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MICROBIOLOGICAL EVALUATION OF THE FOOD SERVICE SYSTEM AT TRAVIS AIR FORCE BASE

by

Gerald J. Silverman,

Edmund M. Powers,

David F. Carpenter

and

Durwood B. Rowley

Series

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Microbiological evaluation studies were conducted prior and subsequent to a modification of the Travis AFB feeding system. Innovations included the introduction of new processing equipment, a specialty meal, a chilled and frozen food operation which included a remote reconstitution facility, centralized preparation of raw salads, a modular fast food facility and a limited training program for personnel.

The initial study indicated certain shortcomings in the microbiological quality of the menu items, in sanitation and in the proper preparation and serving of either cooked or chilled foods.

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As shown in the second study on the modified feeding system, improvements were obtained in the microbiological quality of the cooked items, in the tossed salad operation and in general sanitation. Appropriate recommendations are made for further improvement in the microbiological and sanitary quality of the feeding operation.

TECHNICAL REPORT

Microbiological Evaluation of the Food Service System at Travis Air Force Base

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Natick, Massachusetts 01760

FORWARD

This study by the Food Microbiology Group of the Food Sciences Laboratory, U.S. Army Natick Development Center (NDC) was assigned by the OR/SA Office in a proposed modification of the feeding system at Travis Air Force Base (AFB). This responsibility was undertaken under Task 03, Project No. 1J662713AJ45, Analysis and Design of Military Feeding Systems of the DOD Food Research Development, Test and Engineering Program. The objectives of this study by the Food Microbiology Group were to:

1. Evaluate the microbiological quality of the food items being consumed and the state of sanitation of the facilities and equipment.

2. To compare the effect of modifications of these facilities and production procedures on the resultant microbiological quality of the food items and on sanitation.

3. To help insure the safety of the entire food service system with emphasis on new production procedures in the In-Flight Kitchen (IFK) and S–13 operation.

4. To recommend, where indicated, methods for improving the microbiological quality of the menu items and the sanitation of the facilities.

In monitoring the system the Food Microbiology Group was afforded the opportunity to employ the data generated for not only comparing the impact of modifications on safety and sanitation but also to evaluate newer techniques for monitoring. It is anticipated that this effort will result in more effective and economical procedures for evaluating food service systems.

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INTRODUCTION

These studies were conducted during two periods, 24 July through 2 August 1973 and 3 through 13 December 1973. The initial study was initiated prior to the introduction of innovations and consisted of 3 consolidated dining halls a bakery and an in-flight kitchen that produced boxed meals for ground feeding and flight lunches. The bakery, in-flight kitchen and dining halls were conventional systems, similar in their physical plant to those found elsewhere in the Air Force. For the second study one dining hall and the bakery were left unchanged. Two other dining halls were renovated, with a specialty meal operation added to one of them: A precooked frozen and chill system was introduced to the flight-line work area for customers unable to conveniently reach a dining hall and fresh salad components were prepared and distributed from a central facility. A modular facility was added to supply fast food items on an informal basis. The result was that a new more sophisticated feeding system evolved whose main objective was to increase satisfaction to the customer. It was also apparent that microbiological problems could be introduced into the feeding systems and that proper surveilance for preventive purposes was necessary.

EXPERIMENTAL PROCEDURE

MICROBIOLOGICAL ANALYSIS

Prepared media was supplied by a local source and sent by air freight to the Western Regional Research Laboratory, USDA, Berkeley, CA. It was received within 24 hr of shipment and immediately refrigerated. Food samples were collected either on the afternoon or evening prior to analysis or on the morning of the analysis but the delay between collection and analysis never exceeded 24 hr. Samples were maintained in crushed ice in an insulated container during collection, storage and transportation to the laboratory. Two types of sterile sample receptacles, screw cap jars and plastic whirl-pak bags (Scientific Products), were used.

The procedures followed for the microbiological analysis for total aerobic plate count (APC), coliforms, and coagulase positive staphylococci (*S. aureus*) were those of the Food and Drug Administration's Bacteriological Analytical Manual (BAM) with the following modifications. The diluent consisted of 0.1% peptone in place of phosphate buffer and 0.1 ml aliquots of serial dilutions of the food homogenate were spread on prepoured plate count agar. A 1.0 ml aliquot of the 1:10 food slurry was used for the initial MPN (most probable number) inoculum for the coliform and fecal coliform tests.

In this study the term fecal coliform is comparable to the designation *Escherichia coli* in the Microbiology Laboratory Guidebook, U.S. Department of Agriculture and to the presumptive *E. coli* test as described in BAM. The test enumerates, by the MPN technique, the ability of organisms to produce gas in EC broth at 45.5°C after preliminary selection in lauryl sulfate tryptose broth.

SANITATION AND CLEANING PROCEDURES

RODAC Plate Analysis (Replicate organism detection and counting).

RODAC plates were tempered at ambient temperature prior to use. The number of plates used to evaluate the sanitation of a surface was dependent upon the area under consideration, with the following guide being employed whenever possible.

No. of square feet	No. of square meters	No. of RODAC plates
≤1	≤0.093	1
1–2	0.093 – 0.186	2
2–5	0.186 – 0.465	4
5–25	0.465 – 2.323	8
25–100	2.323 – 9.290	12

After use in testing, the plates were generally kept overnight at room temperature (20–25°C) before being transported to the laboratory and placed in an incubator at 32°C. Those RODAC plates used to test refrigerated surfaces were incubated at 20°C.

Visual Inspection

Visual inspection was conducted in at least one facility daily over approximately a 4 hr period. Both the time of day and the sequence of inspections were randomized as much as possible.

Temperature of food items during preparation, immediately after cooking and on the serving line were obtained with a Weston model 2292 (±2°F, 1.1°C) thermometer, calibrated in boiling water.

MONITORING CRITERIA

Microbiological

The following criteria served as microbial guidelines in this study:

	Cooked food	Raw salad
Aerobic plate count (APC)	$\leq 1 \times 10^5$ CFU[a]/g	None
Coliform	$\leq 1 \times 10^2$ MPN[b]/g	None
Fecal coliform	0 MPN/g	None
Staphylococcus aureus	$\leq 1 \times 10^3$ CFU/g	$\leq 1 \times 10^3$ CFU/g

[a]CFU – Colony forming units

[b]MPN – Most probable number

Sanitation

For sanitation involving RODAC plates the following standard was employed: The sanitary state of a surface was considered satisfactory if, of the number of plates used to test a given surface, 1/2 or more of the plates contain 50 colony forming units (CFU)/plate or less and no plate exceeds 100 CFU/plate.

This is equivalent to imposing an average of not more than 75 CFU/plate when an even number of plates are used. When an odd number of plates are employed the average value will approach 75 CFU/plate but the actual value will depend upon the number of plates used. Each plate has an area of 4 in^2 (25.8 cm^2).

Temperature

1. With the exception of whole (not rolled) roasts, cooked foods should be heated to an internal temperature of not less than 165°F (74°C). Roasts may be cooked to an internal temperature of 150°F (66°C). It should be noted that the cooking temperature recommended for microbiological safety may not be as high as that recommended by technologists for achieving optimal food quality and acceptability by the consumer.

2. Foods served hot shall be maintained at 140°F (60°C) or above.

3. Left-overs from dinner may be maintained at 140°F (60°C) or higher for serving at supper.

4. The display temperature for chilled items should not exceed 55°F (13°C). The constraint for 45°F (7°C) for displays of over 3 hr was not considered due to the difficulty of monitoring the duration that a chilled item was displayed.

5. Refrigerated foods should be maintained at 45°F (7°C) or below during storage.

6. The final rinse in the warewasher or pot and pan washer should be 180°F (82°C). This should allow the surface of china and eating utensils to attain 160°F (71°C).

The initial study involved dining hall facilities (DH) 1,3 and 7, the bakery and the in-flight kitchen (IFK). For the second study DH 3 and the bakery were not renovated and served as limited controls although the personnel were trained and the bakery had limited supervision. DH's 1 and 7 were renovated, a precooked frozen and chill system satellited on the IFK in building S-13, and a modular fast food facility (MF) were added to the study.

FIRST STUDY – CONDUCTED PRIOR TO MODIFICATIONS

24 July to 2 August 1973

RESULTS

Microbiological Analysis of Ration Items

The results of the analysis of forty-two ration items consisting of 22 entree items, 5 cooked vegetables, 5 cold sandwiches, 5 raw salad items and 5 formulated salads made mainly from cooked ingredients are summarized in Table 1 and detailed in Table I of the appendix. Those cooked samples found to exceed one or more microbiological constraint(s) are presented in Table 2.

A total of 10 out of 32 (31%) items processed and cooked at the base (Table 2) were not within the suggested guidelines. Five entree items (23%) exceeded the guidelines, three had an aerobic plate count (APC) greater than 10^5 colony forming units (CFU)/g, 3 had more than 100 coliforms/g and 4 were positive for fecal coliforms. Two of the samples which had either excessive coliform or fecal coliform levels (samples 9 and 22) had low APC's of 4,300 and 13,000 CFU/g respectively but the remaining 3 samples had APC's of over 10^5 CFU/g.

A sample of fried potato, (sample 40), having an APC of 2×10^6 CFU/g also had extremely high coliform and fecal coliform counts. Four of the five cooked salad items sampled were in excess of the guidelines; 1 had an excessive APC, 3 had excessive coliform counts and fecal coliform organisms were present in 3 samples.

The ration items exceeding the constraints were prepared in all three dining facilities. A number of entree items might have been contaminated by unsanitary cutting boards and improper handling since it was the practice to place these cooked ration items on cutting boards for slicing and, as it will be noted below in Tables II and III, the RODAC counts of some of the cutting boards were high. Gloves were not used in any food dispensing operation.

While there were no constraints imposed on the tossed salads (Table 3) it should, nevertheless, be noted that all 5 samples contained at least 10^7 CFU/g, over 1,100 coliforms/g and 4 of the 5 samples contained fecal coliform organisms.

RODAC Plate Evaluation

The results of this evaluation (Tables 4, II to VII) indicated that a number of sanitary practices required improvement. With the exception of the IFK over half of the surfaces examined were unsatisfactory. Overall, few items were consistently found to be satisfactory, and specific operations, such as the warewasher and pot and pan washing operations, produced unsatisfactory items such as plates, teaspoons, forks, rolling pins, and cutting boards. The stainless steel preparation tables in the kitchen area were almost always improperly sanitized. This was most likely due to the use of sponges and dirty cloths for wiping (see Tables IV, V and VI).

The bakery also suffered from poor sanitizing practices (Tables 4, III and VII). The tables, cutting board, roller, shelves, can opener, etc., were unsatisfactory. Almost all of the pastry carts had adhering food residues and the surfaces of those examined in the bakery and in DH 3 had excessive microbial counts. These carts were occasionally stored in the garbage disposal room of the DH's. In contrast, the sanitation of the IFK was much more satisfactory. With the exception of the meat cutter and wrapping machine the cleanup effort was much more effective.

Visual Evaluation

Tables 5 and VIII indicated that the presence of unsatisfactory items, reflecting poor housekeeping, was common to all three dining halls. Approximately 50% of the items either needed an improved cleaning effort (but were acceptable) or were unsatisfactory. The IFK was superior in this regard with 78% of the items inspected being graded as satisfactory. Although no visual inspection of the bakery was conducted, analysis by RODAC plates had demonstrated (Tables 4, III and VII) that its sanitation could also be improved.

Thirty-five specific operations were found, by visual evaluation (Table VIII), to be either unsatisfactory or in need of improvement. It is apparent that the food was not being cooked or served at the proper temperature, that equipment was not being cleaned, that the appearance of the facilities and equipment was at times, unsightly, that china and utensils were not being washed properly, that health certificates were being left to expire, the toilet facilities were unsatisfactory and that garbage disposal was inadequate. Refrigerated storage facilities suffered from being dirty and were often not in the proper temperature range. The visual operational evaluation of the 3 dining facilities did not materially improve over the two week period of inspection.

The surfaces of serving areas were often found to be unsatisfactory. While the plates, bowls and cutlery were generally of acceptable sanitary quality they were often stacked on unsatisfactory shelves and carriers. The temperature of the water in the warewashing machines was too low for consistent effective washing and sanitizing.

Leftovers were refrigerated undated and unlabeled and inserted in the menu in an improvised manner.

The clean-up operation was inadequate. Food material was allowed to accumulate on floors, tables, equipment, etc. Dirty mops, sponges and dirty rags were commonly employed. A wide variety of surfaces and receptacles, used to prepare food items, were never washed thoroughly. Clean-up was not considered to be a separate operation assigned to specific personnel and cooks and other KP personnel cleaned up as time permitted. In certain cases insufficient time or labor was available between meal-times for conducting a proper cleaning operation. After supper, clean-up was often terminated even though it was obvious that much remained to be done.

Cooking and Serving Temperatures

Relatively few cooking temperatures were monitored (Table I items 17, 19 and 21). Of the three items monitored one never attained the proper cooking temperature of 165°F (74°C) but was found to be microbiologically acceptable.

A large number of items were served at nonrecommended temperatures (Tables 6, IX). The problem was common to all 3 facilities but the extent of the departure from recommended practice varied with the menu item. The entree items, generally a high risk category for susceptability to food spoilage and poisoning microorganisms, had the highest incidence of noncompliance. Forty-two percent of the items monitored were not being served at the proper temperatures. Of the three dining halls DH 1 had the lowest percentage of noncompliance, 39% followed by DH's 7 and 3 with 42% and 45% respectively.

Thirty-eight to 67% of the items were served below 140°F (60°C). The two samples, sliced roast beef and frankfurters (samples 44 and 8, Table I), served at the lowest temperature recorded in study 90°F (32°C) were both microbiologically conforming.

Of the 22 cooked vegetables and potatoes monitored on 51 occasions, 17 were served below 140°F (60°C). The lowest temperature noted was 108°F (42°C; sample 11, Table I) and this sample was microbiologically acceptable as were, in fact, all of the cooked vegetables sampled.

Of the 4 soups monitored, 2 were non-conforming but were microbiologically satisfactory.

Of the samples with unsatisfactory microbial counts (Tables 2, I) veal loaf (sample 33) was served at 132°F (56°C); meat loaf (sample 9) at 135°F (57°C) but, roast beef (sample 22) was served at 144°F (62°C). Although the temperature of the baked ham sample (sample 23) was not recorded, a comparable ham item at DH 3 was previously served at 128°F (53°C). Fried potato (sample 40) was served at 136°F (58°C).

In certain cases portions of the contents of a pan on the steam table was in excess of 140°F (60°C) (Tables I, IX) but food at other locations within the pan was considerably cooler. In many instances food on the steam table was too cold due to negligence in not employing sufficient steam, or, to prematurely turning off the steam.

At times the duration of cooking and tempering depended upon the exigency of demand and food items were often prematurely removed from ovens. Thermometers were not used to measure cooking temperatures.

DISCUSSION

An evaluation of the feeding system of the Travis Air Force Base during the first testing period indicated that the system suffered from ineffectual supervision and that a number of practices which can contribute toward food poisoning or infectious outbreaks were present. Raw materials were handled improperly. Frozen food was commonly thawed at room temperature. If refrigerated, the refrigeration was, at times, not in the correct temperature range. The sanitation of the refrigerators was unsatisfactory, materials were

kept on the floor, food items were not dated and identified and raw materials were not properly segregated from cooked food.

Food was prepared in unsanitary environments in that tables, kettles, steamers, etc. were often not cleaned and sanitized properly.

Food items were cooked in an arbitrary manner with no time-temperature control. Often ovens and fryers did not operate correctly resulting in poor temperature control and undercooking. After cooking, foods were frequently maintained in make-shift warming areas and at times portions of the panned items cooled to below 140°F (60°C). Personnel serving cooked food did not wear gloves.

The high incidence of entree items which were in excess of the guidelines (23%) may reflect a bias in sampling in that the samples chosen were not randomly selected. The policy was to select those samples which were below 140°F (60°C) at serving or which were, by their nature, a high risk item. Nevertheless, the fact that a high percentage of samples were found to be nonconforming is indicative of the risk factor present in the system. The fact that some items which were cooked or served at a noncomplying temperature were microbiologically acceptable does not minimize this problem. Improper temperature control aggravates problems from microbial contamination and improper processing.

SECOND STUDY – EVALUATION OF MODIFICATIONS

3 December to 13 December 1973

RESULTS

Microbiological

Of a total of 44 food samples which had been cooked and served by the new system 5 were nonconforming (Tables 7 and 8, X, XI and XII). Forty-two (95%) had aerobic plate counts of 10^5 CFU/g or less and 40 (91%) of these were below 10^4 CFU/g. Two of these items, a frankfurter (DH 1) and a pizza (modular) which were formulated from without the system, had excessive APC's and were served at 113°F (45°C) and 120°F (49°C) respectively. The remaining three nonconforming samples, buttered potatoes (DH 3), ham (S–13) and baked chicken (DH 3) had excessive numbers of coliform and/or fecal coliform organisms. Two of the nonconforming samples were prepared in DH 3 which was, as noted previously, a control facility and therefore unmodified.

All of the soups, gravies, desserts and the cooked salad conformed to the recommended standards. In only one sample, macaroni salad, was *S. aureus* found and then at a concentration of less than 1000/g.

The APC of 3 out of 7 samples of tossed salad ranged from 1 x 6 x 10^6 MPN/g which was a reduction in the CFU from that noted in the initial study where all samples had more than 10^7 CFU/g. A main problem still appeared to be the presence of excessive numbers of coliform and especially of fecal coliform organisms.

RODAC Plate Evaluation

The evaluation of cleaning and sanitizing procedures for both studies is presented in Tables 4, XIII–XIX. The warewashing and pot and pan operations appeared to be better in DH 1 but all three dining halls did not make an effective effort in cleaning such items as tables, counter tops and slicers. The fact that the items tested can be sanitized is indicated by the fact that at least one of the three DH's managed to sanitize items considered to be difficult. The IFK still maintained a high sanitary standard, with only the steam kettle being found unsatisfactory. The bakery did indicate an improved sanitization of surfaces (Table 4) but the overall efficacy for the three dining halls was not appreciably altered. Dining hall 3 still had the highest percentage of unsatisfactory surfaces and the improvement in DH's 1 and 7 was marginal.

Visual Evaluation

Visual inspection indicated that the general appearance of DH 3, S–13 and the IFK was acceptable whereas the other facilities were less satisfactory (Tables 9, XX).

The largest percentage of unsatisfactory items was noted for DH 7 and the smallest percentages for DH 3, S–13 and the modular facility. There seemed to be some improvement in the visual appearance between the two test periods in lowering the percentage of items in the unsatisfactory category, especially for dining halls 1 and 3. The number of unsatisfactory items in the in-flight kitchen actually increased, most likely due to its more complex processing operation.

The tops of dispensers and coffee urns in all dining halls were dusty. In facilities other than DH 1 the final rinse temperature was below 180°F (82°C) so that dishware was not sanitized and did not dry properly, resulting in spotted surfaces. Cleaned items were often stored in unclean, improperly sanitized containers and on dirty storage racks and shelves. Cleaned dishware was handled by the same personnel who handled dirty dishware.

Personal habits were poor. Personnel were observed eating or smoking while cooking or serving food. Bare hands instead of utensils or gloves were used to handle food. Personnel with colds or with an ear infection were allowed to prepare and/or serve food. Knives used for food preparation and which were personal properties of the cooks were transported and stored in dirty boxes.

A cleaning schedule was not evident and thorough cleaning was accomplished only if time and personnel permitted.

Serving Temperature

A comparison of Table 10 with that of 6 demonstrates that the percentage of noncompliance decreased during the second study for all categories of cooked items. Chilled salads, vegetables and desserts, though remained high, averaging over 50% noncompliance. The highest incidence of noncompliance was observed in DH 1 (47%) with DH's 3(24%) and 7 (25%) being appreciably lower. Fried chicken was served at 60°F (16°C) in the Modular Facility (Table XXI). A tray containing swiss steak and mashed potatoes in different compartments was reconstituted in a microwave oven in the S–13 facility. The temperature of the steak was found to be in the range 160–166°F (71–74°C) but the mashed potato was only at 80–115° (27–30°C). Boiled and buttered potatoes containing more than 1100 of both coliforms and fecal coliforms per gram were served in DH 3 at 90°F (35°C) which is near the optimum growth temperature for these organisms. In the modular facility, pizza pie (a commercial item) was reconstituted to only 120°F (49°C). This commercial product contained fecal coliforms. As previously noted the reconstitution temperature was not high enough to destroy these organisms, nor was the product at the recommended temperature (140–150°F; 60–66°C) for consumption. In DH 1 a frankfurter, also a commercial item, was being served at 113°F (45°C) and contained an excessive number of microorganisms ($> 3 \times 10^6$ CFU/g).

A Comparison of Evaluation by Visual Inspection and by RODAC Plates

In Tables 11, and XXII–XXVII, a comparison is made between evaluation by visual inspection and by RODAC plates. An appreciable number of surfaces which were unsatisfactory by RODAC plate evaluation were considered satisfactory by visual inspection. As much as 47% (DH 1) and 59% (DH 3) of items were in disagreement. The number of instances whereby both techniques were in agreement varied from 41–100% for surfaces which were unacceptable to 62 to 100% for acceptable surfaces. This rationale assumes that the more objective evaluation by RODAC plates is the standard for accuracy. This assumption is not unreasonable considering the subjectively inherent to the technique of visual evaluation.

DISCUSSION

As noted in the Forword, the improvement in sanitation was not a specific objective in this study by OR/SA. In fact, the additional requirements for improving the food service operation actually increased the work load of the food service personnel leaving them less time for clean-up even after additional people were added. The increased work load could be compensated for by increasing personnel efficiency and the mechanical

performance of the equipment. It was hoped that the innovations would improve sanitation. This was realized in a number of operations; and overall, the facilities either remained the same or did not deteriorate to the point where any would present a public health hazard. It is expected that as the food service personnel become more proficient with the new system they would become more effective in dealing with the increased workload.

In comparing the results of the two studies it is seen that the incidence of nonconformity of food contact surfaces for each of the three dining halls varied this respect. The fact that in certain instances a conforming state of sanitation could be achieved for difficult articles indicates that the monitoring objectives and standards were reasonable and attainable with the available personnel. For example, in the in-flight kitchen the cutting boards were usually in compliance although the kettles and meat slicer were not. In DH's 1, 3 and 7 the cutting boards were generally unsatisfactory. The pots and pans were consistently found to be effectively sanitized in the dining halls and in the IFK but not in the bakery.

In all of the facilities examined in the first and second study a large percentage of serving line equipment surfaces used for dispensing both hot and cold foods were, with an extremely high frequency, found to be unsatisfactory.

The efficiency of the machine warewashing operation in the second study was found to have decreased. In the initial study, the china in all three DH's and the silverware in DH's 1 and 7 (but not DH 3) were found to be sanitized properly. The results of the second study demonstrated that while DH 1 continued to effectively sanitize its china and silverware, DH 7 was distributing unsatisfactory knives and DH 3 had a large percentage of noncompliance for both its china and knives.

The sanitation of the utensils, equipment and facility involved in salad preparation improved between the two studies. In the first study almost all of the contact surfaces and equipment were consistantly unsatisfactory. For the second study a centralized salad preparation facility was established in DH 1. The personnel in DH 1 were able to effectively sanitize many contact surfaces such as tables, counters and utensils but had less success with the vegetable peeler and centrifuge. The sanitary quality of DH 3 remained unsatisfactory. As noted below, the improvement in sanitation and technology was reflected in a decrease in the aerobic plate count in the salads but did not eliminate the presence of fecal coliforms.

In the modification of the feeding system, personnel were given a lecture on the rationale and techniques of sanitation and processing, and personnel from NDC were available for guidance. A possible beneficial result was a subsequent decrease in the APC of cooked meats, potato and vegetables. In the initial study four cooked samples out

of 27 analyzed had APC's in excess of 10^5 CFU/g and were as regards to this criterion, unsatisfactory. In the second study none of the 44 cooked items formulated by personnel in these facilities exceeded 10^5 CFU/g. This was most likely due to the above mentioned training program, to the introduction of warming ovens into the system and to the presence of trained professional personnel from the Natick Development Center. The employment of warming ovens in the second study resulted in a lower incidence, 24%, of items served at temperatures below 140°F (60°C) as against an incidence of 36% in the initial study. The problem remains of an inability to maintain temperatures below 55°F (7°C) for chilled items displayed on salad bars and serving lines. More than 75% of the items monitored for this constraint in the second study were non-complying as against 60% in the first study.

Two commercial items in the second study, a frankfurter and pizza pie were found, after reconstitution, to contain excessive APC's. In addition, fecal coliform organisms were also detected in the pizza pie. The sources for both the excessive APC and fecal coliforms probably originated outside the Travis AF Base Facility. In both cases, though, the facilities responsible for reconstitution of the frankfurter and pizza pie from the frozen state, DH 1 and the modular facility respectively, failed to heat the item sufficiently to effectively decrease the microflora. The frankfurter was being reconstituted to 113°F (45°C) and the pizza pie to 120°F (49°C).

The microbiological quality of the tossed raw salads and of the cooked macaroni salad were improved. In the first study all five samples of tossed salads were found to contain at least 10^7 CFU/g, more than 1100 coliform/g and 4 samples harboured fecal coliform organisms. The one tuna and three macaroni salads examined in that study were also noncomplying due to excessive APC's and /or coliform counts or to the presence of fecal coliforms. In the second study a smaller ratio, three out of seven samples of tossed salad, had APC's of 10^6 CFU/g or greater but none contained 10^7 CFU/g. It should be noted that experiments at Natick Development Center indicate that commercially purchased lettuce with an APC of even 10^6 CFU/g can be considered a normal microbial load after washing and that coliforms appear to be part of the flora. Reasonably low APC for raw salads is obtained by controlling the quality of the raw material, effective washing and care to minimize processing and storage temperatures. The significance of large numbers of fecal organisms awaits further investigation.

While the use of coliforms as an indice in tossed salads may therefore be questionable, its use, and also that of fecal coliforms, as an indice for cooked items is of more validity, since it indicates a lack of either effective sanitary procedures or effective processing. The presence of fecal coliforms and large numbers of coliforms in both processed raw and cooked foods, obtained in different dining halls over an extended period, appears to be a problem worthy of special attention. Analysis of the incidence, numbers and distribution of this indice indicates a constant source of contamination rather than a random, opportunistic inoculum by an individual or, for example, an occasional improperly cleaned utensil.

The facilities were subjectively examined and evaluated for visual cleanliness of equipment and operational procedures that are in accordance with good sanitation practices. The conclusions drawn are that there was little if any improvement in this area. The main problem appeared to be due to a lack of adequate and effective supervisory effort. It was frequently observed that considerable effort would go into a particular operation (cooking, clean-up, warewashing, etc.) but that due to ineffective and often incorrect procedures, habits and/or lack of guidance the results were less than adequate.

Many surfaces which were visually evaluated as satisfactory were, in fact, unsatisfactory by the more objective RODAC plating technique. A surface used in food preparation should, when properly sanitized, be both visually and microbiologically satisfactory. This study confirms the disadvantage of depending solely upon visual inspection for evaluating sanitizing procedures and indicates that visual inspection should be supplemented by quantitative tests such as RODAC plates or swabs.

The determination of the relationship between cooking and serving temperature and subsequent microbial quality in the military feeding system will require the collection of additional data. Insufficiently high serving temperatures can magnify the danger from poor sanitary practices, inadequate cooking temperatures and contamination and result in a microbiological hazard. Since numerous factors are involved in a particular food poisoning incident, it would therefore be an oversimplification to state that every item not served at 140°F (60°C) or above is, ipso facto, dangerous. Realistically, it can only be emphasized that studies of this nature, with limited sampling and time, can evaluate a systems hazard potential while not necessarily, detecting actual incidences of food poisoning or infection.

SUMMARY AND RECOMMENDATIONS

The overall objectives of the Food Microbiology Group were accomplished. An evaluation of the microbiological quality of the food items prior to and during the study indicated an improvement in quality during the study although the presence of fecal coliforms continued to be a problem. Results for sanitation were mixed with both an increase and decrease in compliance being noted. It should be emphasized that effective evaluation of sanitation programs should include the use of more objective quantitative evaluation procedures for monitoring.

The modification of the facilities and production procedures did not result in any specific break-down in microbial quality or in sanitation but some problems are indicated. Three samples in S-13 and the MF-facilities were non-conforming. Indications are that the unfamiliarity of the equipment was a contributing factor and that closer supervision and additional training was necessary. The microbial quality of the food from the other DH's was improved but further improvement is needed. In any event no food poisoning incident occurred.

The specific recommendations for further improving microbial quality and sanitation are:

1. The source(s) of fecal coliforms be located and eliminated.

2. The main evaluation of the sanitary condition of food contact surfaces be conducted with swab or RODAC plate techniques. This does not eliminate the requirement that the surface also be visually satisfactory.

3. Accurate, periodically calibrated thermometers be issued for monitoring cooking and serving temperatures.

4. The proper evaluation of the IFK and S-13 operation should be conducted after proper and sufficient food preparation, refrigeration and transportation equipment for a continuing operation is supplied. The limited study of the experimental operation which included only the essential elements needed to evaluate the innovations indicate that a more thorough evaluation of the precooked frozen and chill system involving IFK, S13 and the modular facility be made. The limited study indicated that certain chilled items arrived too warm and that the microwave oven did not consistently heat some items to the correct serving temperature. Two items (pizza pie and ham) from these units were microbiologically nonconforming.

5. That training courses in sanitary and food processing principles and procedures should be made available to senior personnel.

6. Equipment such as the warewasher, hot water heater, etc, which are critical for maintaining an acceptable degree of sanitation be maintained at proper efficacy.

TABLE 1

Microbiological analysis[a] of menu items obtained during the first study

	Entree	Potato and cooked vegetable	Cold sandwiches	Tossed salad	Cooked[d] salad
No. of samples	22	5	5	5	5
Aerobic plate count/g (APC/g)					
⩽ 10,000 CFU[b]/g	18	4	4	0	2
⩽ 50,000 CFU/g	19	0	5	0	3
⩽100,000 CFU/g	19	0	–	0	4
>100,000 CFU/g	3	1	–	5	1
Highest APC	1×10^6	2×10^6	4×10^4	$> 10^7$	6×10^5
Coliform count (MPN[c]/g)					
No. of positive samples	8	1	1	5	4
⩽ 10/g	1	0	1	0	0
⩽ 50/g	4	0	–	0	1
⩽100/g	5	0	–	0	0
>100/g	3	1	–	5	3
Highest coliform count	$>1.1 \times 10^3$	$>1.1 \times 10^3$	3.6×10^0	$>1.1 \times 10^3$	$>1.1 \times 10^3$
Fecal coliform count (MPN/g)					
No. of positive samples	4	1	0	4	3
⩽10/g	2	0	–	2	1
⩽50/g	2	0	–	1	–
>50/g	2	1	–	1	2
Highest fecal coliform count	2.9×10^2	1.5×10^2	0	7.5×10^1	4.6×10^2

[a]See text for constraints. No sample contained over 10^3 *Staphylococcus aureus* /g.
[b]CFU – Colony forming units
[c]MPN – Most probable number
[d]Made mostly from processed ingredients

TABLE 2

Cooked items which exceeded the microbial constraints[a] in the first study

Sample No.[d]		Dining hall	Serving Temperature °F	°C	Aerobic plate count CFU[b]/g	Coliform MPN[c]/g	Fecal coliform MPN[c]/g
	Entree						
9.	Meat loaf	3	135	57	4.3×10^3	93	4
22.	Roast beef	3	144	62	1.3×10^4	2.4×10^2	Neg.[e]
23.	Ham	3	—	—	1×10^6	$> 1.1 \times 10^3$	75
33.	Veal loaf	7	150	66	1.5×10^5	20	7
38.	Macaroni, meat and cheese	1	115	46	3×10^5	1.1×10^3	2.9×10^2
	Cooked potato and vegetable						
40.	Fried potato	1	136	58	2×10^6	$> 1.1 \times 10^3$	1.5×10^2
	Cooked salad						
10.	Tuna salad	3	62	17	1×10^5	2.4×10^2	4.6×10^2
15.	Macaroni and egg	7	60	16	TFTC[f]	1.5×10^2	Neg.
26.	Macaroni	1	— —	— —	3×10^3	23	9
35.	Macaroni and egg	7	50	10	6×10^5	1.1×10^3	2.9×10^2

[a]Less than or equal to 10^5 CFU/g, 10^2 coliform organisms/g, 10^3 *Staphlococcus aureus* /g and no fecal coliform All samples contained less than 10^3 *S. aureus*/g.
[b]Colony forming unit
[c]Most probable number
[d]Numbers are those assigned in Appendix, Table I.
[e]Negative
[f]TFTC – Too few to count

TABLE 3

Microbiological analysis of tossed salad items in the first study

Sample No.[a]	Dining Hall	Total aerobic plate count CFU[b]/g	Coliform MPN[c]/g	Fecal coliform MPN[c]/g
1	1	$> 10^7$	$> 1.1 \times 10^3$	4
7	3	$> 10^7$	$> 1.1 \times 10^3$	75
18	7	1×10^7	$> 1.1 \times 10^3$	15
27	1	2×10^7	$> 1.1 \times 10^3$	Neg.[d]
41	1	$> 10^7$	$> 1.1 \times 10^3$	4

[a]Number assigned in Table I

[b]Colony forming unit

[c]Most probable number

[d]Negative

TABLE 4

Sanitary evaluation[a] of surfaces by RODAC plates

	Facility[b]					
	DH 1	DH 3	DH 7	IFK	Bakery	MU
First study						
No. surfaces evaluated	66	64	40	16	13	–
% satisfactory	36	20	30	81	8	–
% unsatisfactory	64	80	70	19	92	–
Second study						
No. surfaces evaluated	19	11	14	11	6	3
% satisfactory	53	27	57	91	83	100
% unsatisfactory	47	73	43	9	17	0

[a]See text and Table XV for definition of satisfactory and unsatisfactory

[b]DH – dining hall; IFK – In-flight kitchen; MU – modular unit

TABLE 5

Visual sanitation inspection[a] of facilities in the first study

Dining hall	Percentage Satisfactory	Unsatisfactory	Needs improvement
1	43	39	18
3	56	26	18
7	51	23	26
IFK[b]	78	4	18

[a]Satisfactory – No visible food particles or cleanser stains.
Unsatisfactory – excessive amount of food particles and stains indicating poor cleaning procedures.
Needs Improvement – A minimal amount of soil still remaining but satisfactory.

[b]In-flight kitchen.

TABLE 6

Incidence of items in noncompliance of serving temperature constaints[a] in the first study

Item	Number of items	Dining facility	Number that were monitored	Number that were in noncompliance	% in noncompliance
Entree	34	1	26	15	58
		3	21	8	38
		7	12	8	67
Cooked vegetable, potato	22	1	20	8	40
		3	19	6	32
		7	12	3	25
Chilled vegetable and salad	14	1	18	3	17
		3	18	12	67
		7	9	4	44
Soup	4	1	5	1	20
		3	2	1	50
		7	3	0	0
Total	74		165	69	42

[a]The constaints for this table consisted of a serving temperature of ≥ 140°F (60°C) for cooked items and ≤ 55F (13°C) for chilled items displayed for serving.

TABLE 7

Menu items[a] which were microbiologically nonconforming in the second study

Item	Dining Facility	Serving temperature °F	Serving temperature °C	Aerobic plate count CFU[d]/g	Coliform MPN[e]/g	Fecal coliform MPN/g
Baked chicken	3	–	–	1.5×10^3	$> 1.1 \times 10^3$	$> 1.1 \times 10^3$
Frankfurter	1	113	45	$> 3 \times 10^6$	0	)
Ham	S–13[b]	–	–	4×10^3	4	0
Boiled, buttered potato	3	95	25	1.2×10^4	$> 1.1 \times 10^3$	$> 1.1 \times 10^3$
Frozen pizza	MF[c]	–	–	$> 3 \times 10^4$	93	4
Cooked pizza	MF	120	49	1.2×10^5	93	4

[a]All samples contained less than 10^3/g *Staphylococcus aureus*/g

[b]S–13 facility

[c]MF – modular facility

[d]CFU – colony forming unit

[e]MPN – most probable number

TABLE 8

Microbiological analysis of menu items[a] obtained during the second study

	Number of samples					
	Cooked meat items	Potato, cooked vegetable	Tossed salad	Cooked salad	Soup, gravy	Dessert
Total No. of samples tested	31	6	7	1	3	3
Aerobic plate count[b]						
$\leq 10^2$	16	5	0	0	3	2
$\leq 10^3$	23	–	–	–		3
$\leq 10^4$	28	–	–	1		
$\leq 5 \times 10^4$	29	6	1			
$\leq 10^5$	–					
$\leq 10^6$	30		4			
$> 10^6$	1		3			
Coliforms[c]						
0	24	5	0	0	3	3
$\leq 10^1$	29		0	1		
$\leq 10^2$	30		1			
$> 10^3$	1	1	6			
Fecal coliforms[c]						
0	28	5	2	1	3	3
$\leq 10^1$	30	–	4			
$\leq 10^2$	–	–	6			
$> 10^3$	1	1	1			
Coagulase positive staphylococci[d]						
$\leq 10^3$	31	6	7	1	3	3

[a]Frozen pizza not included in this tabulation

[b]Colony forming units/g

[c]Most probable number/g

[d]Organisms/g

TABLE 9

A comparison of the visual sanitation inspections of food service facilities in the two study periods

	Percentage of observations								
	First study			Second study					
				Inspection 1			Inspection 2		
Food service facility	Satis-factory	Unsatis-factory	Needs improve-ment	Satis-factory	Unsatis-factory	Needs improve-ment	Satis-factory	Unsatis-factory	Needs improve-ment
Dining hall 1	43	39	18	50	28	22	42	18	40
Dining hall 3	56	26	18	67	12	21	74	3	23
Dining hall 7	51	23	26	38	43	20	49	23	28
In-flight kitchen	78	4	18	68	17	15	72	19	9
S-13	–	–	–	75	0	25	–	–	–
Modular facility	–	–	–	53	10	38	–	–	–
Bakery	–	–	–	53	20	27	–	–	–

Satisfactory – Items appeared to be properly cleaned.

Unsatisfactory – Items appeared to be excessively soiled.

Needs improvement – Slightly soiled and acceptable.

TABLE 10

Incidence of items in noncompliance of service temperature constraints[a] in the second study

Item	Facility	Number that were Monitored	In Noncompliance	% in non-compliance
Entree	1	27	10	27
	3	15	3	20
	7	12	3	25
Cooked vegetable and potato	1	9	3	33
	3	10	1	10
	7	9	0	0
Chilled vegetable, salad, dessert	1	11	10	91
	3	9	4	45
	7	6	4	67
Soup	1	2	0	0
	3	0	—	—
	7	1	0	0
Total		111	38	34

[a]The constraints for this table consisted of a serving temperature of $\geq$ 140°F (60°C) for cooked items and $\leq$ 55°F (13°C) for chilled items displayed for serving.

TABLE 11

A comparison between visual and RODAC plate evaluation of surfaces in the second study

Facility	Number of surfaces evaluated	Percentage[a] Satisfactory as evaluated by RODAC plates		Unsatisfactory as evaluated by RODAC plates	
		Visually satisfactory	Visually unsatisfactory	Visually satisfactory	Visually unsatisfactory
DH[b] 1	44	62	38	47	53
3	20	78	22	59	41
7	23	79	21	22	78
Bakery	7	100	0	0	100
IFK[c]	23	68	32	0	100
MF[d]	7	100	0	50	50

[a]The percentage was obtained with RODAC analysis as the denominator. Data taken from Tables XIX-XXIII and also detailed in Table XXIV.

[b]Dining hall

[c]In-flight kitchen

[d]Modular unit

APPENDIX

TABLE I

Microbiological analysis of menu items obtained during the first study

Sample no.	Description[a]	Date	Dining hall	Serving temperature °F	Serving temperature °C	APC[b] CFU/g	Coliform MPN/g[b]	Fecal coliform MPN/g[b]
1	Tossed saiad	24–7	1	68	20	$> 10^7$	$> 1.1 \times 10^3$	4
2	Fried chicken	24–7	1	115–130	46–54	TFTC[i]	Neg[c]	
3	Macaroni, chili and cheese	24–7	1	142	61	TFTC	43	Neg
4	Rice	24–7	1	132	56	TFTC	Neg	
5	Buttered potato	24–7	1	132	56	TFTC	Neg	
6	Stuffed pepper	24–7	1	115–160	46–71	6×10^3	4	Neg
7	Tossed salad	25–7	3	62	17	$> 10^7$	$> 1.1 \times 10^3$	75
8	Frankfurter	25–7	3	90	32	TFTC	Neg	
9	Meat loaf	25–7	3	135	57	4.3×10^3	93	4
10	Tuna salad	25–7	3	62	17	2×10^5	2.4×10^2	4.6×10^2
11	Lima beans	25–7	3	108	42	3×10^3	Neg	
12	BBQ ribs	25–7	3	124–132	51–56	TFTC	Neg	
13	Turkey sandwich	25–7	IFK[d]			TFTC	Neg	
14	Roast beef sandwich	25–7	IFK			TFTC	4	Neg

TABLE I (cont'd)

Microbiological analysis of menu items obtained during the first study

Sample no.	Description[a]	Date	Dining hall	Serving temperature °F	Serving temperature °C	APC[b] CFU/g	Coliform MPN/g[b]	Fecal coliform MPN/g[b]
15	Macaroni and egg salad	26–7	7	60	16	TFTC	1.5×10^2	Neg
16	Fried potato (from lunch)	26–7	7	135–168	57–76	TFTC	Neg	
17	Fried chicken[e]	26–7	7	136–162	58–72	TFTC	Neg	
18	Tossed salad	26–7	7	70	21	1×10^7	$> 1.1 \times 10^3$	15
19	Chicken fried steak[f]	26–7	7	135–160	57–71	8.6×10^3	Neg	
20	Chicken fried steak[g]	26–7	7			1×10^4	Neg	
21	Fried chicken[h]	29–7	3	128–180	53–82	TFTC	Neg	
22	Roast beef	29–7	3	144	62	1.3×10^4	2.4×10^2	Neg
23	Ham	29–7	3			1×10^6	$> 1.1 \times 10^3$	75
24	Chipped beef	29–7	3	122–128	50	3×10^3	Neg	
25	Fried chicken	30–7	1			TFTC	Neg	

TABLE I (cont'd)

Microbiological analysis of menu items obtained during the first study

Sample no.	Description[a]	Date	Dining hall	Serving temperature °F	Serving temperature °C	APC[b] CFU/g	Coliform MPN/g[b]	Fecal coliform MPN/g[b]
26	Macaroni for salad	30–7	1			TFTC	23	9
27	Lettuce in salad	30–7	1			1.7×10^7	$> 1.1 \times 10^3$	Neg
28	Potato salad	30–7	1			1.5×10^4	Neg	
29	Cooked hamburger	30–7	1			TFTC	Neg	
30	Pork roast	30–7	1			TFTC	Neg	
31	Thawed raw hamburger	30–7	1			3×10^4	4.6×10^2	4.6×10^2
32	Raw egg	30–7	1			TFTC	43	23
33	Veal loaf	31–8	7	150–174	66–79	1.5×10^7	20	7
34	Fish steak	31–8	7	172	78	TFTC	Neg	
35	Macaroni and egg salad	31–8	7	50	10	5.9×10^6	$> 1.1 \times 10^3$	2.9×10^2
36	Turkey sandwich (36 hr old)	31–8	IFK			4.1×10^5	Neg	
37	Beef sandwich (24 hr old)	31–8	IFK			TFTC	Neg	

TABLE I (cont'd)

Microbiological analysis of menu items obtained during the first study

Sample no.	Description[a]	Date	Dining hall	Serving temperature °F	Serving temperature °C	APC[b] CFU/g	Coliform MPN/g[b]	Fecal coliform MPN/g[b]
38	Macaroni, chili meat and cheese	1–8	1	115	46	3.6×10^6	1,100	1.5×10^2
39	Roast beef sandwich	1–8	IFK			TFTC	Neg	
40	Fried potato	1–8	1	136	58	2×10^6	> 1,100	1.5×10^2
41	Tossed salad	1–8	1	70	21	$> 3 \times 10^7$	> 1,100	4
42	Sliced roast beef	1–8	1	165	74	TFTC	Neg	
43	Chicken fried steak	1–8	1	132–144	56–62	3×10^3	Neg	
44	Sliced beef with gravy	1–8	1	90	32	TFTC	23	Neg

[a] Entree items: 2,3,6,8,9,12,17,19,20,21,22,23,24,25,29,30,33,34,38,42,43,44
Cooked potato and vegetable: 4,5,11,17,40
Cold sandwich: 13,14,36,37,39
Tossed green salad: 1,7,18,27,41
Cold cooked salad: 10,15,26,28,35

[b] APC – Aerobic plate count, CFU – Colony forming unit, MPN – Most probable number

[c] Negative

[d] IFK – In-flight kitchen

[e] Cooking temperature was 133 – 145°F (56 – 63°C)

[f] Cooking temperature was 165 – 180°F (74 – 82°C)

[g] Sample obtained immediately after frying

[h] Cooking temperature was 165 – 180°F (74 – 82°C)

[i] TFTC - less than 3000 CFU/g

TABLE II

Sanitary evaluation[a] of surfaces in the dining halls by RODAC plates in the first study

	Dining hall		
	1	3	7
Warewashing and pot and pan washing operations:			
Table	U	U	
Shelf	U	U	U
Salad bowl	U,S	U(2)	
Plate	S(2),U	U(2)	U(2),S
Bowl		S(2)	
Tray	S	U	
Glass	S(2)		
Knife	S(2)	U(2)	S(2)
Teaspoon	U,S	U(2)	S,U(2)
Fork	U,S	U(3)	S(2)
Soup spoon	S	U(2)	S
Ladle, dipper, spoon	S(2),U	S,U	U(2)
Rolling pin-wooden	U(2)		
Cutting board	U(2),S		U(2)
Collander	U		S
Pot	S(2)	S(2)	U
Pan	S(3)	S(3)	U(2)
Large mixing bowl	U(2)		
Kitchen area			
Preparation table	U(2)	U(9)	U(2),S
Meat slicer	U	U(2)	U
Steam kettle	U	S(2)	
Steam cooker	S(2)	U	
Large kettle	S(2),U	S(2),U	S(2)
Shelf			U
Steam pressure cooker	U		
Electric steam pan		U	
Pastry steam pan		U	
Serving line			
Display shelf	U(2)	U	U(3)
Table	U(4)	U(3)	U(2)
Grill		S	
Cutting board		U	U
Serving area	U	U(7)	U

TABLE II (cont'd)

Sanitary evaluation[a] of surfaces in the dining halls by RODAC plates in the first study

	Dining hall		
	1	3	7
Refrigerator			
Shelf – reach-in			U
Shelf – walk-in	U		
Flat pan used as lid	U		
Vegetable preparation – salad bar			
Preparation table	U(2)		U
Storage cart for dish	U	U	
Vegetable slicer	U(2)	U	
Slicing board	U		
Salad bar table	U	U(2)	
Handle on serving fork or spoon	U		
Vegetable peeler		U	
Other			
Through shelf			U(2)
Milk dispenser-pressure plate	U(4)	U(2)	U(3)
Pitcher containing egg mix	U		
Pail which soaks raw potato	S		
Pastry transporter		U	

[a]S–satisfactory; U–unsatisfactory; see text for definition of constraint

[b]The number in parenthesis indicates the frequency of a given S or U evaluation for a particular surface.

TABLE III

Sanitary evaluation[a] of the in-flight kitchen and bakery by RODAC plates in the first study

	In-flight kitchen	Bakery
Cutting board		U
Spatula, dipper, knife		U
Pot and pan		U
Tables — stainless steel	S(5)[b]	U(3)
— wooden	S(2)	U
Shelf — pot and pan		U
— area for placing baked cake		U
— other	S	U
Transporter		U
Can opener		U
Kettle		S
Wrapping machine	U	
Butcher knife	S(2)	
Meat cutter	U,S	
Large pan	S	
Large bake sheet	S	
Cart	U	

[a]S—satisfactory; U—unsatisfactory; see text for definition of this constraint

[b]The number in parenthesis indicates the frequency of the S or U evaluation during the test period.

TABLE IV

Distribution of RODAC plate counts obtained in dining hall 1 in the first study

Warewashing, pot and pan operation	No. of plates	CFU[a]/plate ⩽50	⩽75	>100
Table	5	0	0	4
Shelf	5	1	1	4
Salad bowl	11	6	6	5
Plate	30	28	28	1
Tray	4	3	3	0
Glass	10	10	5	0
Knife	15	15	15	0
Teaspoon	9	5	5	3
Fork	10	5	5	5
Soup spoon	5	4	5	0
Laddle, dipper, spoon	20	18	18	1
Rolling pin (wooden)	4	0	2	1
Cutting board	10	5	5	5
Collander	1	0	0	1
Pot and pan	28	27	29	0
Kettle	10	3	4	6
Kitchen area				
Table	16	0	16	16
Meat slicer	4	0	0	4
Steam kettle	12	8	9	2
Steam cooker	9	1	1	8
Kettle	5	4	1	0
Steam pan	10	9	9	1
Serving area				
Display shelf	12	0	0	10
Table	5	0	0	5
Serving counter	25	1	1	19
Salad bar	5	0	0	5
Refrigerator				
Shelf, walk-in	3	0	0	3
Bake pan used as lid	10	4	4	6

TABLE IV (cont'd)

Distribution of RODAC plate counts obtained in dining hall 1 in the first study

	No. of plates	CFU[a]/plate ⩽ 50	⩽ 75	> 100
Vegetable preparation				
Table	16	0	0	16
Storage cart for dishes	9	4	6	3
Vegetable slicer	8	1	1	7
Cutting board	5	0	0	5
Handle on serving fork or spoon	7	0	1	6
Other				
Milk dispenser-pressure plate	18	0	0	18
Pitcher containing egg mix	3	0	1	2
Pail which soaks raw potatoes	2	2	2	0

[a]Colony forming unit

TABLE V

Distribution of RODAC plate counts obtained in dining hall 3 in the first study

Warewashing, pot and pan operation	No. of plates	CFU[a]/plate ⩽50	⩽75	>100
Table	5	0	0	5
Shelf	8	0	0	8
Salad bowl	5	3	4	1
Plate	15	13	14	1
Bowl	10	9	9	1
Tray	4	3	3	1
Knife	10	3	4	5
Teaspoon	16	12	13	3
Fork	14	5	5	8
Soup spoon	9	2	3	6
Laddle, dipper, spoon	15	9	11	3
Cutting board	3	0	0	3
Pot and pan	30	30	30	0
Kitchen area				
Preparation table	64	0	2	62
Meat slicer	13	2	2	11
Steam kettle	11	11	11	0
Steam cooker	4	1	1	2
Kettle	3	3	3	0
Shelf	4	0	0	4
Electric steam pan	9	7	8	1
Serving area				
Display shelf	5	0	1	3
Grill	8	8	8	0
Serving counter	64	6	12	45
Salad bar	5	0	0	5
Vegetable preparation				
Storage cart for dishes	2	0	0	2
Vegetable slicer	8	2	2	5
Vegetable peeler	8	0	0	8
Other				
Milk dispenser-pressure plate	10	3	3	7
Pastry transporter	5	0	1	4

[a]Colony forming unit

TABLE VI

Distribution of RODAC plate counts obtained in dining hall 7 in the first study

Warewashing, pot and pan operation	No. of plates	CFU[a]/plate ⩽ 50	⩽ 75	> 100
Shelf	5	0	0	3
Plate	12	1	12	0
Bowl	10	6	8	1
Knife	10	9	9	1
Teaspoon	10	9	9	0
Fork	10	9	10	0
Soup spoon	5	5	5	0
Ladle, dipper, spoon	18	6	7	10
Cutting board	9	0	0	9
Pot and pan	19	16	16	3
Kitchen area				
Preparation table	19	1	1	17
Meat slicer	4	0	0	4
Steam kettle	5	4	5	0
Kettle	10	10	10	0
Serving area				
Serving counter	35	3	3	22
Refrigerator (reach-in)				
Shelf	5	4	4	1
Vegetable preparation area				
Table	8	0	0	8
Potato peeler	2	0	0	2
Other				
Through shelf	8	0	0	6
Milk dispenser-pressure plate	8	0	0	6

[a]Colony forming unit

TABLE VII

Distribution of RODAC plate counts obtained in the in-flight kitchen and the bakery in the first study

In-flight kitchen	No. of plates	CFU[a]/plate		
		< 50	< 75	> 100
Table-stainless steel	25	23	25	0
Table-wooden	18	16	18	0
Sandwich wrapping machine	5	4	4	1
Butcher knife	7	7	7	0
Meat slicer	11	7	7	1
Pan	4	4	4	0
Bake sheet	4	4	4	0
Cart	13	10	11	10
Bakery				
Cutting board	2	0	0	2
Spatula, dipper, knife	5	3	3	2
Pot and pan	10	6	6	3
Table – stainless steel	19	0	0	14
Table – wooden	7	3	4	1
Shelf – for baked cake	4	1	1	2
Shelf – other	10	0	0	10
Pastry transporter	10	2	2	7
Can opener	1	0	0	1
Kettle	5	4	5	0
Rolling pin	3	0	0	3

[a]Colony forming unit

TABLE VIII

Operations in dining halls and In-flight kitchen found unsatisfactory[a] or in need of improvement by visual inspection in the first study

Observation	Dining hall 1	3	7	IFK
Food cooked to proper temperature	U	–	U	–
Facilities adequate for keeping food hot	N	U	U	–
Thermometer used	U	U	U	U
Cold food below 40°F (4°C)	U	U	U	–
Hot food above 140° (60°C)	U	U	U	–
Frozen food properly thawed	U	U	N	N
Utensils used to handle food	N	N	N	–
Food containers stored off floor	N	U	N	–
Poisons properly identified and stored	U	U	–	–
Serving line temperature	U	N	–	–
Dangerous food-temperature on serving line	U	U	N	–
Temperature of green salads on serving line	U	U	U	–
Leftovers	N	–	U	–
Food equipment readily cleaned	N	–	-	–
Food equipment in good repair	N	N	N	–
Food contact surfaces of equipment	U	U	U	–
Non-food contact surface equipment	U	U	U	N
Tableware and kitchenware clean	U	N	N	–
Kitchenware and tableware sanitized	U	U	U	–
Temperature of wash water	U	N	–	–
Temperature of rinse water	U	U	–	–
Sanitizing of dishware, etc	U	U	U	–
Vending machines (milk, coffee, soft drinks)	U	U	N	–
Floors and walls	U	U	N	N[b]
Hot water supply	U	U	–	–
Personal habits of personnel	N	–	–	–

TABLE VIII

Operations in dining halls and In-flight kitchen found unsatisfactory[a] or in need of improvement by visual inspection in the first study (cont'd)

Observation	Dining hall 1	3	7	IFK
Health certificate	U	–	–	–
Toilet	U	U	N	–
Garbage disposal	U	N	U	–
Refrigerator storage temperature	N	U	N	N[c]
Milk storage	N	U	N	–
Dry storage	N	–	–	–
Unwrapped and potentially hazardous food	–	–	U	–
Freezer storage temperature	–	–	U	N[d]
Outer openings protected	–	–	–	N[e]

[a]U–unsatisfactory – item was dirty and unacceptable
N–needs improvement – item of questionable cleanliness but acceptable

[b]Floors in scullery of IFK

[c]No thermometer in dairy refrigerator

[d]No thermometer in reach-in freezer

[e]Doors need repair

TABLE IX

Serving temperatures of food items monitored in the first study

Entree item	Dining hall	Date	Time	°F	°C
Chili, macaroni and cheese	1	24–7	1630	142	61
Stuffed pepper	1	24–7	1630	115 – 160	46 – 71
Fried chicken	1	24–7	1630	115 – 130	46 – 54
	7	26–7	1115	136 – 162	58 – 72
	3	26–7	1145	134 – 150	57 – 66
	3	29–7	1030	134	57
	1	30–7	1100	110 – 120	43 – 49
Meat loaf	3	25–7	2400	135	57
Braised spare rib	3	25–7	2400	138 – 144	59 – 62
BBQ spare rib	3	25–7	2400	124 – 132	51 – 56
	1	1–8	1130	160 – 176	71 – 80
Chicken a-la-king	3	25–7	2400	140	60
Baked ham	3	25–7	1515	128	53
	1	31–7	1730	151	66
Pot roast	3	25–7	1115	148	64
Corned beef	3	25–7	1515	148	64
Liver	7	16–7	1115	133 – 168	64 – 76
Spaghetti	7	26–7	1115	148 – 168	64 – 76
	3	2–8	1100	142	61
Steak	3	26–7	1445	148 – 162	64 – 72
	1	26–7	1900	95	35
Frankfurter in BBQ sauce	1	16–7	1445	100	38
Ham in sauce	1	26–7	1445	142	61

TABLE IX

Serving temperatures of food items monitored in the first study (cont'd)

Entree item	Dining hall	Date	Time	°F	°C
Fried breaded oyster	1	27–7	1100	146	63
	7	31–7	1100	134 – 146	57 – 63
	1	1–8	1130	118	48
Lobster tail	1	27–7	1100	130	54
Roast beef	1	27–7	1100	176	80
	3	29–7	1030	144	62
	1	30–7	1100	124 – 160	51 – 71
	7	31–7	1730	120 – 126	49 – 52
	1	1–8	1130	90 – 172	32 – 78
Fried fish stick	1	27–7	1100	180	82
	7	31–7	1100	170	77
	7	31–7	1730	135	57
Turkey loaf	3	29–7	1030	166	74
	7	31–7	1730	132	56
	1	1–8	1130	146 – 170	63 – 77
Veal loaf	7	31–7	1100	172	78
Roast pork	1	31–7	1130	152 – 164	67 – 73
Chili and macaroni	1	1–8	1130	134	57
Chicken fried steak	1	1–8	1130	132 – 140	56 – 60
Macaroni and cheese	1	1–8	1130	121	49
Beef and noodle	3	2–8	1100	138	39
Chop suey	3	2–8	1100	168	76
Roast pork	3	2–8	1100	178	81
Frankfurter	3	25–7	2400	90	32
	7	26–7	1115	180	82
	1	30–7	1100	110 – 150	43 – 66

TABLE IX

Serving temperature of food items monitored in the first study (cont'd)

Entree item	Dining hall	Date	Time	°F	°C
Cheeseburger	1	30–7	1100	110	43
Chili	7	26–7	1115	110	43
	1	27–7	1100	141	61
	1	30–7	1100	130 – 150	54 – 66
	1	1–8	1130	159	71
	3	2–8	1100	186	86
Sausage	3	29–7	1030	111	44
Hamburger patty	7	31–7	1730	124	51
	3	2–8	1100	144	62
Chipped beef	3	29–7	1030	126	52
Cooked vegetable, potato					
Escalloped potato	1	26–7	1900	110	43
Fried potato	7	26–7	1115	135 – 168	57 – 76
	1	29–7	1030	128	53
	1	27–7	1100	156	69
	3	29–7	1030	128	53
	1	1–8	1130	136	58
Baked potato	3	26–7	1445	152 – 160	67
Potato	1	24–7	1630	132	56
	3	26–7	1445	114	46
	3	29–7	1030	170	77
	7	31–7	1100	138 – 168	59 – 76
Creamed potato	1	27–7	1100	174	79
Mashed potato	1	30–7	1100	150	66
	7	31–7	1730	143	62

TABLE IX

Serving temperatures of food items monitored in the first study (cont'd)

Cooked vegetable, potato	Dining hall	Date	Time	°F	°C
Mixed vegetables	1	24–7	1630	156	69
	7	26–7	1115	186	86
Lima bean	1	24–7	1630	154	68
	3	25–7	2400	108	42
Rice	1	24–7	1630	132	56
	3	2–8	1100	162	72
Peas and carrots	3	25–7	2400	162	72
	3	25–7	1515	176	80
	3	29–7	1030	176	80
	1	1–8	1130	140 – 178	60 – 81
	3	2–8	1100	170	77
String bean	3	25–7	2400	154	68
	7	31–7	1100	142	61
	7	31–7	1730	182	83
Corn	3	25–7	1515	150	66
	7	26–7	1115	150	66
	3	26–7	1445	192	89
	1	27–7	1100	172	78
Asparagus	3	26–7	1445	196	91
Peas	1	26–7	1900	180	82
	1	30–7	1100	138 – 160	59 – 71
	7	31–7	1100	186	86
Squash	7	27–7	1100	174	79
Spinach	3	29–7	1030	174 – 190	79 – 88
Corn and beans	7	31–7	1730	168	76
Cauliflower	1	1–8	1130	148 – 158	64 – 70

TABLE IX

Serving temperatures of food items monitored in the first study (cont'd)

Cooked vegetable, potato	Dining hall	Date	Time	°F	°C
Rice and scallion	1	1–9	1130	148	64
Brocolli	3	2–8	1100	130	54
Stewed tomato	3	2–8	1100	115	46
Baked beans	7	26–7	1115	132 – 163	56 – 73
	1	26–7	1900	110	43
	1	27–7	1100	162	72
	3	29–7	1030	154	68
	1	30–7	1100	130	54
	7	31–7	1145	136 – 172	58 – 78
	1	1–8	1130	132	56
	3	2–8	1100	132	56
Chilled vegetables, salad					
Tossed salad	1	24–7	1630	68	20
	3	25–7	2400	62	17
	3	25–7	1515	58	14
	7	26–7	1115	62	17
	3	26–7	1445	70	21
	1	27–7	1100	50	10
	3	29–7	1030	56	13
	1	30–7	1030	68	20
	7	31–7	1100	52	11
	7	31–7	1730	70	21
	1	1–8	1130	70	21
	3	2–8	1100	70	21
Jello salad	1	27–7	1100	42	6
	1	27–7	1100	42	6

TABLE IX

Serving temperatures of food items monitored in the first study (cont'd)

Chilled vegetables, salad	Dining hall	Date	Time	°F	°C
Cottage cheese	1	24–7	1630	54	12
	3	25–7	2400	54	12
	3	26–7	1445	62	17
	1	27–7	1100	44	7
	3	29–7	1030	54	12
	1	30–7	1030	49	9
	1	1–8	1130	46	8
Potato salad	7	24–7	1630	52	11
	1	24–7	1100	42	6
	1	30–7	1030	50	10
	7	31–7	1145	50	10
	3	2–8	1100	56	13
Marinated string beans	1	24–7	1030	48	9
Fruit salad	3	25–7	2400	66	19
	3	25–7	1515	64	18
	1	1–8	1730	54	12
Relish	3	25–7	2400	58	14
	3	25–7	1515	64	18
Tuna	3	25–7	1515	62	17
	7	31–7	1145	62	17
Cole slaw	3	26–7	1445	65	18
	3	29–7	1030	54	12
	3	2–8	1100	52	11
Macaroni and egg	3	26–7	1445	60 – 68	16 – 20
	7	31–7	1145	50	10
	1	1–8	1130	50	10
	1	27–7	1100	50	10

TABLE IX

Serving temperatures of food items monitored in the first study (cont'd)

Chilled vegetables, salad	Dining hall	Date	Time	°F	°C
Marinated cucumber	1	30–7	1030	54	12
String beans	7	31–7	1145	60	16
	7	31–7	1730	52	11
Tomato	1	1–8	1130	52	11
Soup					
Split pea soup	1	24–7	1630	152	67
Soup	3	25–7	1515	130	54
	7	26–7	1115	170	77
	3	29–7	1030	176	80
	1	30–7	1100	170 – 190	77 – 88
	1	1–8	1130	140	60
Oyster soup	1	27–7	1100	178	81
	7	31–7	1145	155 – 190	68 – 88
	7	31–7	1730	188	87
Bean soup	1	1–8	1130	124	51
Miscellaneous					
Gravy	1	30–7	1100	110 – 140	43 – 60
	7	31–7	1730	188	87
Cereal	3	29–7	1030	110	43

TABLE X

Microbial analysis[a] of meat items obtained from the dining facilities during the second study

Food item	Dining hall	Serving temperature °F	Serving temperature °C	Aerobic plate count CFU[c]/g	Coliform MPN[d]/g	Fecal coliform MPN[d]/g
Roast pork	1	160	71	TFTC[e]	0	0
BBQ pork	1	141	61	TFTC	0	0
Turkey	1	138	59	1×10^4	0	0
Turkey	1	–		TFTC	0	0
Turkey a-la-king	7	142	61	1×10^4	9	0
Chicken fried steak	1	160	71	TFTC	4	0
Meat balls	1	145	63	TFTC	0	0
Veal roast	3	125	52	TFTC	0	0
Fried chicken	3	100	38	TFTC	0	0
	7	150	66	TFTC	0	0
Baked chicken[b]	3	–		TFTC	$>10^2$	$>1.1 \times 10^3$
Ham	7	130	54	TFTC	0	0
Creamed hamburger	1	128	53	TFTC	0	0
	3	–		TFTC	0	0
Breakfast steak	1	–		TFTC	0	0
Lasagna	1	185	85	TFTC	0	0
Lamb	3	142	62	TFTC	0	0
Liver	7	122	50	TFTC	0	0
Frankfurter[b]	1	113	45	$>3 \times 10^6$	0	0

[a]All of the samples contained less than 1000 *Staphylococcus aureus* per g
[b]Nonconforming
[c]CFU – colony forming unit
[d]MPN – most probable number
[e]TFTC – too few to count; less than 3000 CFU/g

TABLE XI

Microbiological analysis[a] of salads, soups, vegetables and desserts from the dining facilities during the second study

Food item	Dining hall	Serving temperature °F	Serving temperature °C	Aerobic plate count CFU[c]/g	Coliform MPN[d]/g	Fecal coliform MPN[d]/g
Tossed salad	1	55	13	3×10^4	4.6×10^2	4
	1	50	10	3×10^6	$> 1.1 \times 10^3$	0
	1	–		1×10^5	93	0
	3	55	13	6×10^6	2.4×10^2	43
	7	58	14	1×10^6	$>1.1 \times 10^3$	$>1.1 \times 10^3$
	7	40	4	8×10^5	1.1×10^3	93
Macaroni salad[a]	1	–		TFTC[e]	9	0
Pea soup	1	165	74	TFTC	0	0
Gravy	3	150	66	TFTC	0	0
	7	135	57	TFTC	0	0
Baked bean	1	–		TFTC	0	0
Potato	1	110/124	43/51	TFTC	0	0
Boiled, buttered potato[b]	3	95	35	1×10^4	$>1.1 \times 10^3$	$>1.1 \times 10^3$
Cream corn	7	150	66	TFTC	0	0
Cabbage	3	142	61	TFTC	0	0
Green beans	3	155	68	TFTC	0	0
Boston cream pie	1	65	18	TFTC	0	0
Strawberry cream cake	3	72	22	TFTC	0	0
Banana pie	7	72	22	TFTC	0	0

[a]With the exception of macaroni salad, all of the samples contained less than 100 *Staphylococccus aureus* per g. The macaroni salad contained 150 *S. sureus*/g.

[b]Nonconforming

[c]CFU – colony forming unit

[d]MPN – most probable number

[e]TFTC – too few to count; less than 3000 CFU/g

TABLE XII

Microbiological analysis[a] of food items taken from the three food service facilities introduced into the feeding system for the second study

Food item	Facility	Serving tempberature °F	Serving tempberature °C	Aerobic plate count CFU[e]/g	Coliform MPN[f]/g	Fecal coliform MPN[f]/g
Fried chicken	IFK[c]	118	48	TFTC[g]	0	0
	MF[d]	60	16	TFTC	0	0
Cooked hamburger	S–13	–		TFTC	9	0
Ham	IFK	–		TFTC	0	0
Ham[b]	S–13	–		4×10^3	4	4
Swiss steak	IFK	–		TFTC	0	0
	S–13	60	16	TFTC	0	0
Ham and egg omelet	IFK	–		TFTC	0	0
	S–13	120	49	TFTC	0	0
Frozen pizza pie[b]	MF	–		$> 3 \times 10^4$	93	4
Cooked pizza pie[b]	MF	120	49	1×10^5	93	4
Turkey	MF	42	6	TFTC	0	0
Ham	MF	42	6	TFTC	7	0
Tossed salad	IFK	–		2×10^5	1.1×10^3	4

[a]All of the samples contained less than 1000 *Staphylococcus aureus* per g
[b]Nonconforming
[c]In-flight kitchen
[d]Modular facility
[e]CFU – colony forming unit
[f]MPN – most probable number
[g]TFTC – too few to count; less than 3000 CFU/g

TABLE XIII

Sanitary evaluation of equipment in dining halls 1, 3 and 7 by RODAC plates in the second study

Item	Dining hall 1	3	7
Knife	S[a]	U[b]	U
Large spoon	S		
Salad dish	S		
Dinner plate	S	U	S
Glass	S		
Large ladle	S		
Large spatula			S(2)
Butcher knife	S		U
Cutting board	U	U,S	S,U
Meat slicer	U(2)[c]		
Vegetable slicer	U(2)	U	
Vegetable peeler	U,S	U	
Centrifuge			
Bake sheet		S	S
Large pan		S	
Dining table			U
Preparation table (stainless steel)	S	U	
Preparation table (formica)	U		
Counter top (serving line)	U	U(2)	S(2)
Steam kettle	S		
Steam pan	U		
Salad bar			U
Pastry shelf			S
Plate dispenser			U

[a]S—satisfactory; see text for definition.

[b]U—unsatisfactory; see text for definition.

[c]Indicates the number of sampling periods greater than one.

TABLE XIV

Sanitary evaluation of equipment in the in-flight kitchen, bakery and modular unit by RODAC plates in the second study

Item	In-flight kitchen	Bakery	Modular Unit
Spatula	S[a]		
Collander	S		
Rolling pin		S	
Large ladle		S	
Bake sheet	S	S	
Large pot	S	U[b]	
Small pot	S		
Shallow pan	S		S
Sandwich board			S
Cutting board	S		
Meat slicer	S		
Steam pan		S	
Steam kettle	U		
Preparation table (stainless steel)	S		
Preparation table (formica)	S		
Preparation table (wooden)		S	
Counter – grill area			S

[a]Satisfactory, see text and Table XV.

[b]Unsatisfactory, see text and Table XV.

TABLE XV

Sanitary evaluation[a] of equipment in Dining hall 1 by RODAC plates in the second study

Item	No. of plates	No. of RODAC plates with colonies/plate[b] > 50	> 100	Remark
Knife	5	0	0	S
Large spoon	5	0	0	S
Salad dish	10	1	0	S
Dinner plate	5	0	0	S
Glass	15	0	0	S
Large ladle	2	0	0	S
Butcher knife	2	0	0	S
Cutting board	8	3	2	U
Meat slicer	4	2	2	U
Meat slicer	8	7	4	U
Vegetable slicer	3	1	1	U
Vegetable slicer	2	1	1	U
Centrifuge	4	4	3	U
Centrifuge	5	0	0	S
Preparation table (stainless steel)	8	0	0	S
Steam kettle	16	0	0	S
Steam pan	8	2	2	U
Preparation table (formica)	16	8	8	U
Counter top (serving line)	8	8	8	U

[a]A surface was rated as satisfactory (S) when half or more of the RODAC plates had 50 CFU/4 in^2 (25.8 cm^2) or less with none exceeding 100 CFU/plate, otherwise it was rated unsatisfactory (U).

[b]Each plate has an area of 4 in^2 (25.8 cm^2).

TABLE XVI

Sanitary evaluation[a] of equipment in Dining hall 3 by RODAC plates in the second study

Item	No. of plates	No. of RODAC plates with colonies/plate[b] > 50	> 100	Remark
Knife	20	19	19	U
Dinner plate	10	5	2	U
Cutting board	2	2	2	U
Cutting board	2	1	0	S
Large pan	4	0	0	S
Bake sheet	4	0	0	S
Preparation table (stainless steel)	16	15	15	U
Vegetable peeler	2	2	2	U
Vegetable slicer	4	3	3	U
Counter top (serving line)	10	2	2	U
Counter top (serving line)	8	8	0	U

[a,b]See Table XV

TABLE XVII

Sanitary evaluation[a] of equipment in Dining hall 7 by RODAC plates in the second study

Item	No. of plates	No. of RODAC plates with colonies/plate		Remark
		>50	>100	
Knife	10	10	4	U
Dinner plate	10	0	0	S
Large spatula	2	1	0	S
Large spatula	2	0	0	S
Butcher knife	2	2	2	U
Cutting board	5	0	0	S
Cutting board	4	4	4	U
Bake sheet	4	0	0	S
Dining table	8	8	4	U
Counter top (serving line)	5	2	0	S
Counter top (serving line)	5	0	0	S
Salad bar	5	4	2	U
Pastry shelf	5	0	0	S
Plate dispenser	5	4	4	U

[a,b]See Table XV.

TABLE XVIII

Sanitary evaluation[a] of equipment in the in-flight kitchen by RODAC plates in the second study

Item	No. of plates	No. of RODAC plates with colonies/plate[b] > 50	> 100	Remark
Spatula	2	0	0	S
Collander	2	0	0	S
Cutting board	6	0	0	S
Bake sheet	4	0	0	S
Shallow pan	2	0	0	S
Small pot	4	0	0	S
Large pot	9	0	0	S
Preparation table (stainless steel)	8	0	0	S
Preparation table (formica)	8	0	0	S
Meat slicer	4	1	0	S
Steam kettle	4	1	1	U

[a,b]See Table XV.

TABLE XIX

Sanitary evaluation[a] of equipment in the bakery and modular facility by RODAC plates in the second study

Item	Location	No. of plates	No. of RODAC plates with colonies/plate[b] > 50	> 100	Remark
Rolling pin	Bakery	2	0	0	S
Large ladle	Bakery	2	0	0	S
Bake sheet	Bakery	4	0	0	S
Large pot	Bakery	4	3	3	U
Preparation table (wooden)	Bakery	5	0	0	S
Steam pan	Bakery	4	0	0	S
Shallow pan	Modular unit	1	0	0	S
Sandwich board	Modular unit	3	0	0	S
Counter – grill area	Modular unit	4	0	0	S

[a,b]See Table XV.

TABLE XX

Items found unsatisfactory[a] or in need of improvement[b] by visual inspection in the second study

	Observation	Food service facility						
		DH[c] 1	DH 3	DH 7	IFK[d]	S–13	Modular[e]	Bakery
Personnel	Health certificates	N	N	–	N	–	–	N
	Personal habits	U	–	U	U	–	–	–
	Disease – health hazards	U	–	–	U	–	–	–
Kitchen	Thermometer used	N	N	N	N	N	N	N
	Hot food – kept hot (≥ 140°F, 60°C)	U	U	U	–	–	U	–
	Cold food – kept cold (≤ 45°F, 7°C)	N	–	N	–	–	N	–
	Ranges, ovens, grills clean	U	–	U	–	–	N	U
	Food contact surfaces clean	U	–	U	–	–	–	U
	Non-food contact surfaces clean	U	N	N	N	N	N	U
	Utensils clean	–	–	N	U	–	U	U
	Butcher knives	U	–	U	–	–	–	–
	Utensils used to handle food	U	–	–	–	–	–	–
	Facilities adquate for keeping food hot	–	N	–	N	–	–	–
	Food cooked to proper temperature	N	–	N	–	–	–	–
	Frozen food properly thawed	–	U	–	–	–	–	–
	Food containers stored off floor	N	–	–	–	–	–	–
	Sinks clean	N	–	–	–	–	N	N
Dining area	Silverware clean	–	–	N	–	–	–	–
	Glasses clean	U	–	U	–	–	–	–
	Dining tables	–	–	U	–	–	–	–
	Dispensing machines	U	N	N	–	N	–	–

TABLE XX (cont'd)

Items found unsatisfactory[a] or in need of improvement[b] by visual inspection in the second study

	Observation	Food service facility DH[c] 1	DH 3	DH 7	IFK[d]	S–13	Modular[e]	Bakery
Serving line	Dangerous food, temperature	U	–	N	–	–	U	
	Green salads, temperature	U	–	U	–	–	U	
	Pastry display shelf	U	–	–	–	–	–	–
	Sneeze guard cracked	–	–	U	–	–	–	–
	Protective light globes	–	–	U	–	–	–	–
	Glass storage area	–	–	U	–	–	–	–
Storage	Refrigerator clean	N	–	U	–	–	–	N
	Milk storage	N	N	N	–	–	–	–
	Dry storage area clean	N	–	N	–	–	N	N
	Clean equipment storage			N	N	–	–	N
	Self leveling dish storage unit	U	–	U	–	–	–	–
	Storage carts and rack	U	N	U	U	–	–	U
	Leftovers	N	N	–	N	–	–	–
	Ice machine	N	–	N	N			
	Meat						U	
Garbage disposal	Garbage disposal area clean	U	N	N	–	–	–	–
	Garbage cans clean when empty	U	–	U	–	–	–	N
	Pests absent	N	–	–	–	–	N	–
	Mops clean	N	–	N	–	–	–	N
Toilet	Toilet clean	U	U	N	N	–	–	–
	Toilet supplies adequate	–	–	–	N	–	–	–

TABLE XX (cont'd)

Items found unsatisfactory[a] or in need of improvement[b] by visual inspection in the second study

	Observation	Food service facility						
		DH[c] 1	DH 3	DH 7	IFK[d]	S–13	Modular[e]	Bakery
Scullery	Wash water temperature	N	N	U	–	–	–	–
	Rinse water temperature	N	N	U	–	–	–	–
	Sanitizing water temperature	N	N	U	U	–	–	–
	Hot water supply adequate	–	–	U	–	–	–	–
	Drainage	–	–	N	–	–	–	–
	Storage carts and racks	–	–	U	U	–	–	–
General	Floors and walls clean	N	–	N	–	–	N	N
	Windows in good repair	N	–	–	–	–	–	–
	Screening on windows and doors	N	N	N	N	N	–	N
	Outer openings protected	–	N	N	N	–	–	–
	General appearance	N	–	U	N	–	–	N
	Outside area clean	N	N	U	–	–	N	N
	Pastry transporters	–	–	U	–	–	–	U
	Egg shells dirty	–	–	–	U	–	–	–
	Cooked egg shells broken	–	–	–	U	–	–	–

[a]U—Unsatisfactory — Items appeared soiled and were unacceptable.

[b]N—Needs improvement — Appearance indicated a questionable but an acceptable degree of cleanliness.

[c]DH—Dining hall.

[d]IFK—In-flight kitchen.

[e]Modular facility.

TABLE XXI

Food items served at improper temperatures in the second study

Food item	Facility	Temperature °F	Temperature °C
Ham	DH[a] 3	130	54
	MF[b]	58[c]	14
Fried chicken	DH 3	100/120	38/49
	MF	60	16
Meatballs	DH 1	115	46
Chicken fried steak	DH 1	137	58
Frankfurter	DH 1	120	49
Roast beef	DH 1	128	53
Cod fish	DH 7	130	54
Scallops	DH 7	126	52
Sausage	MF	100	38
Veal	DH 3	125	52
Liver	DH 7	122	50
Chili	DH 7	135	57
Beef	DH 1	128	53
Lasagna	DH 1	128	53
Gravy	DH 3	135	57
Pizza pie	MF	120	49
Potato	DH 1	120	49
	DH 3	95	35
	DH 7	130	54
	S–13	80	27
Baked beans	DH 1	120	49
	DH 7	105	41
Tossed salad	DH 1	58	14
	DH 7	68	20
	MF	62	17
Banana pie	DH 7	60	16
Boston cream pie	DH 1	65	18

[a]DH – dining hall, [b]MF – modular facility, [c]cold cut

TABLE XXII

Evaluation of surfaces by visual inspection and by RODAC plates in dining hall 1 in the second study

	No. of RODAC plates	No. plates CFU[c]/plate		Evaluation[d] by	
		> 50	> 100	RODAC	Visual
Salad centrifuge	4	4	3	U	S
Knife (5)[a]	5	0	0	S	U
Drinking glass	5	0	0	S	U
China plate (10)	10	1	0	S	S
Refrigerator holding cabinet	3	0	0	S	U
Pot/pan storage	4	1	0	S	U
Rolling pin	2	1	0	S	S
Pot/pan storage rack	3	2	0	U	U
Bake sheet	4	0	0	S	S
Large pan	4	0	0	S	S
Steam jacketed kettle	8	0	0	S	U
Slicing machine	4	2	2	U	S
Vegetable slicer	3	1	1	U	U
Large ladle	2	0	0	S	S
Steam jacketed pan	8	2	2	U	S
Steam jacketed pan	8	0	0	S	U
Milk dispenser press plate	2	0	0	S	S
Refrigerator door handle	2	2	2	U	U
Butcher knife	2	0	0	S	U
Dining table	8	0	0	S	S
Dining table	8	2	1	U	S
Dining table	8	1	0	S	S
Small table (vegetable)	8	1	1	U	S
S.S.[b] table (vegetable)	8	0	0	S	U
Table (salad preparation)	8	8	8	U	S
S.S. shelf on line	4	4	4	U	U
S.S. shelf on line	4	4	4	U	U
Centrifuge	5	0	0	S	S
Vegetable slicer	2	0	0	S	S
Rolling pin	2	1	0	S	S
Cutting board	4	0	0	S	S
Cutting board	4	3	2	U	S
Bake sheet	4	0	0	S	S
Large ration pan	4	0	0	S	S
Side wall of refrigerator	5	1	1	U	U
Meat slicer	8	7	4	U	U

TABLE XXII (cont'd)

Evaluation of surfaces by visual inspection and by RODAC plates in dining hall 1 in the second study

	No. of RODAC plates	No. of plates CFU[c]/plate		Evaluation[d] by	
		> 50	> 100	RODAC	Visual
Steam jacketed kettle	8	0	0	S	S
Large spoon	5	0	0	S	S
Knife (5)	5	1	0	S	U
Fork (5)	5	0	0	S	U
Dessert dish (10)	10	1	0	S	S
China dish (5)	5	0	0	S	S
Glass (5)	5	0	0	S	U
Pot/pan rack	4	4	4	U	U

[a]Number of items tested.
[b]Stainless steel.
[c]CFU—colony forming unit.
[d]S—satisfactory; U—unsatisfactory. See text and Table XV for definition.

TABLE XXIII

Evaluation of surfaces by visual inspection and by RODAC plates in dining hall 3 in the second study

	No. of RODAC plates	No. plates CFU[c]/plate		Evaluation[d] by	
		> 50	> 100	RODAC	Visual
Knife (10)[a]	10	10	10	U	U
Knife (10)	10	9	9	U	S
Fork (10)	10	10	10	U	U
Shallow pan	2	0	0	S	S
Large pot	4	0	0	S	U
Cookie sheet	4	0	0	S	S
Shallow pan	2	0	0	S	S
S.S.[b] salad preparation table	8	8	8	U	S
S.S. salad preparation table	8	7	7	U	S
Short order serving shelf	10	2	2	U	S
Short order serving shelf	8	8	0	U	S
Cutting board	2	2	2	U	S
Cutting board	2	1	0	S	S
Steam jacketed pan	3	1	0	S	S
Steam jacketed pan	4	0	0	S	S
Vegetable peeler	2	2	2	U	U
Vegetable slicer	4	3	3	U	S
Pot/pan rack	5	3	1	U	U
Milk dispenser press plate	2	0	0	S	U
China plate (10)	10	5	2	U	U

[a]Number of items tested.

[b]Stainless steel.

[c]Colony forming unit.

[d]S—satisfactory; U—unsatisfactory (See text and Table XV for definition).

TABLE XXIV

Evaluation of surfaces by visual inspection and by RODAC plates in dining hall 7 in the second study

	No. of RODAC plates	No. plates CFU[b]/plate		Evaluation[c] by	
		>50	>100	RODAC	Visual
Pastry transporter	4	3	3	U	U
Milk dispenser pressure plate	4	0	0	S	U
Ice cream dispenser	4	0	0	S	S
China plate (10)[a]	10	0	0	S	S
Self-leveling plate dispenser	3	2	2	U	U
Self-leveling plate dispenser	2	2	2	U	U
Large spatula	2	1	0	S	U
Butcher knife	2	2	2	U	U
Large spatula	2	0	0	S	S
Knife (10)	10	10	4	U	U
Knife (10)	10	3	1	U	U
Dining table	8	8	4	U	U
Salad bar on serving line	5	4	2	U	S
Pastry display shelf	5	0	0	S	S
Short order serving line (before cleaning)	5	2	0	S	U
Short order serving line (after cleaning)	5	0	0	S	S
Counter around grill	5	0	0	S	S
Pastry cutting table	5	0	0	S	S
Cutting board	5	0	0	S	S
Cutting board	4	4	4	U	U
Steam jacketed pan	4	0	0	S	S
Bake sheet	4	0	0	S	S
Large pot	4	0	0	S	S

[a]Number of items tested.

[b]Colony forming unit.

[c]S—satisfactory; U—unsatisfactory; (See text and Table XV for definition).

TABLE XXV

Evaluation of surfaces by visual inspection and by RODAC plates in the bakery in the second study

	No. of RODAC plates	No. plates CFU[a]/plate > 50	No. plates CFU[a]/plate > 100	Evaluation[b] by RODAC	Evaluation[b] by Visual
Wooden preparation table	5	0	0	S	S
Jacketed steam table	4	0	0	S	S
Dipper	1	0	0	S	S
Rolling pin	2	0	0	S	S
Bake sheet	4	0	0	S	S
Large pot in refrigerator	4	3	3	U	U
Pastry transporter	4	3	3	U	U

[a]Colony forming unit.

[b]S—satisfactory; U—unsatisfactory (See text and Table XV for definition).

TABLE XXVI

Evaluation of surfaces by visual inspection and by RODAC plates in the modular facility and S–13 in the second study

	No. of RODAC plates	No. plates CFU[b]/plate		Evaluation[c] by	
		> 50	> 100	RODAC	Visual
Shallow pan	1	0	–	S	S
Counter top	10	2	1	U	S
Grill area	4	0	–	S	S
Sandwich preparation board	3	0	–	S	S
Adjacent to deep fat fryer	4	0	–	S	S
Grill–counter	2	0	–	S	S
Dining table[a]	8	2	1	U	U

[a]In S–13, remaining surfaces from the modular facility.

[b]Colony forming unit

[c]S–satisfactory; U–unsatisfactory (See text and Table XV for definition).

TABLE XXVII

A comparison between visual and RODAC plate evaluation of surfaces in the second study

Facility	No. of surfaces evaluated	Visual[a]		RODAC[b]		Percentage[c]			
		Vu	Vs	Ru	Rs	RuVu / Ru	RsVs / Rs	RuVs / Ru	RsVu / Rs
DH[d] 1	44	19	25	15	29	53	62	47	38
DH 3	20	7	13	11	9	41	78	59	22
DH 7	23	10	13	9	14	78	79	22	21
Bakery	7	2	5	2	5	100	100	0	0
IFK[e]	23	8	15	1	22	100	68	0	32
MF[f]	7	1	6	2	5	50	100	50	0

[a]Vs or Rs – Number of items which are satisfactory(s) as evaluated visually (V) or by RODAC (R) plates.

[b]Vu or Ru – Number of items which are unsatisfactory (u) as evaluated visually (V) or by RODAC (R) plates.

[c]The numerator indicates only combinations or R and V, i.e. RuVs – those items which were evaluated as unsatisfactory by RODAC plates and satisfactory visually multiplied by 100, and is not meant to signify the product of R and V.

[d]DH – Dining hall.

[e]IFK – In-flight kitchen.

[f]MF – Modular facility.