICROWAVE OVEN GALLEY CONCEPT

Figure 19. Microwave oven galley concept - front view.

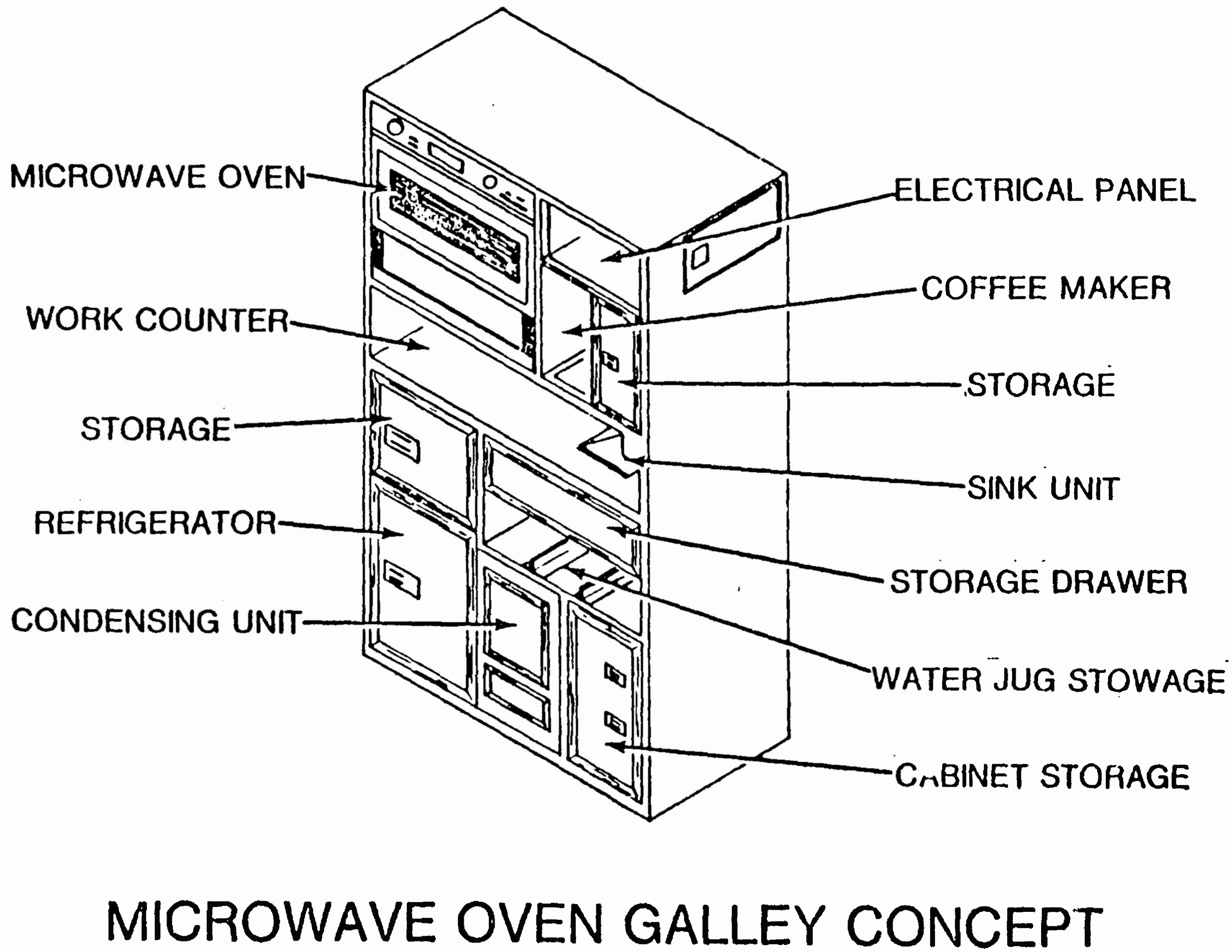


Figure 20. Microwave oven galley concept - side view.

Unlike the commercial version of this system (Figure 21) in which all meals have to be heated at the same time, the Air Force version (Figure 22) would allow individual controls for each meal so that crew members could elect to eat when they want. Heating would require approximately 40 minutes for a frozen meal. Once a meal has been heated, the heater would automatically shift into an automatic holding mode, thus ensuring that the hot meal would be kept at serving temperature but not overcooked. On the other hand, cold items within the carrier (i.e., sandwich meals, salad plates, beverages, desserts, fruits, etc.) would be kept suitably refrigerated. It is important to note that the automatic holding mode system would satisfy crew requirements of flexibility in meal service.

Analysis of the Alternatives

In order to analyze the three alternative on board systems selected for study, a set of criteria and a scoring system were developed which addressed principal issues related to the Ground Support Subsystem, the Onboard Subsystem, and the Management Subsystem. Tables 55, 56 and 57 list these criteria and the scoring system developed to quantify the analysis.

It will be noted in Table 55 that the criteria for evaluating proposed systems in terms of their impact on the Ground Support Subsystem considered effects on staffing, facilities, equipment, and sanitary risk at the flight kitchens. A maximum score of 20 was allowed for the impact on the Ground Support Subsystem if a proposed on board subsystem had no adverse effect on the Ground Support Subsystem.

Table 56 identifies the criteria used in evaluating a proposed inflight feeding system on the On Board Subsystem. The criteria address space restrictions, structural modification considerations, energy availability, whether or not the proposed system provides hot meals and refrigeration, flexibility of eating time, speed of reheating, ease of on board handling, satisfaction of food preferences, and sanitary risk. Because of the importance of the On Board Subsystem, a maximum score of 75 was possible. With respect to the criterion described as "speed of reheating" a system scoring perfectly for this criterion would permit crew members to eat at anytime of their choosing within 10 minutes of their decision to eat. For "flexibility of prep time", if all crew meals had to be heated individually, because the functional design of the equipment made, the score would be 0. On the other hand, if crew members could eat at individual times, according to a staggered schedule, or all at once, the score given would be 10. These particular criteria thus dealt not only with the ability of crew members to eat individually but the length of time required to ready the meal.

Table 57 lists the criteria used in evaluating the impact of alternative inflight feeding systems on the Management Subsystem. The individual criterion identified were the ability to operate within the BDFA, the ability to procure food specified readily from commercial sources, compliance with the Air Force flight feeding regulations, and the complexity of managing the subsystem. A maximum score of 25 was possible for this part of the analysis.

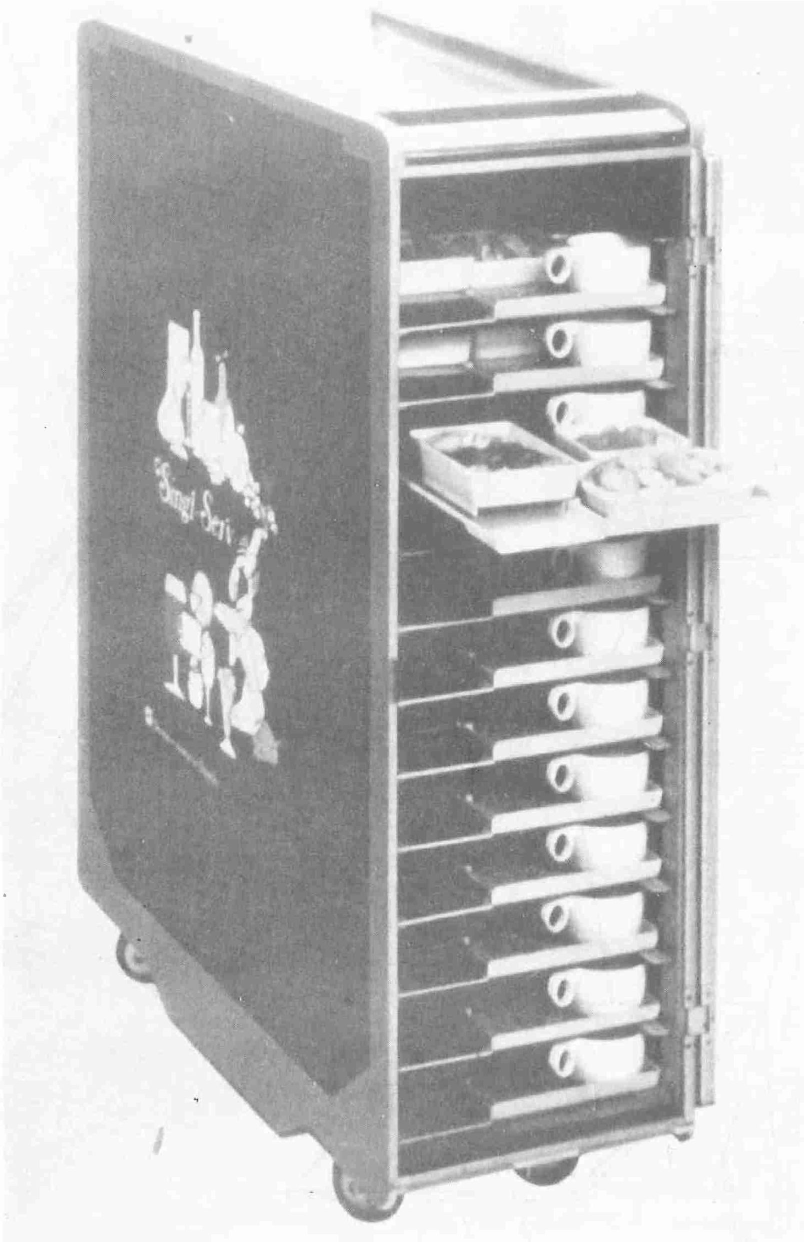


Figure 21. Singl Serv cart.

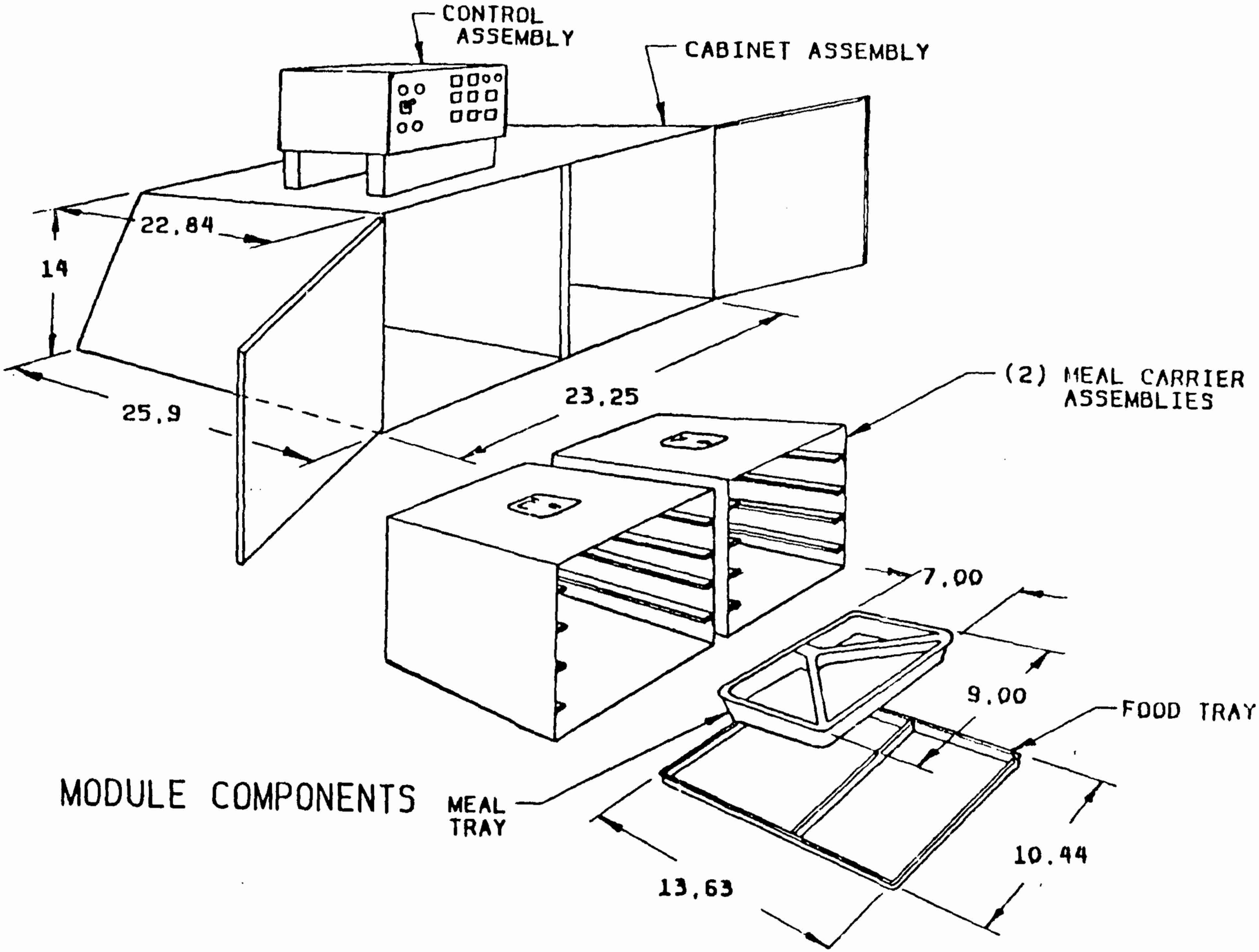


Figure 22. <u>Food service module components</u>.

TABLE 55. Criteria for Evaluation of Alternative Inflight Feeding Systems on the Ground Support Subsystem

CRITERION	SCORE	SCORE	SCORE	CRITICAL FACTOR
Staffing Required	5 No additional Flight Kitchen Staff Required	3 Required 10-25% Increase in Staff	0 Requires Over 25% Increase in Staff	
Flight Kitchen Facilities	5 No Additional Facilities Required	3 Requires Slight Increase in Facility Space	0 Requires Substantial Increase in Facility Space	
Flight Kitchen Equipment	5 No Additional Equipment Required	3 Under $5,000 New Equipment Required	0 Over $5,000 New Equipment Required	
Sanitary Risk	5 None	3 Some Under Extreme Conditions	0 Some Under Normal Conditions	*
MAXIMUM SCORE	20			

TABLE 56. Criteria for Evaluation of Alternative Inflight Feeding Systems on the Onboard Subsystem

CRITERION	SCORE	SCORE	SCORE	CRITICAL FACTOR
Space Restrictions	5 None	3 Space is Difficult to Get	0 Space Not Available	*
Structural Modifications	5 None	3 Requires Slight Modification	0 Major Modifications Required	*
Energy Availability	5 Energy Needed is Available or Not Required	3 Energy is Available But Could Impact on Mission	0 Energy Cannot be Made Available	*
Provides Hot Meal	10 Provides Hot Meals Under All Conditions	5 Provides Hot Meals Under Certain Conditions	0 Does Not Provide Hot Meals	
Provides Chilling Capability	10 Provides Chilling Under All Conditions	5 Provides Short Term Chilling	0 Does Not Provide Chilling	
Flexibility of Prep Time	10 Prepared Individually, Staggered or All At Same Time	5 Prepared Individually or All At Same Time	0 Prepared Individually	*
Speed of Reheating	10 Individual, Staggered, or Multiple Heating in Less Than 10 Minutes	5 Individual Meals Reheated in Less Than 10 Minutes	0 Reheating Requires Greater Than 10 Minutes	
Ease of Onboard Handling	5 Minimal Handling No Skill Required	3 Moderate Handling	0 Time and Skill Required for Preparation for Serving	
Satisfies Food Preferences Within BDFA	10 Can Satisfy All Preferences Revealed by Survey	5 Provides Moderate Improvement Over Existing System	0 Cannot Improve Over Existing System	*
Sanitary Risk	5 None	3 Some Under Extreme Conditions	0 Some Under Normal Conditions	*
MAXIMUM SCORE	75			

TABLE 57. Criteria for Evaluation of Alternative Inflight Feeding Systems on the Management Subsystem

CRITERION	SCORE	SCORE	SCORE	CRITICAL FACTOR
Ability to Remain Within BDFA	10 No Additional Cost Over Existing Foods	5 Requires 1-90% Increase in Food Cost	0 Requires Over 10% Increase in Food Cost	*
Ability to Procure Foods Specified	5 Readily Procured From Existing Commercial	3 Can be Procured in Some Locations & Must be Shipped	0 Requires Custom Manufacturing	*
Compliance With AF Regulations	5 Complies With All Existing	3 Requires Minor Modifications	0 Requires Major Policy Changes	*
Complexity of Managing Sub-Systems	5 Can Be Managed by Current Personnel & Procedures	3 Requires Some Additional Personnel or Procedures	0 Requires Large Increases in Personnel or Major Changes in Procedures	
MAXIMUM SCORE	25			

It is important to note that in each of the component parts of the analysis there were certain criteria that were identified as "critical factors". These criteria were deemed to be of such importance that if the system scored 0 for any one critical factor, the system would have to be rejected regardless of how high its numerical score might be.

Detailed results of the analysis of the three alternative systems studied are presented in Appendixes D through F. Each alternative was analyzed separately for its impact on the Ground Support Subsystem, Management Subsystem, and the On Board Subsystems for the six types of aircraft. For the convenience of the reader in making comparisons between the impact of the three alternatives on each of the total system elements, the Appendixes are grouped by the flight feeding subsystem rather than by the alternative. For example, Appendix D refers to evaluation of the alternatives on the Ground Support System; Appendix E to the Management Subsystem; and Appendix F to the On Board Subsystem.

Table 58 presents an overall summary of the result of the analysis. Noted is that the three alternatives had equal scores of 14 for their impact on the Ground Support Subsystem, and nearly equal scores for their impact on the Management Subsystem with the Insulated Food Carrier alternative scoring highest in this regard. Scores varied considerably for their impact on the On Board Subsystem. However, the Food Service Module System consistently scored higher for the six aircraft analyzed.

The aggregate scores (combining the 6 aircraft scores) for each criterion are presented in Table 59. The information contained in this table highlights both the outstanding and less notable features of each alternative based on perceived inflight performance.

System 1, the Insulated Carrier, achieved a total score of 281 points out of a maximum possible 495 (Table 58). This system basically provides cold menu expansion (i.e., salads and salad-filled sandwiches) and poses the least problem with regard to space restrictions, since it would not need to be hard mounted into the aircraft as the Microwave Galley and Food Service Module would (Table 59). The insulated food carriers are bulky and would be a problem onboard the B-52 aircraft, and possibly the C-130. In the case of the other aircraft, it is felt that use of the insulated carriers would upgrade the quality of the food service on board the tanker and transport aircraft studied because of the cold menu expansion and the ability to safely transport items in a chilled state. Thus, even an aircraft such as the KC-135 with its very primitive existing galley could have a much improved crew food service by using an insulated carrier with blue ice.

System 2, the Microwave Galley, received a total score of 362 points out of 495. It scored highest on "speed of reheating" because it is the only one which, in fact, would permit crew members to ready hot meals in 10 minutes or less. However, this alternative poses involved handling for the user, and is not a quick reheating alternative when several meals must be heated.

The issue of flexibility of preparation time was found through crew interviews to be the most critical on board the KC-10 and the KC-135 due to the nature of their duties. In the case of the KC-10, crew interviews disclosed the limited utility of the convection ovens for crew meal heating.

TABLE 58. Summary of Evaluation Scores for Alternative Onboard Subsystems

SYSTEM COMPONENT	SYSTEM I INSULATED FOOD CARRIER	SYSTEM II MICROWAVE SYSTEM	SYSTEM III FOOD SERVICE MODULE SYSTEM
Ground Support Subsystem	14	14	14
Management Subsystem	25	23	23
On Board Subsystem for:			
B-52	39	49	61
KC-10	41	56	63
KC-135	41	56	63
C-5A	41	56	63
C-130	39	54	61
C-141	41	54	61
TOTAL SCORE:	281	362	409
MAXIMUM POSSIBLE SCORE:	495	495	495

TABLE 59. Aggregate Criterion Scores for Alternative Onboard Subsystems

EVALUATION CRITERION	TOTAL POSSIBLE SCORE	ACTUAL SCORES ALTERNATIVE ON BOARD SUBSYSTEMS INSULATED CARRIER	MICROWAVE	MODULE
Space Restrictions	30	26	24	24
Structural Modifications	30	30	18	18
Energy Availability	30	30	30	30
Provides Hot Meal	60	0	60	60
Provides Chilling Capabilities	60	30	55	60
Flexibility of Prep Time	60	60	0	60
Speed of Heating	60	0	30	0
Ease of On Board Handling	30	18	18	30
Satisfies Food Preferences Within BDFA	60	30	60	60
Sanitary Risk	30	18	30	30

A proposal to this effect from a supplier has been received. However, that supplier's existing aircraft microwave oven is too large to fit into the space that would be vacated by the two convection ovens. Nevertheless, for the purpose of this analysis, that alternative was considered and has obvious merits. The microwave alternative was given a score of 3 out of 5 for "ease of on board handling" because heating foods in the microwave oven usually requires a "trial and error" approach. The most important benefit of a microwave galley is the speed of reheating of a single meal. This capability is especially attractive when crews eat independently. However, if crews find it necessary to eat all at one time, the single service requirement of microwave could become a drawback. For example, it would take a nine man crew approximately 90 minutes to heat nine meals by microwave. These same nine meals can be heated in 40 minutes by the food service module system.

System 3, the Module alternative, was rated highest of the three studied in this analysis with a total score value of 409 out of 495. For the B-52 especially, this alternative seemed to best satisfy the existing requirements. It is the only practical system evaluated which, in fact, would fit into this aircraft and have the capability of providing cold menu expansion and hot meals at the same time. For the KC-10, the self-heating carrier improved the flexibility of heating time because meals that had been heated and could not be consumed as anticipated because of unexpected flight duties would safely remain at a holding temperature until consumed without loss of quality. For the KC-135, this alternative offers a means of heating standard sized frozen meals which cannot be currently heated in the small B-4 oven.

For the six primary aircraft, the use of the self-heating carrier would improve the meal service by expanding the menu, reducing the handling required to heat meals, providing improved hot food quality by eliminating under or overheating, and offering refrigeration. The drawback of the Module system, as compared to microwave, is the relatively long time required to heat single meals. However, when heating multiple meals, the Module becomes more attractive when six or more meals are heated at once (assuming 8 minutes per meal for microwave). The Module requires slightly more time to heat meals than standard aircraft convection ovens.

Despite the benefits each alternative would provide to the Air Force flight feeding system, it was perceived that a mixed or combined system might completely address all of the relevant issues.

Combination System

The combination system proposed is primarily based upon the use of the Food Service Module System with a capacity of 10 meals for most situations, and a microwave concept where quick reheating of meals is considered most valuable. As represented in a proposal received from PTC Aerospace Inc, this unit would consist of two hand portable tray carriers which could be brought to the flight kitchen for tray assembly and carried on board any one of the six aircraft types under consideration. The carriers would be used in conjunction with a structural compartment housing the mechanical chiller and electrical control panel, which would be permanently installed on board the aircraft.

For example, in the case of the B-52, this compartment would be recessed within the rack structure behind the cockpit. In other aircraft the mechanical chiller and electrical control panel would be mounted as close as possible to the existing galley. The Module would have 10 separate control switches; 1 for each of the 10 hot meal positions. A crew member desiring to heat his or her hot meal would press the "Heat" switch and the meal would heat for 40 minutes, after which the heater would automatically go into a "Hold" mode. The heating and holding modes would be displayed on the control panel via illuminated dual legend buttons. The environment within the carrier would be kept chilled by virtue of circulating refrigerated air. Thus, cold components of the meal as well as cold meals requiring no heating (sandwich meals) would remain properly chilled at 45°F or below.

Use of the Module System addresses all important issues save the speed of reheating, which was found to be a feature desired by the KC-10 and KC-135 crews. For this purpose, the combination system proposes to replace the two convection ovens in the crew galley of the KC-10 with one microwave oven, in accordance with information supplied by Nordskog Industries dated January 17, 1984 (Appendix G).

At the very least, microwave ovens should be installed for crew feeding on future KC-10 tanker aircraft. For the KC-135, the combination system would replace the existing galley with a new galley (also described in Appendix F) from Nordskog Industries dated February 8, 1984, which would include a microwave oven, mechanical refrigerator, coffee maker, beverage jug, and hot cup. Under the microwave system, crew meals for the KC-10 and KC-135 would be assembled on expendable trays and brought to the aircraft in tray carriers.

The Food Service Module System favorably supplements the existing C-5A system by providing reheating flexibility, but does not improve the system, in an overall sense, to the degree found with the B-52, C-130, and C-141. With consideration of problems being solved and modifications made via the ongoing C-5B galley program, no major equipment is proposed for the C-5A at this time.

Finally, it is envisioned that the Module System could be used for passenger feeding also. Conceptually, up to eight carriers could be loaded onto standard cargo pallets, and track mounted into the aircraft. Such an arrangement would greatly enhance the passenger feeding capability especially on board aircraft not supported by a comfort pallet. Phase II of this project will address this concept of passenger feeding.

The alternatives proposed under the combination system approach are presented in Table 60.

Cost

The main component of the combination system would be the 10-meal-capacity Food Service Module System. The preliminary budgetary price (1984 dollars) for this unit manufactured by PTC Aerospace after nonrecurring research and development costs (estimated at $331,000) ranges from $7,814 per unit for a minimum order of 100 units, to $4,178 per unit for an order of 1000 units (Table 61). The one-time, nonrecurring research and development charge covers engineering, tooling, prototypes, and test programs.

TABLE 60. Combination System Alternatives

Aircraft	Alternative For Crew Feeding	Alternative For Passenger Feeding
B-52	Food Service Module	N/A
KC-10	Microwave Galley	Pallet Mounted Food Service Module
KC-135	Microwave Galley	Pallet Mounted Food Service Module
C-130	Food Service Module	Pallet Mounted Food Service Module
C-141	Food Service Module	Pallet Mounted Food Service Module

TABLE 61. Budgetary Cost Data for the Food Service Module System

ORDER QUANTITY	UNIT PRICE	TOTAL UNIT* PRICE
100	$4,484	100 units=$7,814 each
101-500	$4,224	500 units=$4,890 each
>500	$3,845	1,000 units=$4,178 each

* Including prorated R&D cost.

The cost of the complete KC-135 microwave galley is shown in Table 62.

TABLE 62. Budgetary Cost Data for the Microwave Galley

DESCRIPTION	UNIT PRICE
Galley	$31,000
Removable Self-Contained Refrigerator	$13,500
Microwave Oven	$ 9,800
Coffee Maker	$ 2,595
Beverage Jug	$ 1,002
Hot Cup	$ 105
Total Galley Cost	$58,002

An additional one-time, nonrecurring change to cover engineering design, weight test, flammability, fire containment, tooling, manuals, and certification package would be $34,500. The cost of a microwave oven to replace the convection ovens on the KC-10 would be $ 9,800, after engineering of a new, smaller unit to fit the cavity vacated by convection ovens had been completed ($50,000).

It must be noted that the prices obtained from the above galley manufacturers are preliminary budgetary estimates, and are stated in 1984 dollars.

Presented in Table 63 is a summary of the key benefits which would be provided by all the alternative systems studied. Where appropriate, only components of an alternative are considered where a benefit to the aircraft is perceived. For example, a microwave oven, and not an entire microwave galley, could be installed on a B-52 to provide reheating capability for that airplane. The combination system offers benefits not possible when considering the microwave galley or Module System separately.

TABLE 63. Summary of Key Benefits Provided by Existing and Feasible Alternative Onboard Subsystems

AIRCRAFT	BENEFIT	EXISTING SYSTEM	MICROWAVE SYSTEM	FOOD SERVICE MODULE SYSTEM	COMBINATION SYSTEM
B-52	Crew Hot Meals	-*	+	+	+
	Flexible Prep	-	+	+	+
	Rapid Heating	-	+	-	-
	Pax Hot Meals	NA	NA	NA	NA
	Refrigeration	-	-	+	+
KC-10	Crew Hot Meals	+	+	+	+
	Flexible Prep	-	+	+	+
	Rapid Heating	-	+	-	+
	Pax Hot Meals	+	-	+	+
	Refrigeration	+	-	+	+
KC-135	Crew Hot Meals	-	+	+	+
	Flexible Prep	-	+	+	+
	Rapid Heating	-	+	-	+
	Pax Hot Meals	-	-	+	+
	Refrigeration	-	-	+	+
C-130	Crew Hot Meals	+	+	+	+
	Flexible Prep	-	+	+	+
	Rapid Heating	-	+	-	-
	Pax Hot Meals	-	-	+	+
	Refrigeration	-	-	+	+
C-141	Crew Hot Meals	+	+	+	+
	Flexible Prep	-	+	+	+
	Rapid Heating	-	+	-	-
	Pax Hot Meals	-	-	+	+
	Refrigeration	-	-	+	+
	TOTAL BENEFITS	5	18	19	20

*Some B-52 aircraft have small, single meal ovens.

V. RECOMMENDATIONS

Based upon the study carried out concerning the existing methods of Air Force flight feeding and feasible system alternatives, the following are recommended:

1. The Food Service Module System should be considered for crew feeding on board the B-52, C-130, and C-141 aircraft.

2. Replacement of the existing convection ovens in the galley of the KC-10 with a microwave oven should be evaluated. Expendable meal trays would be used to replace boxes for crew meals. Meals would be transported to the aircraft in a tray carrier to be stored in the galley refrigerator or insulated container.

3. A new galley replacing the existing galley on board the KC-135 should be procured. This galley should include a microwave oven and mechanical refrigeration. Expendable trays would be used for crew meals.

4. To facilitate further evaluation of these proposals, Natick should procure a prototype Food Service Module. This unit would incorporate mechanical refrigeration and 10 separate heating controls. The aircraft on which this prototype would be tested would be a B-52 bomber.

5. A prototype microwave galley should be tested on board the KC-135 tanker.

6. Operational testing of the prototype systems should be conducted at Griffiss AFB, NY.

7. Following a successful test of the module system for crew feeding, a prototype version for passenger feeding should be procured and field tested.

8. To augment the current system, the Air Force should utilize insulated carriers and blue ice to transport crew meals to aircraft.

The above recommendations were presented to key personnel at the Air Force Engineering and Services Center (AFESC), Tyndall AFB, FL on November 1, 1984. As a result of the presentation given at AFESC by Natick personnel, it was mutually agreed upon that the Food Service Module System for crew feeding was the alternative most appropriate for all the primary aircraft, and that a field test should be conducted on board a B-52G aircraft. In addition, a second phase was added to the project for the purpose of adapting the Module system design for passenger feeding. During Phase II of this effort, fabrication and field testing of the passenger concept will be accomplished.

The microwave galley concept for crew feeding was determined to be a less viable alternative because of its greater cost and limited compatibility to aircraft with restricted available on board space. Consequently, the microwave concept will not be pursued any further at this time.

APPENDIX A.

Primary Aircraft Profile

A.F. 19 - 2 PRIMARY AIRCRAFT PROFILE

BASIC INFORMATION :	B-1 BOMBER	B-52 (G & H MODELS ONLY) STRATOFORTRESS	KC-10A EXTENDER	KC-135 STRATOTANKER
PRINCIPAL CONTRACTOR:	ROCKWELL INTERNATIONAL	BOEING MILITARY AIRPLANE COMPANY	MCDONNELL DOUGLAS CORPORATION	BOEING MILITARY AIRPLANE COMPANY
AIRCRAFT TYPE:	LONGE-RANGE MULTI-ROLE STRATEGIC BOMBER	LONGE-RANGE STRATEGIC BOMBER	ADVANCED TANKER/CARGO (ATC)	TANKER/TRANSPORT
YEAR AIRCRAFT DELIVERED, AVRG. AGE (YRS.):	1984 , *****	@ 1959 , 24.0	1981 , 1.7	1956 , 23.2
COMMERCIAL AIRFRAME NAME:	N/A	N/A	DC-10 SERIES 30CF	BOEING 707
A.F. AIRCRAFT BUILT:	@ 100, (BY 1988)	295 (G: 193, H: 102)	@ 25 (1985)	732
CURRENT A.F. AIRCRAFT:	1	@ 264	@ 60 (BY 1987)	@ 619
A.F. AIRCRAFT MODELS:	B	D, G & H	A	A:(ORIGINAL), R:(MAJOR MODIFICATION) & E:(A.N.G., MINOR MODIFICATION)
RESPONSIBLE COMMAND:	SAC	SAC	SAC	SAC
CREW SIZE:	4 : PILOT , CO-PILOT & TWO SYSTEMS (OFF. & DEF.), OPERATORS	6 - 10 : TWO PILOTS, NAVIGATOR, RADAR NAVIGATOR, ECM, GUNNER ...	4 - 6: PILOT, CO-PILOT, FLIGHT ENG., BOOM OPERATOR...	4 - 6: PILOT, CO-PILOT, NAVIGATOR, BOOM OPERATOR...
PASSENGERS POSSIBLE :	N/A	N/A	@ 75	@ 80
FLIGHT DURATION (HRS.): MAX.	> THAN 24 W/AIR REFUELING	> 24 W/ AIR REFUELING	> 24 W/ AIR REFUELING	*****
AVRG.	*****	8 - 10	4 - 8	4 - 8
GALLEY INFORMATION:				
- MANUFACTURER / TYPE	MIDLAND ROSS CORP., MANSFIELD OHIO		*****	...B-4 TYPE
- APPROXIMATE DIMENSIONS	@ 26"H * 20"W * 25"D, @ 8 CU.FT.		*****	46"H * 33"W * 20"D
- ELECTRICAL SPECIFICATIONS	ELECTRICAL PANEL: 110 V, 400 HTZ., SINGLE PHASE,(230/115 VAC PWR.)		*****	115/200 VOLT AC W/ MCBP CIRCUIT PROTECTION & AUX. PWR. PANELS
- ITEM LIST	1 -HOT CUP, (MIN. 32 OZ.) 2 -TWO GAL. INS. JUGS (AMBIENT & HOT) 1 -CONTROL PANEL (W/ 0-30 MIN. TIMER) 1 -CUP DISPENSER 3 -STORAGE COMPARTMENTS: (MAIN,AUX.,MISC.) 1 -MIN. TWO GAL. WASTE LIQUID CONTAINER	- HOT CUPS	2 -OVENS, (MAX. 12 MEALS) 1 -COFFEE MAKER 1 -BEVERAGE CONTAINER 1 -HOT CUP & RECEPTACLE 1 -TWO COMPARTMENT REFRIG./ FREEZER 1 -ELECTRICAL CONTROL PANEL 1 -WORK COUNTER WITH LIGHT 1 -SINK 1 -PAPER CUP DISPENSER & BOTTLE OPENER 3 -STORAGE COMPARTMENTS 1 -WASTE CONTAINER	1 -OVEN, (MAX. 6 MEALS) 2 -HOT CUPS, (57 OZ. EA.), W/ 0-30 MINUTE TIMER SWITCHES 5 -TWO GALLON BEV. CONTAINERS 1 -HOT JUG COMPARTMENT (TO 180 F.) 1 -MISC. STORAGE CABINET
PERFORMANCE SPECIFICATIONS :				
- MAX. UNREFUELLED RANGE	7,455 MILES	G: 7,500 MILES, H: 10,000 MILES	11,500 MILES	9,200 MILES
- MAX. SPEED	MACH 1.25 (LOW LEVEL)	@ 595 M.P.H.	@ 528 M.P.H.	@ 600 M.P.H.
- MAX. WEIGHT	477,000 LBS.	488,000 LBS.	590,000 LBS.. (MAX. PAYLOAD : 169,000 LBS.)	@ 297,000 LBS.
- ENGINE QUANTITY & MANUFACTURER	4, GENERAL ELECTRIC	8, PRATT & WHITNEY	3, GENERAL ELECTRIC	4, PRATT & WHITNEY

BASIC INFORMATION :	C - 5 GALAXY			C - 141 STARLIFTER
PRINCIPAL CONTRACTOR:	LOCKHEED - GEORGIA COMPANY			LOCKHEED - GEORGIA COMPANY
AIRCRAFT TYPE:	HEAVY LOGISTICS TRANSPORT			CARGO & TROOP TRANSPORT AIRCRAFT
YEAR AIRCRAFT DELIVERED , AVRG. AGE (YRS.):	1969 , 13.0			@ 1965, 18.1
COMMERCIAL AIRFRAME NAME:	N/A			N/A
A.F. AIRCRAFT BUILT:	81 + + (11)+ 50 C-5Bs BEGINNING 1986)			285
CURRENT A.F. AIRCRAFT:	81			@ 271
A.F. AIRCRAFT MODELS:	A & B			A:(ORIGINAL) & B:(STRETCHED VERSION)
RESPONSIBLE COMMAND:	MAC			*****
CREW SIZE:	5 - 20+ : PILOT, CO-PILOT, FLIGHT ENG., NAVIGATOR, LOAD MASTER...			5: PILOT, CO-PILOT, NAVIGATOR, SYSTEMS MGR. & LOADMASTER
PASSENGERS POSSIBLE :	345 (INCLUDING 75 IN THE TROOP COMPARTMENT)			155 TROOPS
FLIGHT DURATION (HRS.): MAX. AVRG.	> 24 W/AIR REFUELING 8 - 10		BUFFET/LAVATORY UNIT (COMFORT PALLET)	***** 9 - 10
GALLEY INFORMATION: - MANUFACTURER - APPROXIMATE DIMENSIONS - ELECTRICAL SPECIFICATIONS	CREW GALLEY : ***** ***** 115/200 VOLT AC POWER (FROM THE NO. 2 AC MONITOR BUS)	TROOP GALLEY : ***** ***** 115/200 VOLT AC POWER (FROM THE NO. 3 AC MONITOR BUS)	R E F DYNAMICS CORPORATION, N.Y. 83"H x 104"L x 113"D 115/200 VOLT AC 3-PHASE 4 WIRE 400 CPS, (8 17,000 WATTS)	***** ***** 115 VOLT, 3 PHASE, 400 CYCLE
- ITEM LIST	2 -REFRIG./FREEZERS 1 -OVEN (MAX. 12 MEALS) 1 -CONTROL PANEL 2 -POTABLE WATER TANKS (2 & 7 GALS.) 1 -HOT BEV. UNIT 1 -COFFEE BREWER 1 -WATER COOLER 1 -PAPER TOWER DISPENSER 1 -PAPER CUP DISPENSER 2 -STORAGE CABINETS 4 -STORAGE DRAWERS 1 -SINK WITH FAUCET 1 -SWING AWAY CAN-OPENER 1 -HOT PLATE 1 -REFUSE CONTAINER 1 -UTILITY OUTLET	2 -OVENS, (MAX. 24 MEALS) 2 -REFRIGS. 1 -HOT BEV. UNIT 1 -HOT PLATE 1 -FOOD WARMING PLATE 1 -PAPER TOWER DISPENSER 1 -PAPER CUP DISPENSER 1 -CONTROL PANEL 5 -STORAGE COMPARTMENTS 1 -CAN-OPENER 1 -SINK 1 -50 GAL. POTABLE WATER TANK 1 -REFUSE CONTAINER	3 -OVENS, (MAX. 36 MEALS) 2 -REFRIGERATORS 2 -COFFEE BREWERS 1 -HOT PLATE 1 -FOOD WARMING CUP 1 -HOT CUP 1 -CHILLED WATER DISPENSER 2 -PAPER CUP DISPENSERS 2 -WATER FAUCETS 5 -STORAGE CABINETS 3 -STORAGE DRAWERS 2 -AUX. WORK SHELVES 80 -FOOD SERVICE TRAYS 2 -TRASH CONTAINERS 1 -UTILITY OUTLET 2 -LAVATORY UNITS	1 -OVEN (MAX. ***** MEALS) 1 -REFRIG. (INS. COMPARTMENT) 1 -HOT CUP 1 -HOT BEV. DISPENSER 1 -CONTROL PANEL 1 -COUNTER TOP 2 -WATER/BEV. STORAGE COMPARTMENTS 1 -TRASH CONTAINER
PERFORMANCE SPECIFICATIONS:				
- MAX. UNREFUELLED RANGE	6,850 MILES			6,390 MILES (2,935; W/ MAX. PAYLOAD)
- MAX. SPEED	571 M.P.H.			566 M.P.H.
- MAX. WEIGHT	635,850 LBS., (MAX. PAYLOAD: 264,700 LBS.)			343,000 LBS., (MAX. PAYLOAD: 90,200)
- ENGINE QUANTITY & MANUFACTURER	4, GENERAL ELECTRIC			4, PRATT & WHITNEY

BASIC INFORMATION :	C - 130 HERCULES	C - 17 #####
PRINCIPAL CONTRACTOR:	LOCKHEED AIRCRAFT CORPORATION	MCDONNELL DOUGLAS CORPORATION
AIRCRAFT TYPE:	MEDIUM/LONG-RANGE COMBAT TRANSPORT	LONG RANGE, INTER/INTRA THEATER, HEAVY LIFT CARGO TRANSPORT
YEAR AIRCRAFT DELIVERED , AVRG. AGE (YRS.):	1955 , 17+	NOT IN PRODUCTION YET
COMMERCIAL AIRFRAME NAME:	LOCKHEED MODEL 382	N/A
A.F. AIRCRAFT BUILT:	461 (A & B MODELS)	N/A
CURRENT A.F. AIRCRAFT:	# 362	N/A
A.F. AIRCRAFT MODELS:	AC, C, DC, EC, HC, JC, MC, RC & WC	N/A
RESPONSIBLE COMMAND:	MAC (AS OF 1974/75)	?
CREW SIZE:	5: PILOT, CO-PILOT, NAVIGATOR, SYSTEMS MGR. & LOADMASTER	3 - 6: PILOT, CO-PILOT, LOADMASTER... BOOM OPERATOR...
PASSENGERS POSSIBLE :	92 TROOPS	144 TROOPS (FOR TRIPS < 4 HRS.)
FLIGHT DURATION (HRS.) :		
MAX.	#####	
AVRG.	5 - 8	
GALLEY INFORMATION:		
- MANUFACTURER	#####	B-9000 GALLEY
- APPROXIMATE DIMENSIONS	# 71"H x 36"W x 23"D	82.5"H x 37"W
- ELECTRICAL SPECIFICATIONS	115 VOLT, 3 PHASE, 400 CYCLE	
- ITEM LIST	1 -OVEN, (MAX. 6 MEALS) 1 -REFRIG. (INS. COMPARTMENT) 2 -FOOD WARMING CUPS 2 -LIQUID CONTAINERS 1 -SINK 1 -CAN-OPENER 1 -CONTROL PANEL 1 -CUP DISPENSER 2 -FOOD STORAGE CONTAINERS 2 -STORAGE COMPARTMENTS 1 -1HO GAL. WATER TANK	1 -OVEN, (MAX. 28 MEALS) 1 -REFRIG./FREEZER (6 CU. FT.) 1 -SINK WITH FAUCET 2 -LIQUID JUG CONTAINERS 1 -HOT CUP 1 -CUP DISPENSER 3 -STORAGE COMPARTMENTS 1 -TRASH CONTAINER
PERFORMANCE SPECIFICATIONS :		
- MAX. UNREFUELLED RANGE	4,894 MILES	5,755 MILES
- MAX. SPEED	374 M.P.H.	MACH .775
- MAX. WEIGHT	175,000 LBS., (MAX. PAYLOAD: # 40,000 LBS.)	570,000 LBS., (MAX. PAYLOAD: 172,200 LBS.)
- ENGINE QUANTITY & MANUFACTURER	4, ALLISON	4, PRATT & WHITNEY

APPENDIX B.

Customer Opinion Questionnaires

AIR FORCE FLIGHT FEEDING SURVEY (SAC)

The Air Force has asked Natick Laboratories to help improve the present flight feeding system for air crews. Please answer the following questions carefully to help provide us with ideas for improvements.

1. What is your base and rank? Base__________________ Rank______________

2. What is the type of aircraft you currently fly or crew?____________________

3. How long have you been assigned to that type of aircraft?__________________

4. Concerning the flights in the last week you flew or crewed:
   a. How many flights?________
   b. How many $1.85 flight meals did you eat?________
   c. How many $.95 snack meals did you eat?____________
   d. What was the typical flight duration?____________
   e. How many flights where you ate more than one meal?________
   f. Were you on per diem?________ Yes ________No

5. Check each meal type listed below that you have eaten on your current aircraft.
   ____Pre-cooked frozen (TV Dinner) ____ Sandwich (flight box lunch)
   ____Snack ______Bite Size ____ Meal-Ready-To-Eat (C-Ration)

6. Is there too much "junk food" in the flight meals and snacks? ___Yes ___No

7. What foods of your own, if any, do you bring to eat on your current type of aircraft?
____

8. Where do you typically eat your flight meal? ___On the ground? ___On the aircraft?
   If on the ground, where? ___ Squadron building ___ Other (explain)____________
   If on the aircraft, where? ___Duty position ___ Other (explain) ____________
   If on the aircraft, when? ___ Before flight ___During flight ___ After flight

9. Please rate each of the factors below as to how important it has been in deciding what to eat on your current type of aircraft. Please circle the appropriate number.

	NOT IMPORTANT	SLIGHTLY IMPORTANT	MODERATELY IMPORTANT	VERY IMPORTANT	EXTREMELY IMPORTANT
a. Quality of the meal	0	1	2	3	4
b. Amount of food in the meal	0	1	2	3	4
c. Ease of eating the meal	0	1	2	3	4
d. Time of day or night	0	1	2	3	4
e. Sufficient time to eat	0	1	2	3	4
f. Place to eat	0	1	2	3	4
g. Clean up after the meal	0	1	2	3	4
h. Cost of the meal	0	1	2	3	4
i. Per diem status	0	1	2	3	4
j. Flight boredom	0	1	2	3	4
k. Low Calorie Meal	0	1	2	3	

l. Is anything else important in deciding what you want to eat? If so, please write it down.
____

10. The number of choices of flight meals presently available is (Please check One)
   ____ Much Too Many ____Too Many ____Adequate ____Too Few ____ Much Too Few

11. Would you prefer: (Please check one)
   ______ Being able to purchase individual components of a meal (or sandwich)? OR
   ______ Being able to purchase complete pre-packaged meals (or sandwich)?

12. If deli-style food were on display at the flight kitchen, how often would you go there to select your meal? ____ Almost Always ___Often ___Sometimes ___Seldom ___Never

13. Please rate each of the applicable factors below in terms of how good or bad it is for you in your current type of aircraft. Please use the following scale.

NEVER TRIED	VERY BAD	MODERATELY BAD	SOMEWHAT BAD	NEITHER BAD NOR GOOD	SOMEWHAT GOOD	MODERATELY GOOD	VERY GOOD
0	1	2	3	4	5	6	7

a.	Quality of pre-cooked frozen flight meals	0	1	2	3	4	5	6	7
b.	Quality of sandwich meals (flight box lunches)	0	1	2	3	4	5	6	7
c.	Quality of snack meals	0	1	2	3	4	5	6	7
d.	Quality of Meal-Ready-To Eat (C-Ration)	0	1	2	3	4	5	6	7
e.	Amount of food in pre-cooked frozen meals	0	1	2	3	4	5	6	7
f.	Amount of food in sandwich meals	0	1	2	3	4	5	6	7
g.	Amount of food in snack meals	0	1	2	3	4	5	6	7
h.	Amount of food in Meal-Ready-To-Eat (C-Rats)	0	1	2	3	4	5	6	7
i.	No. of choices for pre-cooked frozen meals	0	1	2	3	4	5	6	7
j.	Number of choices for sandwich meals	0	1	2	3	4	5	6	7
k.	Number of choices for snack meals	0	1	2	3	4	5	6	7
l.	No. of choices for Meal-Ready-To-Eat (C-Rats)	0	1	2	3	4	5	6	7
m.	Time it takes to prepare hot meals	0	1	2	3	4	5	6	7
n.	Ease of preparing hot meals	0	1	2	3	4	5	6	7
o.	Type of food equipment on board your aircraft	-	1	2	3	4	5	6	7
p.	Service from your flight kitchen	-	1	2	3	4	5	6	7
q.	Trash disposal	-	1	2	3	4	5	6	7

14. Suppose we could make the following meals available for flights. Please rank them from 1 to 6 with "1" being the meal you'd like most and "6" the meal you'd like least.
_____Complete hot meal _____Hot sandwiches _____Snack meal
_____Frozen flight meal _____Cold sandwiches _____Hamburger/Fries

15. What beverages do you want available for flights? ________________________

16. Do you have any of the following problems in getting your meals from the flight kitchen? Please check ALL that apply.

____The time needed to get to and from the kitchen.
____Waiting time in the flight kitchen.
____Lack of a proper vehicle to get to and from the flight kitchen.
____Appropriate containers to carry the food.
____Amount of time required to order ahead.
____Attitude of flight kitchen personnel.
____Amount of paperwork necessary to get food.
____Other (please explain):________________________________

17. Which food-related equipment do you have on board your current aircraft? Again, please check ALL that apply.
____None ____Oven ____Galley ____Coffee maker ____Hot pot/cup ____Insulated Jug
____Refrigerator ____ Freezer ________________________________Other(please write in)

18. Is the food service equipment effective?_____Yes _____No Why? ________________

19. What other equipment do you need on your current type of aircraft for better meals?
____

20. What comments or suggestions do you have to improve flight-feeding?
____
____

21 - [illegible] - none ?

AIR FORCE FLIGHT FEEDING SURVEY (MAC)

The Air Force has asked Natick Laboratories to help improve the present flight feeding system for air crews. Please answer the following questions carefully to help provide us with ideas for improvements.

1. What is your base and rank? Base____________________ Rank______________

2. What is the type of aircraft you currently fly or crew?____________________

3. How long have you been assigned to that type of aircraft?____________________

4. Concerning the flights in the last week you flew or crewed:
   a. How many flights?__________ How many flight segments? __________
   b. How many $1.85 flight meals did you eat?__________
   c. How many $.95 snack meals did you eat?__________
   d. What was the typical flight segment duration?________Entire flight duration? ______
   e. On any segment did you eat more than one meal? _____Yes _____ No
   f. Were you on per diem?__________ Yes __________No
   g. Maximum number of passengers you carried last week? ___None ___5 or more ___20 or mc

5. Check each meal type listed below that you have eaten on your current aircraft.
   _____Pre-cooked frozen (TV Dinner) _____ Sandwich (flight box lunch)
   _____Snack _______Bite Size _____ Meal-Ready-To-Eat (C-Ration)

6. Is there too much "junk food" in the flight meals and snacks? ____Yes ____No

7. What foods of your own, if any, do you bring to eat on your current type of aircraft?

____

8. Where do you typically eat your flight meal? ____On the ground? ____On the aircraft?
   If on the ground, where? ____ Squadron building ___ Other (explain)______________
   If on the aircraft, where? ____Duty position ____ Other (explain) ______________
   If on the aircraft, when? ____ Before flight ____During flight ___ After flight

9. Please rate each of the factors below as to how important it has been in deciding what to eat on your current type of aircraft. Please circle the appropriate number.

	NOT IMPORTANT	SLIGHTLY IMPORTANT	MODERATELY IMPORTANT	VERY IMPORTANT	EXTREMELY IMPORTANT
a. Quality of the meal	0	1	2	3	4
b. Amount of food in the meal	0	1	2	3	4
c. Ease of eating the meal	0	1	2	3	4
d. Time of day or night	0	1	2	3	4
e. Sufficient time to eat	0	1	2	3	4
f. Place to eat	0	1	2	3	4
g. Clean up after the meal	0	1	2	3	4
h. Cost of the meal	0	1	2	3	4
i. Per diem status	0	1	2	3	4
j. Duration of flight	0	1	2	3	4
k. Flight boredom	0	1	2	3	4
l. Low Calorie Meal	0	1	2	3	4

   m. What else is important in deciding what you want to eat? Please write it down.

____

10. The number of choices of flight meals presently available is (Please check One)
   _____Much Too Many _____ Too Many _____Adequate _____Too Few _____ Much Too Few

11. Would you prefer: (Please check one)
   _______ Being able to purchase individual components of a meal (or sandwich)? OR
   _______ Being able to purchase complete pre-packaged meals (or sandwich)?

12. If deli-style food were on display at the flight kitchen, how often would you go there to select your meal? ___ Almost Always ___ Often ___ Sometimes ___ Seldom ___ Never

13. Please rate each of the applicable factors below in terms of how good or bad it is for you in your current type of aircraft. Please use the following scale.

NEVER TRIED	VERY BAD	MODERATELY BAD	SOMEWHAT BAD	NEITHER BAD NOR GOOD	SOMEWHAT GOOD	MODERATELY GOOD	VERY GOOD
0	1	2	3	4	5	6	7

a.	Quality of pre-cooked frozen flight meals	0	1	2	3	4	5	6	7
b.	Quality of sandwich meals (flight box lunches)	0	1	2	3	4	5	6	7
c.	Quality of snack meals	0	1	2	3	4	5	6	7
d.	Quality of Meal-Ready-To Eat (C-Ration)	0	1	2	3	4	5	6	7
e.	Amount of food in pre-cooked frozen meals	0	1	2	3	4	5	6	7
f.	Amount of food in sandwich meals	0	1	2	3	4	5	6	7
g.	Amount of food in snack meals	0	1	2	3	4	5	6	7
h.	Amount of food in Meal-Ready-To-Eat (C-Rats)	0	1	2	3	4	5	6	7
i.	No. of choices for pre-cooked frozen meals	0	1	2	3	4	5	6	7
j.	Number of choices for sandwich meals	0	1	2	3	4	5	6	7
k.	Number of choices for snack meals	0	1	2	3	4	5	6	7
l.	No. of choices for Meal-Ready-To-Eat (C-Rats)	0	1	2	3	4	5	6	7
m.	Time it takes to prepare hot meals	0	1	2	3	4	5	6	7
n.	Ease of preparing hot meals	0	1	2	3	4	5	6	7
o.	Type of food equipment on board your aircraft	-	1	2	3	4	5	6	7
p.	Service from your flight kitchen	-	1	2	3	4	5	6	7
q.	Service from flight service	-	1	2	3	4	5	6	7
r.	Trash disposal	-	1	2	3	4	5	6	7

14. Suppose we could make the following meals available for flights. Please rank them from 1 to 6 with "1" being the meal you'd like most and "6" the meal you'd like least.
_____ Complete hot meal _____ Hot sandwiches _____ Snack meal
_____ Frozen flight meal _____ Cold sandwiches _____ Hamburger/Fries

15. What beverages do you want available for flights? ______________________________

16. Do you have any of the following problems in getting your meals from the flight kitchen? Please check ALL that apply.
____ Amount of time required to order ahead.
____ Attitude of flight services personnel.
____ Amount of paperwork necessary to get food.
____ Other (please explain): ______________________________

17. Which food-related equipment do you have on board your current aircraft? Again, please check ALL that apply.
____ None ____ Oven ____ Galley ____ Coffee maker ____ Hot pot/cup ____ Insulated jug
____ Refrigerator ____ Freezer ______________________________ Other (please write in)

18. Does the food service equipment usually work? ____ Yes ____ No Why? ______________

19. What other equipment do you need on your current type of aircraft for better meals?
____

20. What comments or suggestions do you have to improve flight feeding for crew members?
____
____

21. What comments or suggestions do you have to improve flight feeding for passengers?
____
____

FLIGHT FEEDING QUESTIONNAIRE

The U.S. Army Natick Research, Development and Engineering Center is conducting an evaluation of flight feeding for the U.S. Air Force. Please complete the following as accurately as possible so that future menus and equipment best reflect the needs of pilots and crews.

1. Type of aircraft you currently fly or crew? ______________________

2. Average number of flights per month? ______________________

3. Average length of a typical flight (Air Time)? ______________________

4. If the aircraft you currently fly or crew were equipped with a dependable oven, what foods would you like to eat during flight? (Please mention specific foods.)

5. If a microwave oven were available on the aircraft you crew or fly, would your answer to question #4 change? (If "yes", please explain, mentioning specific foods.)

6. If the aircraft you currently fly or crew were equipped with a dependable refrigerator/freezer, what cold foods and/or beverages would you like during flight? (Please mention specific foods/beverages.)

7. Given a dependable oven on the aircraft you fly or crew, how often would you eat frozen meals? (Please circle one answer.)

   A. Every flight

   B. Every 2nd flight

   C. Every 3rd flight

   D. Every 4th flight

   E. Every 5th flight

   F. Every 6th flight

   G. Never

8. Please indicate how much you like each of the following foods and beverages.

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

Fruit Flavored Drinks	1	2	3	4	5	6	7	8	9
Candy	1	2	3	4	5	6	7	8	9
Potato Chips	1	2	3	4	5	6	7	8	9
Condiments (Ketchup, Mayonnaise, Mustard ...)	1	2	3	4	5	6	7	8	9
Tossed Salad	1	2	3	4	5	6	7	8	9
Tuna Salad Sandwiches	1	2	3	4	5	6	7	8	9
Chicken Salad Sandwiches	1	2	3	4	5	6	7	8	9
Hamburger	1	2	3	4	5	6	7	8	9
French Fries	1	2	3	4	5	6	7	8	9
Hot Sandwiches	1	2	3	4	5	6	7	8	9
Pizza	1	2	3	4	5	6	7	8	9
Meat Pot Pies	1	2	3	4	5	6	7	8	9
Beverages in Resealable Containers	1	2	3	4	5	6	7	8	9
Yogurt	1	2	3	4	5	6	7	8	9
Granola/Nutty-Natural Snacks	1	2	3	4	5	6	7	8	9
Carrot/Celery Sticks	1	2	3	4	5	6	7	8	9
Puddings	1	2	3	4	5	6	7	8	9
Natural Fruit Juices	1	2	3	4	5	6	7	8	9
Coffee	1	2	3	4	5	6	7	8	9
Tea	1	2	3	4	5	6	7	8	9

9. Please indicate how much you like the following types of meals.

Low Calorie Meals	1	2	3	4	5	6	7	8	9
Low Sodium Meals	1	2	3	4	5	6	7	8	9
Frozen Breakfast Meals	1	2	3	4	5	6	7	8	9

10. Which food items currently on the flight feeding menu would you like to remove?

11. Which food items not currently on the flight feeding menu would you like to add?

12. What equipment would you suggest for the aircraft you fly or crew to improve flight feeding?

Equipment:	Reason for Suggestion:
______________________	____
______________________	____
______________________	____
______________________	____

13. Is the Food Service equipment aboard the aircraft you fly maintained so that it works nearly all of the time?

Yes _____ No _____

14. What do you usually eat prior to a flight?

APPENDIX C.

Evaluation of Blue Ice as a Refrigerant for Air Force Meals

FOOD SCIENCE ASSOCIATES

To: Mr. Robert O'Brien   Date: Jan. 5, 1984

From: G. E. Livingston   Client: U.S.Army Natick R&D Labs.

Project: Flight Feeding System   Project No.: FSA 150-83-1

Subject: Evaluation of Blue Ice as Refrigerant for Air Force Meals

INTRODUCTION

Alternative Systems No. 1 which we have proposed is based on the use of insulated carriers and "blue ice" as a means of maintaining inflight meals under refrigeration until consumed.

To verify the assumption that this is a technologically feasible method, we carried out a test in our laboratory to determine temperature changes in a frozen meal and a salad stored in an insulated carrier with blue ice.

METHODS AND MATERIALS

A Swanson Hungry Man Salisbury Steak Dinner in its original packaging, and a fresh tossed salad packed in an aluminium foil bag with a plastic dome lid and placed in US Air Force lunch box, were used in the test. Three one pound blue ice packs ("Kool Pac" manufactured by Flambeau, Baraboo, WI 53913) which had been frozen were used as refrigerant. One pack was placed in the lunch box with the salad; the other two on the floor of the insulated carrier, with the frozen dinner placed on top of them.

The carrier used was a Model 171 Thermosafe, Front-opening Transporter, 2" insulation, 3 metal handles; O.D. 18-3/4" x 15-1/2" x 20" (manufactured by Polyfoam Packers Corp., 230 South Foster, Wheeling, IL 60090).

A Honeywell Electronik 16 Strip Chart Recorder was used to record temperatures. Four locations were measured.

1. air temperature outside carrier
2. air temperature inside carrier
3. salad temperature (thermocouple in tomato wedge)
4. frozen meal temperature (thermocouple on surface of meat below foil cover)

RESULTS AND DISCUSSION

Lapse Time (hours)	Temperature (°F)			
	Outside Air	Inside Air	Salad	Frozen Meal
0	67	67	53	22
1		59	51	19
2		51	48	18
3		52	44	20
4		50	42	19
6		49	42	20
11		49	39	20
12	65	52	46	25

Upon removal from carrier after 12 hours the frozen meal and the blue ice were still frozen hard. Temperature readings shown above confirmed the assumption that the blue ice in an insulated carrier could maintain frozen and chilled foods at safe temperatures (i.e. below 45°F).

It should be noted that the test was carried out under exaggerated conditions, i.e. with little food and relatively little blue ice (3 lbs) in a 1.68 cubic foot carrier which had been stored at room temperature. The salad was not refrigerated prior to the test.

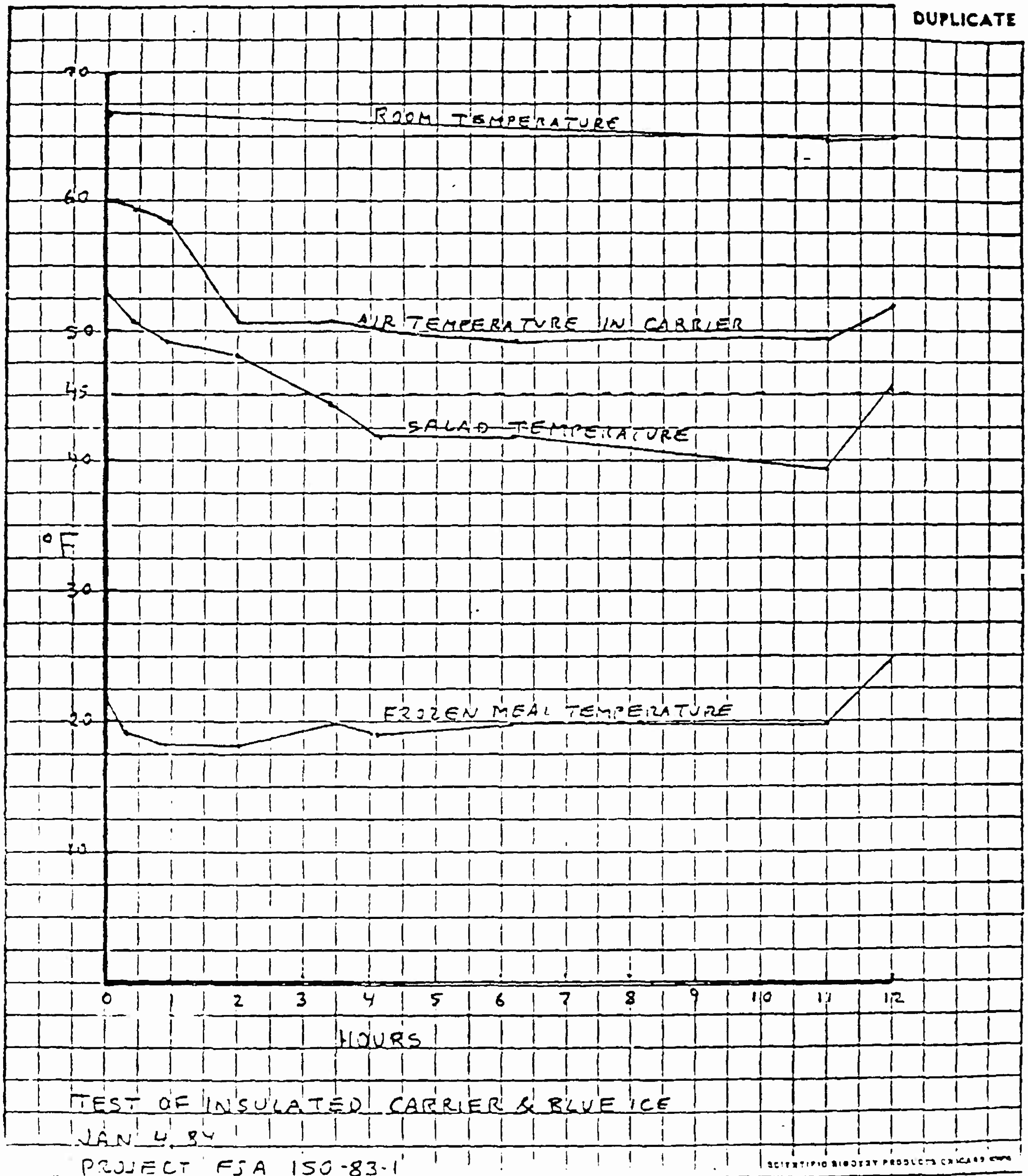
A fully loaded carrier with all chilled food refrigerated prior to loading would have shown even more favorable results.

CONCLUSIONS

It is feasible to use blue ice in an insulated carrier to maintain chilled or frozen foods at 45°F or below for the 10-12 hour period that might be required by the Air Force for flight feeding.

G. E. Livingston, Ph.D.

TITLE PROJECT NO. 2
BOOK NO.
DUPLICATE



APPENDIX D.

Evaluation of Alternatives on the Ground Support Subsystem

TABLE D-1.

Evaluation of Insulated Food Carrier Alternative on Ground Support Subsystem

CRITERION	SCORE		REMARKS
Staffing Required	5		Existing staff can handle preparation of salad plates, etc.
Flight Kitchen Facilities	3		Some additional space required as insulated carriers would be stored in the flight kitchens when not being used on the A/C.
Flight Kitchen Equipment	3		Some flight kitchens might require equipment for salad preparation, e.g., for cutting, dicing, mixing.
Sanitary Risk	3		Risk exists only if there is gross negligence in observing sanitary food handling procedures.
TOTAL SCORE:	14	CONCLUSION:	This alternative requires no major changes in existing flight kitchen operations.

TABLE D-2.

Evaluation of Microwave Oven Alternative on Ground Support Subsystem

CRITERION	SCORE		REMARKS
Staffing Required	5		Existing staff can handle preparation of salad plates, hot sandwiches, and procurement and assembly of commercially manufactured microwavable frozen foods.
Flight Kitchen Facilities	3		Some additional space required as insulated carriers would be stored in the flight kitchens when not used during flight.
Flight Kitchen Equipment	3		Some flight kitchens might require additional equipment for salad preparation, e.g., for cutting, dicing, mixing. Refrigerator and freezer space for the additional menu items must be evaluated at each base.
Sanitary Risk	3		Risk exists only if there is gross negligence in observing sanitary food handling procedures.
TOTAL SCORE:	14	CONCLUSION:	This alternative requires no major change in existing flight kitchen operation.

TABLE D-3.

Evaluation of Food Service Module System Alternative on Ground Support Subsystem

CRITERION	SCORE	REMARKS
Staffing Required	5	Provided that tray assembly is carried out only for crew meals (i.e., not pax meals) existing staffing is deemed adequate.
Flight Kitchen Facilities	3	Some additional space required for tray carriers not being used during flight.
Flight Kitchen Equipment	3	Some flight kitchens might require additional equipment for salad preparation, e.g., cutting, dicing, mixing. Refrigeration and freezer space must be evaluated at each base.
Sanitary Risk	3	Risk exists only if there is gross negligence in observing sanitary food handling procedure.
TOTAL SCORE:	14 CONCLUSION:	This alternative requires no major change in flight kitchen operation.

APPENDIX E.

Evaluation of Alternatives on the Management Subsystem

TABLE E-1.

Evaluation of Insulated Food Carrier Alternative on the Management Subsystem			
CRITERION	SCORE		REMARKS
Ability to Remain within BDFA	10		Menu expansion possibilities would cost no more than existing meals.
Ability to Procure Foods Specified	5		
Compliance With AF Regulations.	5		
Complexity of Managing Subsystems	5		
TOTAL SCORE:	25	CONCLUSION:	This alternative requires no major changes in Management Subsystem.

TABLE E-2.

Evaluation of Microwave Oven Alternative on Management Subsystem

CRITERION	SCORE		REMARKS
Ability to Remain Within BDFA	10		Some of the available commercially frozen dinners are priced the same as the regular dinners now in use. Hot sandwiches and snacks, which would probably be popular, would cost no more than existing menu selections.
Ability to Procure Foods Specified	5		Dinners, entrees, and snacks suitable for microwave heating are commercially available.
Compliance With AF Regulations	5		
Complexity of Managing Subsystems	3		System will require provisioning spare units and maintenance.
TOTAL SCORE	23	CONCLUSION:	This alternative slightly increases the complexity of managing the subsystem.

TABLE E-3.

Evaluation of Food Service Module System Alternative on Management Subsystem		
CRITERION	SCORE	REMARKS
Ability to Remain Within BDFA	10	Some of the available commercial frozen meals are priced equal to the dinners now in use. Snack meals and sandwiches would continue to be used; salads and salad-filled sandwiches would cost more than existing sandwiches.
Ability to Procure Foods Specified	5	
Compliance With AF Regulations	5	
Complexity of Managing Subsystems	3	System will require provisioning of spare units and maintenance.
TOTAL SCORE:	23 CONCLUSION:	This alternative slightly increases the complexity of the subsystem.

APPENDIX F.

Evaluation of Alternatives on the Onboard Subsystem

TABLE F-1.

Evaluation of Insulated Food Carrier Alternative on the Onboard Subsystem for the B-52 Aircraft

CRITERION	SCORE		REMARKS
Space Restrictions	3		Space difficult to obtain.
Structural Modifications	5		None.
Energy Availability	5		Not required.
Provides Hot Meal	0		Hot foods would not be provided via this alternative.
Provides Chilling Capability	5		Short-term chilling available.
Flexibility of Prep Time	10		No inflight prep needed.
Speed of Reheating	0		Assuming only cold meals.
Ease of Onboard Handling	3		Removal of menu items stacked in the carrier requires some handling.
Satisfies Food Preferences Within BDFA	5		Provides cold menu expansion but no hot foods.
Sanitary Risk	3		Risk under extreme conditions.
TOTAL SCORE:	39	CONCLUSION:	This alternative is a moderate improvement to the existing system.

TABLE F-2.

Evaluation of Microwave Oven Alternative on the Onboard Subsystem for the B-52 Aircraft*

CRITERION	SCORE	REMARKS
Space Restrictions	3	Space difficult to obtain.
Structural Modification	3	Slight modification required.
Energy Availability	5	
Provides Hot Meal	10	
Provides Chilling Capability	5	Assuming an insulated carrier used.
Flexibility of Prep Time	0	Meals can only be prepared individually.
Speed of Reheating	5	Only individual meals can be reheated in less than 10 minutes.
Ease of Onboard Handling	3	Reheating of frozen meals does require handling, and some decision making in selection of heating cycle time.
Satisfies Food Preferences Within BDFA	10	
Sanitary Risk	5	
TOTAL SCORE:	49	CONCLUSION: System would significantly enhance existing flight service.

*Assume there is not enough space on B-52 for the entire Microwave Galley. Only an oven is evaluated here.

TABLE F-3.

Evaluation of Food Service Module System Alternative on the Onboard Subsystem for the B-52 Aircraft

CRITERION	SCORE		REMARKS
Space Restrictions	3		Space difficult to get.
Structural Modification	3		Slight modifications required.
Energy Availability	5		
Provides Hot Meal	10		
Provides Chilling Capability	10		
Flexibility of Prep Time	10		
Speed of Reheating	0		
Ease of Onboard Handling	5		System does not require onboard handling of meal components for preparation.
Satisfies Food Preferences Witin BDFA	10		
Sanitary Risk	5		Refrigeration greatly reduces risk.
TOTAL SCORE:	61	CONCLUSION:	This alternative seems to best satisfy B-52 requirements - provides hot and cold meals, allows for flexibility.

TABLE F-4.

Evaluation of Insulated Food Carrier Alternative on the Onboard Subsystem for the KC-10 Aircraft

CRITERION	SCORE		REMARKS
Space Restrictions	5		Insulated carrier ensures refrigeration from flight kitchen to aircraft. Space for carrier available.
Structural Modifications	5		
Energy Availability	5		
Provides Hot Meal	0		
Provides Chilling Capability	5		
Flexibility of Prep Time	10		
Speed of Reheating	0		
Ease of Onboard Handling	3		Removal of menu items from carrier requires some handling.
Satisfies Food Preferences Within BDFA	5		Provides only cold items.
Sanitary Risk	3		
TOTAL SCORE:	41	CONCLUSION:	This alternative only slightly upgrades existing capability of KC-10 onboard subsystem.

TABLE F-5.

Evaluation of Microwave Oven Alternative on the Onboard Subsystem for the KC-10 Aircraft

CRITERION	SCORE	REMARKS
Space Restrictions	5	Assuming that microwave oven would replace existing convection ovens.
Structural Modifications	3	Slight modification necessary.
Energy Availability	5	
Provides Hot Meal	10	
Provides Chilling Capability	10	Assuming existing refrigeration used.
Flexibility of Prep Time	0	
Speed of Reheating	5	
Ease of Onboard Handling	3	Reheating of frozen meals does require handling and decision making when selection of reheating cycle time is made.
Satisfies Food Preferences Within BDFA	10	
Sanitary Risk	5	
TOTAL SCORE:	56	CONCLUSION: This alternative provides speed of heating to crew.

TABLE F-6.

Evaluation of Food Service Module System Alternative on the Onboard System for the KC-10 Aircraft

CRITERION	SCORE		REMARKS
Space Restrictions	5		
Structural Modifications	3		Slight modification to A/C.
Energy Availability	5		
Provides Hot Meal	10		
Provides Chilling Capability	10		Supplements existing refrigeration.
Flexibility of Prep Time	10		
Speed of Reheating	0		
Ease of Onboard Handling	5		Handling of meals not required for reheating.
Satisfies Food Preferences Within BDFA	10		
Sanitary Risk	5		
TOTAL SCORE:	63	CONCLUSION:	This alternative augments existing crew galley capability, reduces onboard handling, and provides reheating flexibility.

TABLE F-7.

Evaluation of Insulated Food Carrier Alternative on the Onboard Subsystem for the KC-135 Aircraft

CRITERION	SCORE	REMARKS
Space Restrictions	5	
Structural Modifications	5	
Energy Availability	5	
Provides Hot Meal	0	Assuming KC-135 oven is not compatible with AF standard frozen meal.
Provides Chilling Capability	5	
Flexibility of Prep Time	10	Assuming no hot foods served.
Speed of Reheating	0	
Ease of Onboard Handling	3	
Satisfies Food Preferences Within BDFA	5	Provides cold menu item expansion.
Sanitary Risk	3	
TOTAL SCORE:	41	CONCLUSION: This alternative provides a slight improvement over existing KC-135 subsystem.

TABLE F-8.

Evaluation of Microwave Galley Alternative on the Onboard Subsystem for the KC-135 Aircraft

CRITERION	SCORE	REMARKS
Space Restrictions	5	
Structural Modifications	3	Slight modifications needed.
Energy Availability	5	
Provides Hot Meal	10	
Provides Chilling Capability	10	
Flexibility of Prep Time	0	
Speed of Reheating	5	
Ease of Onboard Handling	3	
Satisfies Food Preferences Within BDFA	10	
Sanitary Risk	5	
TOTAL SCORE:	56	CONCLUSION: This alternative would allow refrigeration and fast meal reheating onboard KC-135 A/C.

TABLE F-9.

Evaluation of Food Service Module System Alternative on the Onboard Subsystem for the KC-135 Aircraft

CRITERION	SCORE		REMARKS
Space Restrictions	5		
Structural Modifications	3		
Energy Availability	5		
Provides Hot Meal	10		
Provides Chilling Capability	10		
Flexibility of Prep Time	10		
Speed of Reheating	0		
Ease of Onboard Handling	5		
Satisfies Food Preferences Within BDFA	10		
Sanitary Risk	5		Refrigeration reduces risk.
TOTAL SCORE:	63	CONCLUSION:	This alternative would considerably improve existing KC-135 system through the addition of refrigeration and flexibility in reheating.

TABLE F-10.

Evaluation of Insulated Food Carrier Alternative on the Onboard Subsystem for the C-5A Aircraft

CRITERION	SCORE	REMARKS
Space Restrictions	5	
Structural Modifications	5	
Energy Availability	5	
Provides Hot Meal	0	
Provides Chilling Capability	5	
Flexibility of Prep Time	10	
Speed of Reheating	0	
Ease of Onboard Handling	3	
Satisfies Food Preferences Within BDFA	5	
Sanitary Risk	3	
TOTAL SCORE:	41	CONCLUSION: This alternative merely augments existing system by maintaining cold temperatures enroute to the A/C.

TABLE F-11.

Evaluation of Microwave Galley Alternative on the Onboard Subsystem for the C-5A Aircraft

CRITERION	SCORE	REMARKS
Space Restrictions	5	
Structural Modifications	3	Minor modification required.
Energy Availability	5	
Provides Hot Meal	10	
Provides Chilling Capability	10	
Flexibility of Prep Time	0	
Speed of Reheating	5	
Ease of Onboard Handling	3	
Satisfies Food Preferences Within BDFA	10	
Sanitary Risk	5	
TOTAL SCORE:	56	CONCLUSION: This alternative would provide more rapid meal heating capability which does not, however, appear to be a requirement on this aircraft.

TABLE F-12.

Evaluation of Food Service Module System Alternative on the Onboard Subsystem for the C-5A Aircraft

CRITERION	SCORE		REMARKS
Space Restrictions	5		
Structural Modifications	3		Minor modifications required.
Energy Availability	5		
Provides Hot Meal	10		
Provides Chilling Capability	10		
Flexibility of Prep Time	10		
Speed of Reheating	0		
Ease of Onboard Handling	5		
Satisfies Food Preferences Within BDFA	10		
Sanitary Risk	5		
TOTAL SCORE:	63	CONCLUSION:	This alternative would provide additional reheating flexibility and refirgeration to the existing system.

TABLE F-13.

Evaluation of Insulated Food Carrier Alternative on the Onboard Subsystem for the C-130 Aircraft

CRITERION	SCORE		REMARKS
Space Restrictions	3		Space for storage of the carrier on the A/C might be difficult to obtain, depending on operational conditions.
Structural Modifications	5		
Energy Availability	5		
Provides Hot Meal	0		
Provides Chilling Capability	5		
Flexibility of Prep Time	10		
Speed of Reheating	0		
Ease of Onboard Handling	3		
Satisfies Food Preferences Within BDFA	5		Only cold items.
Sanitary Risk	3		Under extreme conditions.
TOTAL SCORE:	39	CONCLUSION:	This alternative provides moderate improvement over existing system.

TABLE F-14.

Evaluation of Microwave Galley Alternative on the Onboard Subsystem for the C-130 Aircraft

CRITERION	SCORE		REMARKS
Space Restrictions	3		The space for mounting of the microwave galley (forward area of cargo bay) may be difficult to get and is somewhat remote from the existing galley.
Structural Modifications	3		
Energy Availability	5		
Provides Hot Meal	10		NOTE: Due to space restrictions in the cargo area, system might not be useable under maximum load or combat conditions.
Provides Chilling Capability	10		
Flexibility of Prep Time	0		
Speed of Reheating	5		
Ease of Onboard Handling	3		
Satisfies Food Preferences Within BDFA	10		
Sanitary Risk	5		
TOTAL SCORE:	54	CONCLUSION:	This alternative provides improvement over the existing system via quick reheating and refrigeration. If equipment could be mounted in aircraft cargo area under all conditions, this alternative would become even more attractive.

TABLE F-15.

Evaluation of Food Service Module System on the Onboard Subsystem
for the C-130 Aircraft

CRITERION	SCORE		REMARKS
Space Restrictions	3		Location (forward cargo bay) somewhat remote from existing galley.
Structural Modifications	3		
Energy Availability	5		
Provides Hot Meal	10		NOTE: Due to space restrictions in cargo area, system might not be useable under maximum load or combat conditions.
Provides Chilling Capability	10		
Flexibility of Prep Time	10		
Speed of Reheating	0		
Ease of Onboard Handling	5		
Satisfies Food Preferences Within BDFA	10		
Sanitary Risk	5		
TOTAL SCORE:	61	CONCLUSION:	This alternative would significantly improve existing system.

TABLE F-16.

Evaluation of Insulated Food Carriers Alternative on the Onboard Subsystem for the C-141 Aircraft

CRITERION	SCORE		REMARKS
Space Restrictions	5		If carrier stored in loft area behind cockpit.
Structural Modifications	5		
Energy Availability	5		
Provides Hot Meal	0		
Provides Chilling Capability	5		
Flexibility of Prep Time	10		
Speed of Reheating	0		
Ease of Onboard Handling	3		
Satisfies Food Preferences Within BDFA	5		Only cold items.
Sanitary Risk	3		
TOTAL SCORE:	41	CONCLUSION:	This alternative provides moderate improvement over existing subsystem.

TABLE F-17.

Evaluation of Microwave Galley Alternative on the Onboard Subsystem for the C-141 Aircraft

CRITERION	SCORE		REMARKS
Space Restrictions	3		Location in cargo area required.
Structural Modifications	3		
Energy Availability	5		
Provides Hot Meal	10		
Provides Chilling Capability	10		
Flexibility of Prep Time	0		
Speed of Reheating	5		
Ease of Onboard Handling	3		
Satisfies Food Preferences Within BDFA	10		
Sanitary Risk	5		
TOTAL SCORE:	54	CONCLUSION:	This alternative augments current onboard system.

TABLE F-18.

Evaluation of Food Service Module System Alternative on the Onboard Subsystem for the C-141 Aircraft

CRITERION	SCORE		REMARKS
Space Restrictions	3		Location in loft area behind cockpit.
Structural Modifications	3		
Energy Availability	5		
Provides Hot Meal	10		
Provides Chilling Capability	10		
Flexibility of Prep Time	10		
Speed of Reheating	0		
Ease of Onboard Handling	5		
Satisfies Food Preferences Within BDFA	10		
Sanitary Risk	5		
TOTAL SCORE:	61	CONCLUSION:	This alternative would significantly improve existing system.

APPENDIX G.

Nordskog Industries

NORDSKOG
INDUSTRIES, INC.

February 8, 1984

G. E. Livingston, President
Food Science Associates, Inc.
145 Palisade Street
Dobbs Ferry, New York 10522

Subject: Proposed Galley for KC135

Reference: Nordskog CIS-1875

Dear Mr. Livingston:

Pursuant to our previous conversations, we are pleased to provide you with a proposal for a crew galley to be used onboard the Air Force KC135 Aircraft.

As an integral part of this proposal, please find enclosed three (3) copies of Proposal Drawing 20850 and a copy of our standard Warranty.

P/N	DESCRIPTION	UNIT PRICE
TBD	Galley	$31,000.00
TBD	Removable Self-Contained Refrigerator	$13,500.00
50361	Microwave Oven	$ 9,800.00
50405-101	Coffeemaker	$ 2,595.00
180146	Beverage Jug	$ 1,002.00
STDS-VT-110	Hot Cup	$ 105.00

Additional one-time non-recurring charge to cover engineering design, weight test, flammability, fire containment, tooling, manuals and certification package - $34,500.00.

Nordskog will supply all supporting data for certification but the actual galley certification will be the responsibility of the Air Force.

Delivery: 150 Days after Receipt of Order for the first unit. Additional units can be delivered per your requirements.

more...

I suggest that, after an initial review of this package, you contact me so that we can discuss any question which you may have.

Sincerely,

NORDSKOG INDUSTRIES, INC.

Larry L. Bozer,
Sales Engineer

LLB:ll
Enc.