STUDIES ON FROZEN FOIL PACK MEAL COMPONENTS

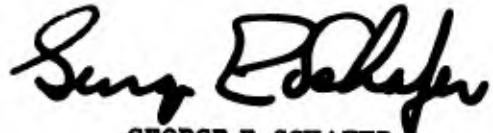
ROBERT K. NELSON, Colonel, USAF, VC
JACK R. AUDISS, Lieutenant Colonel, USAF
RAYMOND A. MADSON, Captain, USAF
JOSEPH T. CORDARO, M.S.
NORMAN D. HEIDELBAUGH, Major, USAF, VC
LESLIE MANLEY, Captain, USAF
GLEN R. DRENNAN, Chief Master Sergeant, USAF

FOREWORD

The research reported in this paper was conducted by personnel of the Biosciences and Physiology Branches under task No. 775803 in conjunction with Headquarters Strategic Air Command (SUV, DM3E), Offutt Air Force Base, Nebr. The work was accomplished between 15 June 1966 and 25 May 1967. The paper was submitted for publication on 27 June 1967.

The authors wish especially to acknowledge the assistance of Captain May J. O'Hara, of the Physiology Branch, and Robert J. Ball, Howard C. Nichols, Airman First Class Fitzroy F. Edwards, Airman Second Class Will E. Ballard, and Airman Second Class Harvey A. Wecker of the Biosciences Branch.

This report has been reviewed and is approved.



GEORGE E. SCHAFER
Colonel, USAF, MC
Commander

ABSTRACT

Components selected from the foil pack meal feeding system were prepared (cooked and packaged) in a foil pack kitchen, frozen, stored in the frozen state, and evaluated organoleptically and bacteriologically after storage for time up to 12 months. These foods were studied for usefulness in a frozen component feeding system offering a la carte selection at remote sites where prestocking of nonfrozen meal components is feasible.

The results of this study indicate that the frozen foods were bacteriologically safe for consumption and, in general, organoleptically acceptable. Suggestions are offered for further development of this frozen component feeding system.

BLANK PAGE

STUDIES ON FROZEN FOIL PACK MEAL COMPONENTS

I. INTRODUCTION

The current 10-day-cycle menu of foil pack meals (1, 2) provides a satisfactory feeding system for short-duration operational missions. The acceptance of this feeding system, however, decreases as the duration of the mission increases. This decline in acceptability results primarily from limitations on the variety of food combinations imposed by the fixed 10-day-cycle menu. This problem has become particularly apparent from experiences gained from feeding airborne alert crews and missile launch control facility crews for extended periods of time.

In-flight precooked frozen meals (1, 9, 10) are likewise poorly accepted by crews after prolonged feeding, primarily because there are currently only five different precooked frozen meals utilized by the Air Force. In addition to the problem of limited variety, these frozen meals offer small portions and low caloric levels not suitable to prolonged feeding programs. It is well-known that limited menu cycles and lack of free choice of food items within the menu soon result in consumers' focusing their hostilities on the feeding system. Such problems have occurred in the Air Force with the increase in duration of aircraft flights and the duty time at isolated sites.

For some time aircrews on long endurance flights have used in-flight precooked frozen meals as backup when foil packed meals were not available. The foil pack meal is prepared in local in-flight kitchens, refrigerated, and considered safe for consumption up to 5 days after preparation. This meal has had higher acceptance among aircrews than the precooked frozen meal which is industrially produced, centrally supplied, and has a storage life expectancy up to 6 months.

Some preliminary observations were made, beginning in 1964, concerning methods to overcome the difficulties described above. Several in-flight kitchens selected food components from the foil pack menu and, following routine preparations, froze them by holding at −12° C. (10° F.). These components were then made available on an a la carte basis to aircrews and were combined with nonfrozen components of the foil pack meal which were prestocked in the in-flight kitchen. These limited trials were attempts to combine the advantages offered by the greater food variety of the foil pack meal with the long storage life of the frozen meal. All of the components so frozen were found to be within acceptable bacteriologic limits before being served.

These results logically led to the possibility of large-scale routine production of the frozen foods from the foil pack meal for use in a feeding system of frozen components supplemented by prestocked nonfrozen components. There is a need for such a feeding system to support remote aerospace operations. Availability of such meals would contribute to increased crew effectiveness. The following criteria were established as the objectives for a frozen component feeding system:

1. It must comply with the microbiologic safety limits of the in-flight precooked frozen meal as well as with all the other medical requirements established for the frozen meal.

2. It must have high acceptability and nutritive value attained by offering a wide variety of menu items a la carte to each individual crewmember and by providing generous serving portions.

3. It must be cost effective; that is, the cost must be within current monetary allowances.

A study was conducted to evaluate meal components developed to meet the criteria.

The components used in this study were produced using routine foil pack kitchen facilities by personnel given no special instructions and taking no special precautions. After preparation, the meals were frozen in an upright freezer.

II. MATERIALS AND METHODS

Preparation of frozen meal components

All of the frozen components tested in this study were prepared by personnel of the Food Service Foil Pack Kitchen, Francis E. Warren AFB, Wyo. No special processing equipment or technics were employed in the preparation of the food items for this study. Routine foods and procedures for preparation of foil pack components were used. The foods were produced in two separate lots with an interval of 3 months between each lot. After production, the food items of the first lot were packaged in three-compartment aluminum trays and covered by an aluminum foil lid, hand-folded over the edge of the tray. Food items of the second production lot were packaged in individual aluminum foil containers with crimped aluminum foil covers. All the foods were frozen by holding in an upright freezer at −23° C. (−10° F.). Figures 1 through 7 show the facilities used in producing both lots of foods and the packaging of the second production lot.

FIGURE 1

View of in-flight kitchen from west end.

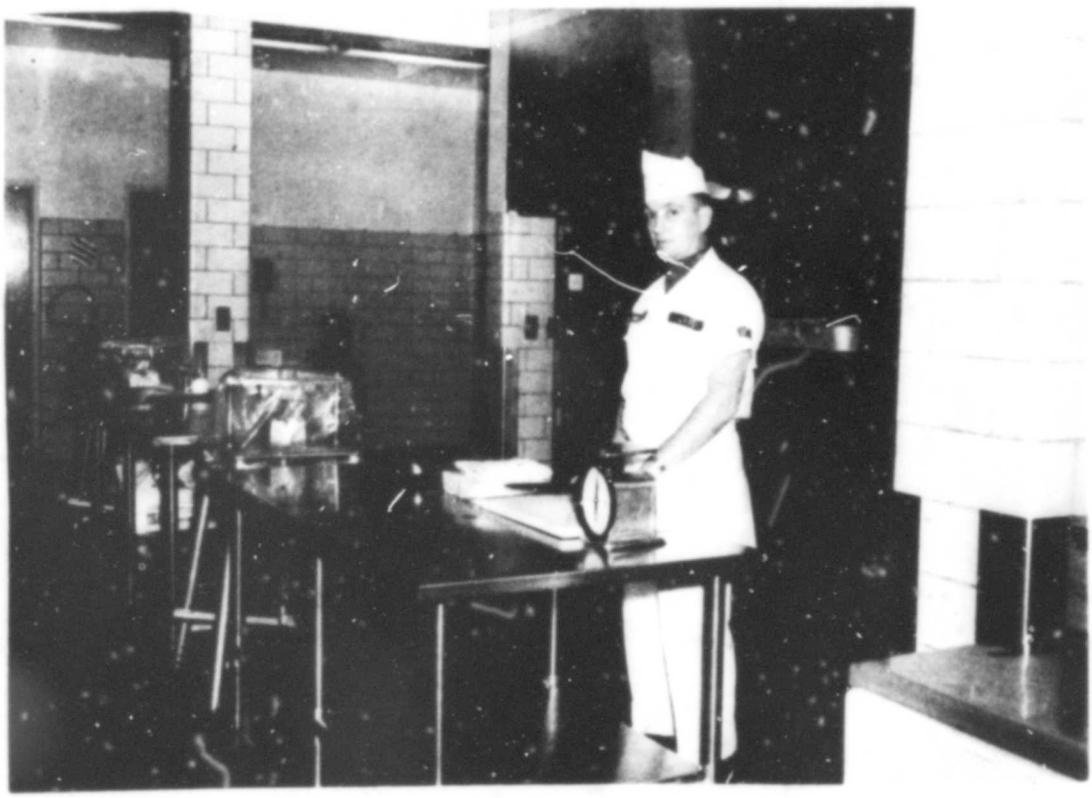


FIGURE 2

View of in-flight kitchen from east end.

FIGURE 3

Meal components in individual aluminum containers before sealing.

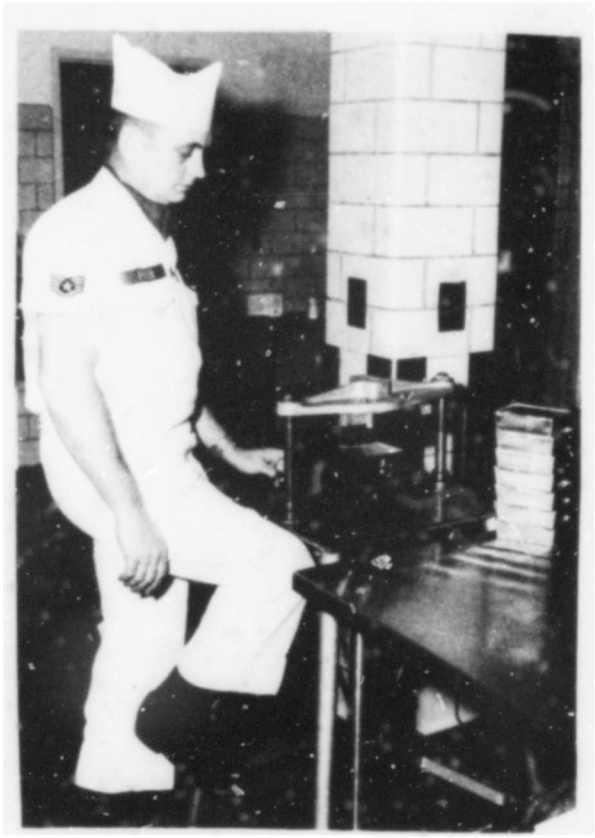


FIGURE 4

Crimping aluminum cover on food container.

FIGURE 5

Food containers in freezer.

FIGURE 6

Assembly of frozen meal components.

Storage prior to testing

Foods of the first production lot were stored for 6 months at approximately −23° C. (−10° F.) prior to testing. The second lot was held under similar conditions for a 12-month period before testing.

Bacteriologic examination

Methods used for bacteriologic examinations are those described in Military Specification MIL-M-13966C, "Meal, Precooked, Frozen," as amended 25 August 1966. The only change in the procedures was that each food component was examined individually so that a bacteriologic evaluation of individual components was obtained rather than a composite evaluation of the meal. Thirty-five groups of

FIGURE 7

Storage of frozen meal components.

frozen foil pack meal components were examined from the first production lot. At the same time as this examination, similar bacteriologic tests were performed on five randomly selected, precooked frozen meals that were commercially prepared. Seventy groups of frozen foil pack meal components were examined from the second production lot.

Organoleptic evaluation of frozen food after storage

The organoleptic evaluation of the frozen food items of the first production lot was made by 4 Air Force men who began eating the meals the same day they completed 40 continuous days of subsistence on foods designed for a space feeding system (4). The men were asked to rate each food item on the 9-point hedonic scale (7), having a null point at 5. Their organoleptic ratings of the frozen foil pack meal constituents were compared to their ratings of the foods of the space feeding system.

Organoleptic evaluation of the second lot of frozen food items, which were stored for 12 months, was performed by the trained taste panel of 6 food technologists and 3 veterinary officers at the U. S. Army Natick Laboratories, Natick, Mass.

III. RESULTS

Table I shows the components of the ten menus studied with their item-by-item costs, as of the time of this study. The food components which were selected for freezing are indicated by an asterisk.

The quality loss, color deterioration, and degree of dehydration were minimal, as determined by visual inspection of the frozen foods after storage. The items which showed significant deterioration were cream style corn, potatoes, and sausage. It was observed that the fresh whole eggs which had been removed from the shell and frozen with a pat of butter maintained their quality very well.

The hedonic ratings of the first lot of frozen foil pack foods (stored for 6 months) had a mean of 6.8 with a range of 2 to 7. The ratings given by the same tasters to foods of space feeding systems had a mean of 6.4 with a range of 1 to 9 (6).

Sixteen meals were selected at random from sixty-seven meals submitted for testing from the second lot. The sample meals were rated as organoleptically unacceptable. It was evident the quality of the meals had deteriorated in storage; therefore, the remaining meals were destroyed without further organoleptic evaluation.

The results of bacteriologic examinations of the individual food items from the first lot of frozen meal components are given in table II. The bacteriologic results from the frozen precooked meals that were commercially prepared are shown in table III. The mean total

TABLE I

Items selected for freezing and costs of foil pack meals

Breakfast		Dinner		Supper	
Menu No. 1					
Chilled apple juice	.07	Baked chicken with gravy*	.20	Salisbury steak with mushrooms*	.18
Assorted dry cereal	.05	Cranberry sauce	.014	Catsup	.014
Fresh milk	.05	Parsley buttered potatoes*	.02	Au gratin potatoes*	.025
Eggs to order*	.07	Mexican corn*	.045	Buttered green beans*	.025
Grilled bacon*	.09	Peach cottage cheese salad on lettuce	.051	Tossed vegetable salad with French dressing	.035
Quick coffee cake	.06	Hot rolls and butter	.02	Bread and butter	.013
Toast and butter	.013	Ice cream	.05	Pineapple pie	.07
Strawberry jam	.017	Chocolate chip cookies	.03	Coffee, tea, or milk	.08
Coffee or tea	.08	Coffee, tea, or milk	.08	Fresh oranges	.05
Cost:	.450	Cost:	.51	Cost:	.492
				Total cost:	$1.452
Menu No. 2					
Chilled tomato juice	.07	Beef pot roast*	.22	Baked ham with mustard*	.238
Assorted dry cereal	.05	Rissolé potatoes*	.02	Browned sweet potatoes*	.046
Fresh milk	.05	Buttered carrots*	.015	Buttered mixed vegetables*	.04
Eggs to order*	.07	Assorted crisp relishes	.02	Jellied fruit salad on lettuce	.055
Grilled pork sausage*	.06	Celery, radishes, and dill pickles	.01	Hot rolls and butter	.02
Toast and butter	.013	Bread and butter	.013	Plain cake with butter cream icing	.053
Apple jelly	.013	Lettuce	.02	Coffee, tea, or milk	.08
Coffee or tea	.08	Fresh fruit cup with coconut	.05	Cheese and crackers	.013
Cost:	.356	Sugar cookies	.02	Cost:	.545
		Coffee, tea, or milk	.08		
		Cost:	.468	Total cost:	$1.369
Menu No. 3					
Chilled orange juice	.07	Roast turkey with gravy*	.26	Barbecued beef patties*	.20
Assorted dry cereal	.06	Cranberry sauce	.014	Home fried potatoes*	.025
Fresh milk	.05	Cornbread dressing*	.01	Buttered lima beans	.05
Eggs to order*	.07	Mashed potatoes	.023	Lettuce wedge with salad dressing	.035
Grilled bacon*	.09	Buttered peas	.08	Hot rolls and butter	.02
Toast and butter	.013	Assorted crisp relishes: celery, carrots, sweet pickles, lettuce	.04	Peach pie	.053
Strawberry jam	.017	Bread and butter	.013	Coffee, tea, or milk	.08
Coffee or tea	.08	Brownies	.075	Cheese and crackers	.013
Cost:	.400	Coffee, tea, or milk	.08	Cost:	.476
		Fresh apples	.04		
		Cost:	.585	Total cost:	$1.461

TABLE I (contd.)

Breakfast		Dinner		Supper	
Menu No. 4					
Chilled pineapple juice	.07	Meat sauce and spaghetti*	.145	Grilled pork chops*	.33
Assorted dry cereal	.06	Grated cheese*	.01	O'Brien potatoes*	.025
Fresh milk	.05	Buttered green beans*	.02	Buttered corn*	.037
Eggs to order*	.07	Tossed green salad with French dressing	.035	Assorted relishes: celery, radish roses, green olives, lettuce	.04
Grilled bacon*	.09	French bread and butter	.02	Hot rolls and butter	.02
Cinnamon rolls	.026	Apple pie	.053	Ice cream	.05
Grape jelly	.015	Coffee, tea, or milk	.08	Oatmeal cookies	.02
Toast and butter	.013	Fresh oranges	.05	Coffee, tea, or milk	.08
Coffee or tea	.03				
Cost:	.424	Cost:	.413	Cost:	.602
				Total cost:	$1.439
Menu No. 5					
Chilled grapefruit sections	.04	Southern fried chicken with gravy*	.20	Beef fricassee*	.221
Assorted dry cereal	.06	Mashed potatoes*	.023	Parsley buttered noodles*	.024
Fresh milk	.05	Buttered lima beans*	.05	Buttered peas*	.03
Eggs to order*	.07	Cranberry and pineapple gelatin salad on lettuce	.037	Lettuce wedge with salad dressing	.038
Grilled ham*	.129	Hot rolls and butter	.02	Bread and butter	.013
Toast and butter	.013	Plain cake with butter cream icing	.053	Cherry pie	.052
Strawberry jam	.017	Coffee, tea, or milk	.08	Coffee, tea, or milk	.08
Coffee or tea	.03	Fresh apples	.04	Cheese and crackers	.013
Cost:	.409	Cost:	.503	Cost:	.469
				Total cost:	$1.381
Menu No. 6					
Stewed prunes with lemon	.021	Roast turkey with gravy*	.26	Swiss steak*	.321
Assorted dry cereal	.06	Cranberry sauce	.014	Rissolé potatoes*	.024
Fresh milk	.05	Cornbread dressing*	.01	Buttered julienne carrots*	.023
Eggs to order*	.07	Mashed potatoes*	.023	Assorted crisp relishes: celery, ripe olives	.037
Grilled bacon*	.09	Buttered mixed vegetables*	.04	Green pepper rings, lettuce	.013
Doughnuts	.051	Tossed salad with French dressing	.035	Hot rolls and butter	.02
Toast and butter	.013	Bread and butter	.013	Jellied fruit cocktail	.035
Grape jelly	.015	Spice cake with butter cream icing	.058	Vanilla wafers	.021
Coffee or tea	.03	Coffee, tea, or milk	.08	Coffee, tea, or milk	.08
Cost:	.400	Fresh apples	.04	Cost:	.574
		Cost:	.573	Total cost:	$1.547

TABLE I (contd.)

Breakfast		Dinner		Supper	
Menu No. 7					
Chilled pineapple juice	.07	Meat loaf with catsup*	.144	Breaded veal cutlet with lemon slices	.253
Assorted dry cereal	.06	Mashed potatoes*	.023	Chilled applesauce	.016
Fresh milk	.05	Green beans with tomatoes and onion*	.031	Hash brown potatoes*	.027
Eggs to order*	.07	Grapefruit gelatin salad on lettuce	.029	Buttered peas*	.03
Grilled bacon*	.09	Hot rolls and butter	.02	Lettuce wedge with salad dressing	.053
Coffee cake	.06	Devil's food cake with chocolate icing	.057	Bread and butter	.013
Toast and butter	.013	Coffee, tea, or milk	.08	Ice cream	.05
Strawberry jam	.017	Fresh oranges	.05	Sugar cookies	.02
Coffee or tea	.03	Cost:	.434	Coffee, tea, or milk	.08
Cost:	.460			Cost:	.542
				Total cost:	$1.436
Menu No. 8					
Fresh apples	.04	Pork chop suey*	.335	Oven roast with natural gravy*	.371
Assorted dry cereal	.06	Steamed rice*	.014	French baked potatoes*	.025
Fresh milk	.05	Chow mein noodles*	.012	Cream style corn*	.033
Eggs to order*	.07	Glazed carrots	.03	Assorted crisp relishes: celery, lettuce, ripe olives, radishes	.05
Grilled bacon*	.09	Pineapple cottage cheese salad on lettuce	.05	Bread and butter	.013
Toast and butter	.013	Hot rolls and butter	.02	Peach gelatin	.043
Grape jelly	.015	Plain cake with butter cream icing	.053	Icebox cookies	.021
Coffee or tea	.03	Coffee, tea, or milk	.08	Coffee, tea, or milk	.08
Cost:	.368	Crackers and jelly	.025	Cost:	.636
		Cost:	.619	Total cost:	$1.623
Menu No. 9					
Chilled tomato juice	.07	Southern fried chicken*	.20	Grilled ham steak with pineapple*	.264
Assorted dry cereal	.05	Cranberry sauce	.014	Scalloped potatoes*	.028
Fresh milk	.05	Mashed potatoes*	.023	Buttered green beans*	.025
Waffles with hot maple syrup*	.072	Buttered mixed vegetables*	.04	Molded pear salad on lettuce	.04
Grilled bacon*	.09	Tossed salad with French dressing	.035	Hot rolls	.02
Toast and butter	.013	Bread and butter	.013	Brownies	.075
Strawberry jam	.017	Apple pie	.053	Coffee, tea, or milk	.08
Coffee or tea	.03	Coffee, tea, or milk	.08	Cheese and crackers	.013
Cost:	.392	Fresh oranges	.05	Cost:	.527
		Cost:	.508	Total cost	$1.427

TABLE I (contd.)

Breakfast		Dinner		Supper	
Menu No. 10					
Chilled orange juice	.07	Braised meat balls*	.135	Breaded pork chops*	.323
Assorted dry cereal	.05	Catsup	.014	Rissolé potatoes*	.024
Fresh milk	.05	Macaroni with tomatoes and cheese	.041	Buttered lima beans*	.05
Eggs to order*	.07	Buttered peas*	.03	Assorted relishes: celery, radishes, dill pickles	.02
Grilled bacon*	.09	Lettuce wedge with salad dressing	.035	Lettuce	.02
Doughnuts	.051	Hot rolls and butter	.02	Bread and butter	.013
Toast and butter	.013	Banana cake with butter cream icing	.057	Cherry pie	.053
Grape jelly	.015	Coffee, tea, or milk	.08	Coffee, tea, or milk	.08
Coffee or tea	.03	Fresh apples	.05	Cost:	.593
Cost:	.369	Cost:	.462		
				Total cost:	$1.424

*Items included in the frozen part of the meal.

bacterial count of the frozen foil pack foods was 2,637 per gram (range 120 to 15,000), and the comparative mean count of commercially prepared frozen meals was 6,324 (range 80 to 14,000). These means differ significantly ($P < .01$). The variance in the total bacterial plate counts of the foods in the foil pack meals does not differ from the variance in counts in the commercially prepared meals ($P > .05$). Coliform counts of both groups of meal components were within specification limits.

The results of the bacteriologic examinations of the individual food items from the second lot of frozen foil pack meal components are given in table IV. All the coliform counts were negative with the exception of dinner No. 10 in which the mashed potatoes had a count of 18 coliform/gm. Nine of these colonies were transferred to *Escherichia coli* medium. All nine colonies were confirmed as fecal organisms. Two of the items from dinners Nos. 2 and 11 (baked chicken and fried chicken) had total bacterial counts per gram in excess of 100,000. The results for supper meal No. 21 were lost owing to a laboratory accident which resulted in contamination of the plate count agar. No coliform organism was present in any of the food items of this meal.

IV. DISCUSSION

The selection of foods for freezing, from the foods offered by the foil pack menus, was made on the basis of which foods required freezing so that on-the-site meal preparation would be simplified and an a la carte selection could be provided. Under this concept the using agency would prestock the nonfrozen components which would be drawn upon as the consumer desired. The consumer would thus be provided a free choice of meal constituents as long as he did not exceed the overall authorized monetary allowance and the selection, as a whole, remained within the overall meal pattern.

The results of the bacteriologic analysis of the foods showed that they met current standards. This indicates that food which is prepared under the conditions of this study can be bacteriologically acceptable. These results were not unexpected. Air Force food preparation facilities are operated by competent and conscientious food service personnel whose efforts come under close veterinary medical scrutiny. These facilities consistently produce wholesome, acceptable, and nutritious foods for ground and in-flight feeding (3, 5, 8). There

TABLE I (contd.)

Breakfast		Dinner		Supper	
Menu No. 7					
Chilled pineapple juice	.07	Meat loaf with catsup*	.144	Breaded veal cutlet with lemon slices	.253
Assorted dry cereal	.06	Mashed potatoes*	.023	Chilled applesauce	.016
Fresh milk	.05	Green beans with tomatoes and onion*	.031	Hash brown potatoes*	.027
Eggs to order*	.07	Grapefruit gelatin salad on lettuce	.029	Buttered peas*	.03
Grilled bacon*	.09	Hot rolls and butter	.02	Lettuce wedge with salad dressing	.053
Coffee cake	.06	Devil's food cake with chocolate icing	.057	Bread and butter	.013
Toast and butter	.013	Coffee, tea, or milk	.08	Ice cream	.05
Strawberry jam	.017	Fresh oranges	.05	Sugar cookies	.02
Coffee or tea	.03	Cost:	.434	Coffee, tea, or milk	.08
Cost:	.460			Cost:	.542
				Total cost:	$1.436
Menu No. 8					
Fresh apples	.04	Pork chop suey*	.335	Oven roast with natural gravy*	.371
Assorted dry cereal	.06	Steamed rice*	.014	French baked potatoes*	.025
Fresh milk	.05	Chow mein noodles*	.012	Cream style corn*	.033
Eggs to order*	.07	Glazed carrots	.03	Assorted crisp relishes: celery, lettuce, ripe olives, radishes	.05
Grilled bacon*	.09	Pineapple cottage cheese salad on lettuce	.05	Bread and butter	.013
Toast and butter	.013	Hot rolls and butter	.02	Peach gelatin	.043
Grape jelly	.015	Plain cake with butter cream icing	.053	Icebox cookies	.021
Coffee or tea	.03	Coffee, tea, or milk	.08	Coffee, tea, or milk	.08
Cost:	.368	Crackers and jelly	.025	Cost:	.636
		Cost:	.619	Total cost:	$1.623
Menu No. 9					
Chilled tomato juice	.07	Southern fried chicken*	.20	Grilled ham steak with pineapple*	.264
Assorted dry cereal	.05	Cranberry sauce	.014	Scalloped potatoes*	.028
Fresh milk	.05	Mashed potatoes*	.023	Buttered green beans*	.025
Waffles with hot maple syrup*	.072	Buttered mixed vegetables*	.04	Molded pear salad on lettuce	.04
Grilled bacon*	.09	Tossed salad with French dressing	.035	Hot rolls	.02
Toast and butter	.013	Bread and butter	.013	Brownies	.075
Strawberry jam	.017	Apple pie	.053	Coffee, tea, or milk	.08
Coffee or tea	.03	Coffee, tea, or milk	.08	Cheese and crackers	.013
Cost:	.392	Fresh oranges	.05	Cost:	.527
		Cost:	.508		
				Total cost	$1.427

TABLE I (contd.)

Breakfast		Dinner		Supper	
Menu No. 10					
Chilled orange juice	.07	Braised meat balls*	.135	Breaded pork chops*	.323
Assorted dry cereal	.05	Catsup	.014	Rissolé potatoes*	.024
Fresh milk	.05	Macaroni with tomatoes and cheese*	.041	Buttered lima beans*	.05
Eggs to order*	.07	Buttered peas*	.03	Assorted relishes: celery, radishes, dill pickles	.02
Grilled bacon*	.09	Lettuce wedge with salad dressing	.035	Lettuce	.02
Doughnuts	.051	Hot rolls and butter	.02	Bread and butter	.013
Toast and butter	.013	Banana cake with butter cream icing	.057	Cherry pie	.053
Grape jelly	.015	Coffee, tea, or milk	.08	Coffee, tea, or milk	.08
Coffee or tea	.03	Fresh apples	.05	Cost:	.593
Cost:	.369	Cost:	.462		
				Total cost:	$1.424

*Items included in the frozen part of the meal.

bacterial count of the frozen foil pack foods was 2,637 per gram (range 120 to 15,000), and the comparative mean count of commercially prepared frozen meals was 6,321 (range 80 to 14,000). These means differ significantly ($P < .01$). The variance in the total bacterial plate counts of the foods in the foil pack meals does not differ from the variance in counts in the commercially prepared meals ($P > .05$). Coliform counts of both groups of meal components were within specification limits.

The results of the bacteriologic examinations of the individual food items from the second lot of frozen foil pack meal components are given in table IV. All the coliform counts were negative with the exception of dinner No. 10 in which the mashed potatoes had a count of 18 coliform/gm. Nine of these colonies were transferred to *Escherichia coli* medium. All nine colonies were confirmed as fecal organisms. Two of the items from dinners Nos. 2 and 11 (baked chicken and fried chicken) had total bacterial counts per gram in excess of 100,000. The results for supper meal No. 21 were lost owing to a laboratory accident which resulted in contamination of the plate count agar. No coliform organism was present in any of the food items of this meal.

IV. DISCUSSION

The selection of foods for freezing, from the foods offered by the foil pack menus, was made on the basis of which foods required freezing so that on-the-site meal preparation would be simplified and an a la carte selection could be provided. Under this concept the using agency would prestock the nonfrozen components which would be drawn upon as the consumer desired. The consumer would thus be provided a free choice of meal constituents as long as he did not exceed the overall authorized monetary allowance and the selection, as a whole, remained within the overall meal pattern.

The results of the bacteriologic analysis of the foods showed that they met current standards. This indicates that food which is prepared under the conditions of this study can be bacteriologically acceptable. These results were not unexpected. Air Force food preparation facilities are operated by competent and conscientious food service personnel whose efforts come under close veterinary medical scrutiny. These facilities consistently produce wholesome, acceptable, and nutritious foods for ground and in-flight feeding (3, 5, 8). There

TABLE II

Bacteriologic examination of foods from frozen foil pack meals of lot No. 1*

Sample	Breakfast items			Dinner items			Supper items		
	Food	Coliform (gm.)	Total bacterial count/gm.	Food	Coliform (gm.)	Total bacterial count/gm.	Food	Coliform (gm.)	Total bacterial count/gm.
1	Eggs	8	400	Chicken	0	6,500	Steak	0	820
	Bacon	0	40	Potatoes	0	10,000	Potatoes	0	1,300
				Corn	0	13,000	Beans	0	470
2	Eggs	0	0	Roast beef	4	550	Ham	0	4,800
	Sausage	0	760	Potatoes	0	1,500	Sweet potatoes	0	310
				Carrots	0	1,200	Vegetable	0	2,400
3	Eggs	0	110	Turkey and dressing	0	1,500	Barbecued beef	0	250
	Bacon	0	90	Potatoes	1	9,800	Potatoes	0	2,500
				Peas	2	410	Beans	0	9,400
4	Eggs	0	25	Meat sauce	0	230	Pork chops	0	710
	Bacon	0	55	Spaghetti	0	330	Potatoes	0	5,600
				Green beans	0	1,300	Corn	0	(Unsatisfactory sample)
5	Eggs	0	25	Chicken	0	5,200	Beef fricassee	1	1,000
	Ham	0	530	Potatoes	0	1,200	Noodles	0	450
				Lima beans	0	690	Peas	0	15,000

TABLE II (contd.)

Sample	Breakfast items			Dinner items			Supper items		
	Food	Coliform (gm.)	Total bacterial count/gm.	Food	Coliform (gm.)	Total bacterial count/gm.	Food	Coliform (gm.)	Total bacterial count/gm.
	Eggs	0	50	Turkey and dressing	0	9,400	Swiss steak	0	860
6	Bacon	0	60	Potatoes	0	1,900	Potatoes	0	590
				Mixed vegetables	0	6,300	Carrots	0	120
	Eggs	0	70	Meat loaf	0	310	Veal cutlets	0	1,400
7	Bacon	0	0	Potatoes	1	1,600	Potatoes	0	12,000
				Green beans	0	430	Peas	0	2,800
	Eggs	0	35	Chop suey and			Roast beef	1	930
8	Bacon	0	50	noodles	0	350	Potatoes	0	980
				Rice	0	210	Corn	0	150
				Carrots	0	70			
	Waffles	0	75	Chicken	0	2,600	Ham	0	640
9	Bacon	0	20	Potatoes	1	1,700	Potatoes	0	610
				Vegetables	0	3,000	Beans	0	510
		(Not		Meat balls	0	780	Pork chops	0	4,400
10	(Package broken)	sampled)		Macaroni	0	30,000	Potatoes	0	4,000
				Peas	0	3,700	Lima beans	0	10,000

*Examined in accordance with methods given in Military Specification MIL-M-13966C, "Meal, Precooked, Frozen," as amended 25 Aug 1966.

TABLE III

Bacteriologic examination of commercially prepared, frozen precooked meals selected at random for comparison study*

Sample	Food item	Coliform/gm.	Total bacterial count/gm.
	Turkey	0	1,600
1	Potatoes	0	8,200
	Peas and carrots	0	14,000
	Salisbury steak	5	8,100
2	Potatoes	0	4,400
	Peas and carrots	0	14,000
	Swiss steak	0	160
3	Potatoes	5	7,200
	Peas and carrots	1	9,000
	Ham	0	690
4	Yams	3	10,000
	Peas and carrots	1	14,000
	Pork loin	0	100
5	Potatoes	0	3,600
	Apples	0	80

*Each food item examined individually employing the methods given in Military Specification MIL-M-13966C, "Meal, Precooked, Frozen," as amended 25 Aug. 1966.

is no reason to expect that food prepared under these conditions, when properly packaged and properly frozen immediately after preparation, would not be bacteriologically safe for consumption after being held in the frozen state.

The acceptability of the items evaluated in this study indicated that the overall concept is sound. A frozen shelf life of 30 to 90 days for the frozen food components will assure maximum organoleptic acceptability. Additionally, improvements can be made by selecting menu items, changing recipes, and improving packaging to better adapt the system for freezing, shipping (11), and a la carte serving. Food technologists know that certain food items keep their quality better than others when subjected to freezing and frozen storage. There is a need to select and evaluate each food item and develop items suited to the feeding concept being considered here.

Specifically, there is a need to develop recipes that require the use of ingredients adaptable to freezing—e.g., rice flour in lieu of wheat flour for gravies or sauces. Specific direction is needed in actual preparation and freezing of the foil pack meal—i.e., preparing vegetables with less liquid and eliminating foods with poor keeping qualities. All recipes now being used to prepare the 10-day foil pack meal should be reviewed and revised, where necessary, to insure stability during freezing. Specific suggestions which can be offered as the result of the studies completed here are the following:

1. Use canned or fresh vegetables as much as possible in frozen meals. Frozen vegetables lose eye appeal after being cooked, refrozen, and reheated before serving.

2. Fresh vegetable salads are not stable when packed with frozen meals going to remote sites. They tend to wilt and discolor.

3. Pot roast should not be used owing to the fat and gristle content. Shrinkage is high on this item.

4. Use of rolled turkey should be considered. Whole turkey is more expensive because of waste, has less eye appeal, and requires more man-hours to prepare.

5. Moist heat cooking methods should be used because frozen meal components tend to dehydrate in storage. It is advisable to use gravies and sauces on all meat items to preserve moisture. Grilled items should not be used because they tend to dry out and lose moisture.

A new packaging system is required to store, transport, and serve the foil pack meal. The development of the packaging should consider the following factors:

1. Single-compartment containers. These containers will be required for packaging individual components of the foil pack menu in an a la carte ordering system. Two sizes will be required, one for the entree and potatoes, and one for the vegetable, dessert, and bread.

TABLE IV

Bacteriologic examination of foods from frozen foil pack meals of lot No. 2*

Sample	Breakfast items		Dinner items		Supper items	
	Food	Total bacterial count/gm.	Food	Total bacterial count/gm.	Food	Total bacterial count/gm.
1	Eggs	30	Beef pot roast	170	Oven roast	1,130
	Bacon	25	Rissolé potatoes	350	French baked potatoes	3,400
			Buttered carrots	420	Cream style corn	240
2	Eggs	40	Baked chicken	104,000	Breaded pork chop	285
	Bacon	260	Buttered peas	230	Rissolé potatoes	475
			Mexican corn	1,010	Buttered lima beans	830
3	Eggs	85	Fried chicken	3,400	Swiss steak	330
	Bacon	220	Mashed potatoes	3,800	Rissolé potatoes	1,730
			Lima beans	6,400	Buttered julienne carrots	260
4	Waffles	130	Roast turkey	7,300	Baked ham	250
	Bacon	0	Mashed potatoes	1,800	Browned sweet potatoes	110
			Buttered peas	710	Buttered mixed vegetables	1,000
5	Eggs	10	Roast turkey	850	Swiss steak	875
	Bacon	15	Mashed potatoes	650	Rissolé potatoes	755
			Mixed vegetables	940	Buttered julienne carrots	315
6	Eggs	0	Braised meat balls	110	Beef fricassee	15
	Bacon	0	Macaroni	760	Buttered parsley noodles	145
			Buttered peas	1,230	Buttered peas	31,500
7	Waffles	385	Pork chop suey	360	Breaded veal cutlet	1,145
	Bacon	0	Steamed rice	300	Hashed brown potatoes	10,350
			Glazed carrots	20	Buttered peas	11,850
8	Eggs	0	Beef pot roast	145	Salisbury steak	2,065
	Bacon	10	Rissolé potatoes	745	Au gratin potatoes	1,470
			Buttered carrots	310	Buttered green beans	460
9	Eggs	10	Meat loaf	135	Grilled pork chop	1,355
	Bacon	35	Mashed potatoes	770	O'Brien potatoes	5,650
			Green beans	1,520	Buttered corn	910
10	Eggs	20	Roast turkey	925	Salisbury steak	1,050
	Sausage	4,000	Mashed potatoes	720	Au gratin potatoes	6,250
			Mixed vegetables	1,755	Buttered green beans	395
11	Eggs	5	Fried chicken	149,000	Baked ham	415
	Bacon	0	Mashed potatoes	3,350	Brown sweet potatoes	0
			Lima beans	4,850	Buttered mixed vegetables	4,050
12	Eggs	50	Baked chicken	4,000	Beef fricassee	25
	Ham	740	Buttered parsley	220	Buttered parsley noodles	405
			Mexican corn	880	Buttered peas	1,910

TABLE IV (contd.)

Sample	Breakfast items		Dinner items		Supper items	
	Food	Total bacterial count/gm.	Food	Total bacterial count/gm.	Food	Total bacterial count/gm.
13	Eggs	20	Roast turkey	3,150	Baked ham	15
	Sausage	190	Mashed potatoes	5,000	Browned sweet potatoes	220
			Mixed vegetables	3,050	Buttered mixed vegetables	530
14	Eggs†	20	Beef pot roast	720	Barbecued beef patties	710
	Bacon	1,125	Rissolé potatoes	100	Home fried potatoes	170
			Buttered carrots	235	Buttered lima beans	3,100
15	Eggs†	30	Roast turkey	3,500	Grilled ham steak	145
	Bacon	365	Mashed potatoes	6,500	Scalloped potatoes	3,300
			Buttered peas	1,365	Buttered green beans	4,800
16	Eggs†	75	Roast turkey	790	Grilled ham steak	120
	Bacon	140	Mashed potatoes	4,450	Scalloped potatoes	1,150
			Buttered peas	250	Buttered green beans	3,100
17	Eggs†	15	Spaghetti and cheese	30	Beef fricassee	20
	Sausage	165	Meat sauce	225	Buttered parsley noodles	270
			Buttered green beans	1,200	Buttered peas	460
18	Eggs	10	Fried chicken	285	Swiss steak	680
	Bacon	70	Mashed potatoes	4,300	Rissolé potatoes	550
			Buttered lima beans	625	Buttered julienne carrots	390
19	Eggs	15	Fried chicken	300	Salisbury steak	7,900
	Bacon	75	Mashed potatoes	4,200	Au gratin potatoes	320
			Lima beans	610	Buttered green beans	940
20	Eggs	0	Roast turkey	505	Salisbury steak	5,150
	Bacon	10	Mashed potatoes	3,700	Au gratin potatoes	760
			Mixed vegetables	710	Buttered green beans	1,095
21	Eggs	5	Meat loaf	745		
	Bacon	0	Mashed potatoes	4,900	(Specimens lost)	
			Green beans	230		
22	Eggs	15	Pork chop suey	90	Swiss steak	190
	Sausage	25	Steamed rice	100	Rissolé potatoes	990
			Glazed carrots	95	Buttered julienne carrots	810
23	Eggs	0	Fried chicken	4,350	Oven roast	475
	Bacon	5	Mashed potatoes	9,100	French baked potatoes	275
			Mixed vegetables	1,045	Cream style corn	3,050
24	‡		‡		Breaded pork chop	970
					Rissolé potatoes	290
					Buttered lima beans	665
25	‡		‡		Baked ham	415
					Rissolé potatoes	680
					Buttered green beans	685

*Each food item examined individually employing the methods given in Military Specification MIL-M-13966C, "Meal, Precooked, Frozen," as amended 25 Aug. 1966. All coliform counts were negative with the exception of dinner No. 10 in which mashed potatoes had a count of 18 coliform/gm.

†Egg yolk broken in shipment.

‡Meals not included in production lot.

2. Hooding for single-compartment containers. The hooding material should be transparent, effect a tight spillproof seal, and evaporate during the heating process.

3. Tray insert. A tray insert is required to hold individual components in a complete meal. This insert should contain die-cut or recessed compartments to hold individual components to avoid spillage and provide stability during consumption. Recessed compartments are required for the entree, potato, vegetable, and dessert. The tray insert should be constructed of a material which will withstand a maximum heat of 450° F. The tray insert will be removed from the meal container and used to place individual components in the heating receptacle.

4. Meal container. A container is required to hold the tray insert during transit. This container should have insulation characteristics to avoid thawing during transit. The meal container should also have die-cut or recessed compartments to receive the tray insert, a salad, and a beverage. Styrofoam is the desired material, but it must be adaptable to high-altitude flights.

5. Equipment. Reheating frozen meals will be in conventional ovens, the military B-4 oven and the Valad or Whirlwind oven. Since there is a possibility of using microwave ovens in the future, all containers, except the meal containers, should be adaptable to the microwave oven. The heating characteristics of the microwave oven are ideally suited to reheating frozen meals.

The most logical next step in the further evaluation of this feeding concept would be a small-scale field trial. A 3- to 6-month test utilizing existing facilities and personnel and involving at least five missile launch control facilities, security guard campers, and maintenance vans should provide a trial of sufficient size to obtain valid data. During this trial, observations should be systematically collected concerning the following: food service management, veterinary food technology, microbiology, professional taste panel evaluation, and consumer acceptability ratings.

The concept of frozen foil pack meals as evaluated in this report offers great promise for aerospace feeding situations, not only at missile sites but also in remote sites wherever prestocking of selected meal components is feasible. This would include in-flight passenger and air evacuation patient feeding. Advances in food technology have made this improved method of feeding feasible. Costs of food ingredients in this feeding system have been shown to be equivalent to the garrison ration costs.

V. CONCLUSION

This study showed that it is feasible to produce bacteriologically acceptable frozen components of foil pack meals for use in an a la carte frozen component feeding system for remote sites. Furthermore, it showed that this could be done by utilizing existing Air Force food preparation facilities without special precautions or personnel training.

The organoleptic acceptability of most food components stored 180 days or less was adequate. Suggestions for correcting deficiencies included the selection of food types and recipes suitable to freeze-processing and the development of a package affording better protection of the product and a more serviceable configuration.

These results indicate that the concept of the frozen component feeding system warrants further evaluation by field trial to identify operational problems. This trial should be designed so as to provide sufficient data for developing a routine quality-control system for production of frozen components with a la carte selection.

REFERENCES

1. Air Force Manual 146-2. Flight feeding, 5 Mar. 1965 as amended (146-2A, 28 Mar. 1966).

2. Ballentine, D. Foil pack meal guide (Including recipes and associated equipment). Aero Med. Lab., WADC TR 55-183, Wright-Patterson AFB, Ohio, Apr. 1955.

3. Costilow, R. N., A. A. Taylor, and H. C. Dyme. Bacteriological study of the foil pack in-flight feeding system. Aero Med. Lab., WADC TN 56-134, Wright-Patterson AFB, Ohio, Mar. 1956.

4. Heidelbaugh, N. D., J. E. Vanderveen, M. J. O'Hara, H. G. Iger, A. C. Grim, R. E. Chapin, R. S. Kronenberg, and D. C. Loper. Development and evaluation of feeding systems for aerospace applications. J. Food Tech. (In press)

5. Mock, R. O., A. A. Taylor, and H. C. Dyme. Field test of foil pack in-flight feeding system. Aero Med. Lab., WADC TR 55-400, Wright-Patterson AFB, Ohio, Oct. 1955.

6. O'Hara, M. J., R. E. Chapin, N. D. Heidelbaugh, and J. E. Vanderveen. Acceptability of a feeding system composed of bite-size and dehydrated foods. J. Amer. Diet. Ass. (In press)

7. Peryam, D. R., B. W. Polemis, J. M. Kamen, J. Eindhaven, and F. J. Pilgrim. Food preferences of men in the U. S. Armed Forces. Dept. of the Army, Quartermaster Res. Engr. Comd., 1960.

8. Taylor, A. A., and R. N. Costilow. Bacteriological study of foil pack in-flight meals during refrigerated storage. Aero Med. Lab., WADC TN 57-73, Wright-Patterson AFB, Ohio, Mar. 1957.

9. Taylor, A. A., and B. Finkelstein. An operational evaluation of precooked frozen meals. Aero Med. Lab., WADC TR 56-12, Wright-Patterson AFB, Ohio, Apr. 1956.

10. Welbourn, J. High performance aircraft feeding. Activities Reports Res. Develop. Associates 17: 14-18 (spring 1958).

11. Witt, M. J., and H. T. Schmidt. The ability of a 24-meal dry ice box to maintain safe food storage temperatures. Aero Med. Lab., WADC TN 56-361, AD-97187, Wright-Patterson AFB, Ohio, Aug. 1956.

Unclassified

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
USAF School of Aerospace Medicine
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b GROUP

3. REPORT TITLE
STUDIES ON FROZEN FOIL PACK MEAL COMPONENTS

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Final report 15 June 1966 - 25 May 1967

5. AUTHOR(S) *(Last name, first name, initial)*
Nelson, Robert K., Colonel, USAF, VC
Audiss, Jack R., Lieutenant Colonel, USAF
Madson, Raymond A., Captain, USAF
Cordaro, Joseph T.
Heidelbaugh, Norman D., Major, USAF, VC
Manley, Leslie, Captain, USAF
Drennan, Glen R., CMSgt., USAF

6. REPORT DATE
September 1967

7a. TOTAL NO. OF PAGES
16

7b. NO. OF REFS
11

8a. CONTRACT OR GRANT NO.

b. PROJECT NO.

c. Task No. 775803

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
SAM-TR-67-84

9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*

10. AVAILABILITY/LIMITATION NOTICES
This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY
USAF School of Aerospace Medicine
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas

13. ABSTRACT

Components selected from the foil pack meal feeding system were prepared (cooked and packaged) in a foil pack kitchen, frozen, stored in the frozen state, and evaluated organoleptically and bacteriologically after storage for time up to 12 months. These foods were studied for usefulness in a frozen component feeding system offering a la carte selection at remote sites where prestocking of nonfrozen meal components is feasible.

The results of this study indicate that the frozen foods were bacteriologically safe for consumption and, in general, organoleptically acceptable. Suggestions are offered for further development of this frozen component feeding system.

DD FORM 1 JAN 64 1473

Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Nutrition and metabolism Feeding system Foods Foil pack meals Aerospace feeding systems						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through

_____."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through

_____."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through

_____."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS)*, *(S)*, *(C)*, or *(U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.

GPO 886-551