GUIDE TO
HYGIENE AND SANITATION
IN AVIATION

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1. INTRODUCTION

Health and sanitation aspects of international traffic have been of concern to the World Health Organization since 1951, when the Fourth World Health Assembly recommended that all governments should "improve sanitary and environmental conditions, especially in and around ports and airports" (resolution WHA4.80); at the same time the need "for the sanitary protection of populations in mass movement" was also expressed (resolution WHA4.81). Subsequent resolutions of both the World Health Assembly and the Executive Board emphasize the importance of maintaining high standards of hygiene and sanitation in international traffic (particularly in relation to the provision of safe water and food and the correct procedures for the collection and disposal of wastes). The reports of the Committee on International Surveillance of Communicable Diseases, as adopted by the World Health Assembly, also emphasize the importance of preventing disease through the improvement of sanitary conditions. The relevant articles of the International Health Regulations* (1) lay down sanitation requirements at airports. The provision of criteria and guidelines for the use of administrations in fulfilling their obligations under the International Health Regulations forms an essential part of WHO's functions.

The annex to the first report of the WHO Expert Committee on Hygiene and Sanitation in Aviation (2) was published in 1960 by the Organization as a Guide to Hygiene and Sanitation in Aviation (3). Its use was recommended by the Twelfth World Health Assembly to guide health administrations in "fulfilling their obligations under the International Sanitary Regulations, especially the provisions of Article 14, in providing safe food for international air traffic, and in maintaining satisfactory control of, and protection from, malaria vectors at airports" (resolution WHA.12.18).

The basic principles of hygiene have not altered since 1960. However, with the tremendous growth in both the volume and the speed of traffic in the air transport industry generally, especially in specific sectors such as charter flights and package tours, the continued application of these principles has assumed even greater importance. In addition, new

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* For resolutions of the 1st to 25th World Health Assemblies (WHA) and of the 1st to 50th sessions of the Executive Board (EB), see Handbook of Resolutions and Decisions..., Vol. I, published by the World Health Organization in 1973; for resolutions of the 26th and 27th World Health Assemblies and of the 51st to 54th sessions of the Executive Board, see ibid., Vol. II, published in 1975.

* The International Health Regulations (1969) represent a revised and consolidated version of the previous International Sanitary Regulations.
practices have been introduced—particularly in flight catering—since the publication of the first edition of the *Guide to Hygiene and Sanitation in Aviation*. The current trend in international civil aviation is for aircraft of larger passenger-carrying capacity and greater speed and range. The introduction of new air routes into areas with low levels of sanitation may exert a strain on essential basic services such as catering, water supply, and waste disposal facilities. It is therefore pertinent to appreciate that the provision of services and facilities, as well as the application of high standards of hygiene, forms an integral part of efficient airport and airline operations.

Though hygiene standards may have improved during the last decade, there is still a pressing need to safeguard the health of crew and passengers against the international spread of disease. Incidents of water- and foodborne illness associated with international air travel that are reported from time to time, serve to emphasize the appropriateness of the concern expressed in recent WHO resolutions (WHA26.54 and EB53.R27) relating to the quality of food and drinking-water in international traffic.

It was with this in mind that in 1974 the Twenty-seventh World Health Assembly “Believing that, in view of the growth of international traffic, continuous attention should be given to the safety of food and water and the handling of wastes in such traffic”, stressed “the need for each Member State to clarify the ultimate responsibility for the safety of food and water and the proper handling of wastes in international traffic” and, furthermore, recommended that “Member States coordinate and ensure the close and active participation in such a responsibility of health authorities, port and airport management, aircraft operators, shipping companies, tourist associations, and any other service or agency concerned with international traffic” (resolution WHA27.46). At the same time, the Director-General was requested to maintain close contact with representatives of international organizations concerned with international traffic with a view to promoting the implementation and coordination of activities aimed at improving the safety of food and water and the handling of wastes, and to prepare appropriate guidance materials for the use of health and other agencies in this field and keep them up to date.

The original draft of this publication was circulated to a number of experts in different parts of the world and to selected WHO staff in headquarters and the regional offices (see Annex 8 for the names of the reviewers concerned). A later draft served as a basis of discussion at a meeting convened by the WHO Regional Office for Europe, in collaboration with the Spanish Government, at Torremolinos in November-December 1976. The participants, who were representative of various disciplines connected with food hygiene and aviation, endorsed the principles and practices set forth in the Guide and recommended that they be widely studied.
2. OBJECT OF THE GUIDE

The magnitude of air transport operations grows steadily every year. For example, the number of passengers flying on scheduled international and domestic flights rose from 177 million in 1965 to 438 million in 1975 (7), and these figures do not take into account the millions of charter-flight passengers, whose numbers also continue to increase.

Tourism provides an important source of revenue for many countries. The World Tourism Organization (formerly known as the International Union of Official Travel Organizations) estimated total receipts from international tourism in 1975 at US$ 34 000 million, of which a large percentage was derived from air travellers. Countries receiving income from tourism therefore have an economic reason for providing the facilities and services required to protect the health and wellbeing of air passengers. Bodies such as the International Air Transport Association (IATA), the International Civil Aviation Organization (ICAO) and the Airport Associations Coordinating Council have an important role to play in ensuring this protection by arranging for a frequent exchange of information between their members.

Recognizing the importance of the need for improved health standards in international air transport, ICAO has added the following two recommended practices in the 7th edition of Annex 9 (Facilitation) to the Convention on International Civil Aviation (Chicago, 1944) (8):

"6.45 RECOMMENDED PRACTICE:
Contracting States, in cooperation with airport authorities and aircraft operators should take all steps to ensure that the preparation, handling, storage and service of food and water supplies intended for consumption both at airports and on board aircraft are hygienically carried out in accordance with the recommendations and standards of the World Health Organization.

"6.46 RECOMMENDED PRACTICE:
Contracting States in cooperation with airport authorities and aircraft operators should ensure that an effective system is instituted for the safe removal and safe disposal of excrement, refuse, waste water, waste, unused and condemned food and other matter dangerous to health in accordance with the recommendation of the World Health Organization."

Similarly, the Medical Advisory Committee of IATA is recommending to member airlines that they apply specific procedures for the monitoring of sanitary standards in the purveyance, preparation, handling and storage of food and water supplies for aircraft by airport caterers,
and has issued a code of practice on food hygiene in air transport (9) that is intended to supplement the detailed provisions of the present Guide, and to act as a day-to-day manual for those engaged in all catering activities within the aviation industry.

It is appreciated that the public health requirements for the protection of air travellers are well known, and that in many countries there exists national or local legislation aimed at providing such safeguards. The Guide therefore aims at facilitating the practical application of principles and implementation of legislation by providing specific information necessary to achieve satisfactory standards of hygiene and sanitation in international aviation.

This publication is intended for the use of those in any way involved in, or responsible for, the planning and implementation of measures for the provision, operation, maintenance and control of such equipment, services and facilities, both at airports and aboard aircraft, as are directly or indirectly necessary to protect crews, passengers, and ground staff, as well as members of the general public using airports, against infection. As such, the Guide is directed to the following agencies and individuals:

1. public health administrations, public health authorities, aviation administrations and airport authorities;
2. air transport operators;
3. airport and airline employees;
4. airport and airline caterers and concessionaries;
5. airport designers and aircraft manufacturers.

Its purpose is to show how such protection can be provided on a worldwide basis through the application of measures for the sanitary control of the environment both at airports and aboard aircraft, for which detailed instructions are given.

Where further information is required, reference is made herein to sources from which this may be obtained. Since this Guide deals almost wholly with protection against infection, no comments are offered relating to passengers' comfort, involving such factors as ventilation, temperature, humidity, odours, barometric changes, noise and vibration.
3. GENERAL CONSIDERATIONS

The principles outlined below should be regarded as minimum criteria. With a view to achieving optimum protection of the health of air crews and passengers, responsible bodies may apply action that goes beyond the measures advocated in this Guide, and operators may provide, maintain and use equipment and procedures considered superior to those recommended herein. Although applications may vary in different areas, there should be no deviation from the following basic principles:

1. Food and water and equipment and utensils must be as free as possible from pathogenic organisms and toxic substances; in any event, such contaminants must never be present in amounts that would constitute a health hazard;
2. Persons must not be in contact with infected wastes, particularly those of human origin; and
3. Disease vectors must be kept under control.

In the planning and construction of airports, health aspects should be taken into consideration when sites are selected. Provision should be made for sufficient space and facilities to cover both present needs and the possible future expansion of all services. Failure to do this may eventually create numerous problems, some of which may relate to aspects of hygiene and sanitation. When sites for new airports are under consideration, full consultation with health administrations and health authorities should be an integral part of the planning phase.

In order to minimize the risk of contracting diseases that could be spread rapidly to all parts of the world, a full analysis of existing and potential sanitary problems needs to be made before a final decision on siting and construction is arrived at. The aspects to be considered include the following:

1. Source, safety and adequacy of water supply;
2. Distance from mosquito breeding areas and direction of prevailing winds (10); and
3. Natural and artificial means of drainage.

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* In the International Health Regulations the following definitions are given:
"health administration" means the governmental authority responsible over the whole of a territory to which these regulations apply for the implementation of the health measures provided herein;
"health authority" means the authority immediately responsible in its jurisdiction for the appropriate health measures permitted or prescribed by these Regulations" (I, p. 9).
Airports that are not classified as "sanitary" and do not possess an organized and adequately staffed medical service can usually call upon the local health authority for assistance, which in many cases will have specialist personnel whom it will designate to assist in dealing with health and sanitation problems at the airport.

Some airports are located in isolated areas, at some distance from the main water supply and sewerage installations. They may also be outside the jurisdiction of established, well-organized health authorities. In this case greater responsibilities fall on the airport authorities, which may have to organize the provision and maintenance of facilities and services for wholesome food and water supplies, vector and rodent control, and collection and disposal of solid and liquid wastes.

Owing to the continuing expansion in air travel, to which reference has already been made, new airports are being built and existing ones enlarged to meet the growing demand. They are often brought into operation before all the requisite facilities are available or before reconstruction is completed. During such times, extra vigilance is required to ensure that standards of hygiene and sanitation are maintained.

All ground servicing of aircraft at airports, including the loading of food and water, the removal of excreta and dry wastes, and the cleaning of aircraft interiors, has to be carried out efficiently and speedily. It is essential that departures are not delayed because of inefficient ground handling, since this would detract from one of the principal advantages of air transport—namely, speed. Furthermore, delays in flight schedules may be caused if crew members are not fit for duty owing to sudden illness—for example, food poisoning. Relief crews may not be available, particularly at transit airports, as increased aircraft speeds have reduced the number of locations where crews need to be accommodated. The basic principles of rapid handling of air traffic have been enunciated by ICAO (8).

Most airlines have their own medical service, primarily to provide health protection for their staff and passengers. Although the health authority has the ultimate responsibility to inspect airport and airline facilities, specialist health staff employed by some airlines often complement this work. Their duties, whose purview extends to all countries in which the airline operates, usually consist in giving advice on any matters of hygiene and sanitation that might affect air crew, ground staff and passengers. Such health personnel are concerned with food hygiene in all its aspects, water supply, disinfection, disinfestation, disinfesting, solid and liquid waste collection and disposal, participation in hygiene education, etc.; their recruitment by all airlines is recommended. There is a praiseworthy tendency shown by some airlines to liaise and act jointly when specific hygiene problems arise at airports other than the "main base"—i.e., the airport at which an airline's maintenance headquarters are situated.

Owing to the rapidity of air travel, air crews and passengers, many of whom are accustomed to safe food and water in their own countries, have no time in which to acquire immunity or resistance to local food-
and waterborne diseases, with which they are increasingly being brought into contact. Indeed, they have little choice in what they are offered to eat and drink. It is therefore of the utmost importance that the strictest precautions should be taken by all concerned to protect the health of all air travellers throughout their journey.

Passengers and crew should be provided with prior information on the precautions to be taken, particularly when visiting countries with a low level of sanitation (11). Such information should include advice on practical ways of avoiding food- and waterborne illnesses—for example:

(1) the boiling of all drinking-water if the source is doubtful;
(2) avoidance of unpeeled fruit;
(3) adequate disinfection of all uncooked vegetables such as salads;
(4) the thorough cooking of all meat and fish;
(5) avoidance of ice cream unless it is known to have been produced by an established, reputable firm;
(6) avoidance of shellfish of which the sources are unknown;
(7) maintenance of a high standard of personal hygiene.

(Information on malaria risk for international travellers has been published elsewhere (12).)

It is important that, in order to fulfil their responsibilities, health administration personnel as well as all health authority staff employed at airports—especially those concerned in any way with standards of hygiene and sanitation in international aviation—should be fully conversant with the relevant provisions of the International Health Regulations—in particular Article 14, which reads:

"1. Each health administration shall ensure that ports and airports in its territory shall have at their disposal an organization and equipment adequate for the application of the measures provided for in these Regulations.
2. Every port and airport shall be provided with pure drinking-water and wholesome food supplied from sources approved by the health administration for public use and consumption on the premises or on board ships or aircraft. The drinking-water and food shall be stored and handled in such a manner as to ensure their protection against contamination. The health authority shall conduct periodic inspections of equipment, installations and premises, and shall collect samples of water and food for laboratory examinations to verify the observance of this Article. For this purpose and for other sanitary measures, the principles and recommendations set forth in the guides on these subjects published by the Organization shall be applied as far as practicable in fulfilling the requirements of these Regulations.
3. Every port and airport shall also be provided with an effective system for the removal and safe disposal of excrement, refuse, waste water, condemned food, and other matter dangerous to health."

Among other articles of the Regulations that should be noted in conjunction with this Guide are Articles 19 and 63. Their texts are as follows:
“Article 19

1. Depending upon the volume of its international traffic, each health administration shall designate as sanitary airports a number of the airports in its territory, provided they meet the conditions laid down in paragraph 2 of this Article, and the provisions of Article 14.
2. Every sanitary airport shall have at its disposal:
   (a) an organized medical service with adequate staff, equipment and premises;
   (b) facilities for the transport, isolation, and care of infected persons or suspects;
   (c) facilities for efficient disinfection and disinsecting, for the control of vectors and rodents, and for any other appropriate measure provided for by these Regulations;
   (d) a bacteriological laboratory, or facilities for dispatching suspected material to such a laboratory;
   (e) facilities within the airport for vaccination against smallpox, and facilities within the airport or available to it for vaccination against cholera and yellow fever.”

“Article 63

1. If on arrival of a ship, aircraft, train, road vehicle or other means of transport a case of cholera is discovered, or a case has occurred on board, the health authority (a) may apply surveillance or isolation of suspects among passengers or crew for a period not to exceed five days reckoned from the date of disembarkation; (b) shall be responsible for the supervision of the removal and safe disposal of any water, food (excluding cargo), human excreta, waste water including bilge water, waste matter, and any other matter which is considered to be contaminated, and shall be responsible for the disinfection of water tanks and food handling equipment.
2. Upon accomplishment of (b) the ship, aircraft, train, road vehicle or other means of transport shall be given free pratique.”

From the foregoing it follows naturally that in order to achieve first-class facilities and observance of high standards of hygiene, the closest cooperation between the various authorities is essential. Personnel of health authorities, airlines and airport management, particularly those connected with the provision of food and water supplies, the collection and disposal of solid and liquid wastes, including catering wastes, should pool their knowledge and resources and coordinate their activities for the benefit of all. Suggested national administrative measures necessary to ensure the application of provisions contained in this Guide are given in Annex 7.

At the international level, WHO, with the cooperation of civil aviation administrations through ICAO and the airline industry through IATA, as well as with assistance from other organizations, is endeavouring to effect improvements in the monitoring of airport and aircraft water supplies, in the collection and disposal of wastes, and in the handling, preparation, storage and transportation of food served at airports and on international flights.
4. FOOD

4.1 General

Food hygiene has been defined (1,3) as meaning all the measures necessary for ensuring the safety, wholesomeness and soundness of food at all stages—from its growth, production or manufacture to its final consumption. Within the terms of reference of this Guide, the object of food hygiene practice consists in the production and serving of food as free as possible from contaminants, including toxic substances, thus ensuring that its consumption will not cause illness. Passengers often assess an airline by the quality of the meals served on board. Commercially, therefore, it is important to provide food that is safe, of high quality, palatable, and attractively served.

Food is responsible for the transmission of a large number of illnesses, most of which can be grouped under the following headings:

1. Bacterial diseases (infections and intoxications):
   - Staphylococcal intoxication
   - Salmonellosis
   - Typhoid fever
   - Paratyphoid fever
   - *Clostridium perfringens* (*C. welchii*) foodborne illness
   - Botulism
   - *Bacillus cereus* food poisoning
   - *Escherichia coli* diarrhoea
   - Cholera
   - Non-cholera vibrio (NCV) illness
   - *Vibrio parahaemolyticus* infection
   - Streptococcal infection
   - Shigellosis
   - Brucellosis
   - Tuberculosis
   - Anthrax
   - Tularaemia
   - Diphtheria

2. Viral diseases:
   - Viral hepatitis

3. Protozoal and zooparasitic diseases:
   - Amoebic dysentery
   - Taeniasis
   - Diphyllolothriasis
Trichinosis
Oxyuriasis
Ascariasis
Fascioliasis
Opisthorchiasis
Hydatidosis

4. Illnesses induced by chemical poisons (e.g., pesticides and heavy metals)
5. Illnesses induced by radioactive contamination
6. Illnesses induced by plant and animal toxins (e.g., poisonous fungi and marine biotoxins).

Some of the more important foodborne diseases and their characteristics are described in Annex I (14; see also 15 and 16).

Common foodborne illnesses and causative agents

(1) Staphylococcal intoxication is caused by the enterotoxins produced by many strains of *Staphylococcus aureus* as they grow in food. Although staphylococci are widely distributed in the environment, the primary sources of staphylococci involved in the contamination of food are the skin and nasal passages of man and the udders of cows. Contamination of cooked food by staphylococci occurs mainly during the handling of the food, nasal secretions or septic lesions being the source of the organisms.

The most effective means of prevention or control of staphylococcal food poisoning are: (a) strict observance by food handlers of the hygiene practices described later in this chapter; (b) ensuring that any cooked foods not kept continuously hot before consumption—especially meat, poultry, and seafood—are rapidly cooled and placed under constant refrigeration, in order to prevent the multiplication of staphylococci and the production of enterotoxin (refrigeration does not, however, destroy enterotoxin already present in the food); and (c) ensuring that all milk and milk products are pasteurized or sterilized.

(2) When outbreaks of salmonellosis occur, there is still a tendency to search for secondary cases and carriers among staff, while too little attention is given to contaminated raw materials handled in the kitchens. The importance of meat and poultry as a source of salmonellae cannot be overemphasized. The risk is particularly great when the method of thawing allows these foods to reach too high a temperature or when cooking is inadequate. Furthermore, salmonellae will pass from one item of raw food to another and from raw to cooked or processed food through the medium of equipment, surfaces and cloths and also when raw and cooked foods are handled together. If the time allowed for cooling and the interval between cooking and eating or cooking and refrigeration are too long, organisms will proliferate. As a safeguard, food should be cooked for an adequate length of time and at a suitable temperature. Other precautionary measures are described later in this chapter.
(3) *Clostridium perfringens* (C. welchii) is widely distributed in soil, sewage, water and the intestinal tract of man and animals. Because of its ubiquitous nature, *C. perfringens* is a potential contaminant of many foods, particularly raw meat and poultry. The spores are able to survive cooking and if cooked meat and poultry are not cooled rapidly enough, they will germinate, and the young vegetative cells will multiply quickly in the anaerobic conditions created by cooking. Also, since other bacteria are reduced in number by the process of cooking, *C. perfringens* will be subject to less competition for survival. Prevention of *C. perfringens* food poisoning is primarily concerned with not giving the spores much opportunity to germinate after cooking. This can be achieved by cooking food just prior to its consumption or, if it has to be stored after cooking, by rapid and adequate cooling. The provision and use of adequate cooling and cold storage facilities for cooked meat and poultry that cannot be eaten immediately (as in flight catering) are essential. Kitchens producing hot meals require a cold-room annexe with a special cooling unit and steam extractor fans to ensure that cooked food is cooled rapidly.

(4) Botulism—associated with improperly canned or fermented foods—is caused by *Clostridium botulinum*, an anaerobic spore-forming organism widely distributed in nature. The spores are heat-resistant; the toxins are heat-sensitive. To destroy the toxins, the food should be boiled for 15 minutes. Growth of the organism can be prevented by freezing.

(5) *Bacillus cereus* is a widely distributed organism producing spores that can survive cooking and germinate into aerobic bacilli in cooked foods. Ingestion of large numbers in foods may result in nausea, abdominal cramps and watery diarrhoea. A syndrome often associated with the consumption of rice containing large numbers of *B. cereus* accompanied by toxin is characterized by acute vomiting (thus resembling staphylococcal enterotoxin food poisoning) within a few hours of eating the contaminated food. Preventive measures are similar to those for *Clostridium welchii*—namely, rapid cooling and refrigeration of foods (particularly rice) not intended for immediate consumption after cooking.

(6) Cholera is a serious acute diarrhoeal disease caused by *Vibrio cholerae*. Polluted water is the most common vehicle of infection, but foods also play an important role. They may be contaminated after cooking or pasteurization. Fruits and vegetables may cause outbreaks if washed with sewage-polluted water and eaten raw. Shellfish and other seafood have been implicated in some outbreaks. Proper disposal of sewage, chlorination of water supplies, health education directed at personal hygiene and food hygiene, and adequate cooking of foods in endemic areas are important for prevention.

(7) Outbreaks of diarrhoeal disease caused by non-cholera vibrios (NCV) are being increasingly reported from Asia and elsewhere (17-19).

(8) *Vibrio parahaemolyticus* commonly causes food poisoning in Asia and may be found in coastal waters all over the world. Seafood may be contaminated and there is a constant danger of cross-contamination
from raw to cooked seafood—e.g., crab, lobster, and prawns—in kitchens in countries where ambient temperatures are high and the organism is endemic.

(9) Parasitic infections arise when meat or fish containing infective larvae is not thoroughly cooked. Meat should be obtained from reliable sources, where all carcasses have been examined by a meat inspection service vested with the necessary legal authority. If such conditions cannot be fulfilled meat—and fish—should be thoroughly cooked at 62 °C (144 °F) to destroy infective larvae. It should not be overlooked that freezing meat is a means of affecting the viability of most parasites. *Cysticercus bovis*, the larvae of beef tapeworms, are killed after 6 days at −10 °C (14 °F).

(10) Chemical contaminants such as pesticide residues (20) and heavy metals (e.g., lead and cadmium) (21) may find their way into food. Food additives are used in the production and processing of food to improve quality, flavour and shelf life (22). If used according to generally accepted recommendations, they should not create a health risk. This is not necessarily so in the case of heavy metal contaminants. Contamination may occur during the processing of foods, from lead-glaze coating on ceramic cooking vessels that are used as containers for acidic foods and beverages, and also from the use of lead-soldered containers or utensils. Yet another hazard may arise from the application of pesticides around areas where food is stored and handled.

**Food supplies**

Raw materials must be of the highest quality obtainable. The source should be checked to find good produce as free from *Salmonella* as possible. Safe food cannot be produced from unsound materials. All food should be checked on arrival and then placed in properly designed storage maintained at the correct temperatures (see Fig. 1). Raw food should always be stored separately and prepared in separate areas from cooked foods to prevent the risk of cross-infection.

Certain foods present special risks, since they provide good media for the growth of bacteria that cause food poisoning. These include any perishable food that consists in whole or in part of milk or milk products, eggs, meat, poultry, fish, shellfish, or other ingredients capable of supporting the rapid and progressive growth of infectious or toxigenic microorganisms. The danger of environmental contamination and cross-contamination from raw meat, poultry and seafood to cooked foods cannot be overemphasized. Mussels, crabs, oysters, prawns and other shellfish should not be used unless it is certain that they are fresh and have been obtained from uninfected sources.

Air transport operators have to decide whether or not to uplift any of these “potentially hazardous” foods. However, passengers need not be deprived of many of the more attractive and appetizing foods, provided that good manufacturing practices are followed to prevent contamination and the multiplication of pathogenic microorganisms. These
practices include the strict microbiological control of raw ingredients, the checking of critical control points, the careful cleaning and sanitizing of utensils and equipment, and the hygienic handling, preparation and storage of foods, combined with proper kitchen discipline. Adequate cooling refrigeration as described on page 35 et seq. is of the utmost importance.

Where hygiene standards are unsatisfactory or subject to variation, care should be taken to choose those foods least likely to present a health hazard. When there is a suspected or confirmed foodborne disease incident, menus should be changed immediately and the “suspected” or “potentially hazardous” food replaced with a safe emergency menu. It is therefore vital that the occurrence of any such outbreak should be reported immediately to airlines and caterers so that emergency menus can be introduced. The public health authority should also be notified. A comprehensive investigation, including laboratory examination of any suspected food, should be made.

4.2 Quality control of food

In a publication of the International Commission on Microbiological Specifications for Foods (23) it is stated that “Microbiological methods,
no matter how accurate and reproducible, are inadequate to appraise the microbiological quality of food without a satisfactory sampling plan. The publication in question is a valuable work of reference of special utility to all persons concerned with the principles and techniques of sampling food. It should be of great interest not only to those responsible for quality control in large-scale food manufacturing plants and food examination laboratories, etc., but also to health authorities and other bodies engaged in regular food sampling. The airlines that control their own flight catering kitchens and the large catering contractors who possess quality control and microbiological laboratories will also find the manual helpful, particularly in deciding which foods to sample and in determining the frequency of sampling and the quantities required.

The bacteriological control of meals served in flight presents a practical difficulty. With the exception of frozen meals, kept till after a laboratory examination has been completed, meals generally will have been consumed before the results of such examinations. Foods from all catering premises at airports serving passengers and the public at large, as well as those from premises at airports or elsewhere that provide in-flight meals for both crews and passengers, should be subject to surveillance and regular sampling.

Routine, planned food sampling is necessary in order to investigate the prevailing microbiological characteristics and determine whether these can be regarded as satisfactory. No worldwide microbiological standards for food have as yet been established, but a number of international organizations are at present actively engaged in this work. In the publication mentioned (23), a number of microbiological standards for foods are included. Meanwhile, assistance in the interpretation of results can usually be obtained from the national food hygiene laboratory of the country concerned.

The frequency, regularity, and choice of foods to be sampled will be influenced by the laboratory facilities available. Catering premises possessing their own laboratories will be able to sample on a daily basis. For those without laboratories, the frequency will depend on the ability of external laboratories to accept samples for analysis.

At the minimum, the foods most likely to be contaminated with pathogenic organisms should be sampled on a routine monthly basis. Foodstuffs less likely to be infected need not be sampled so frequently. This routine sampling should reveal any unsatisfactory conditions, which, if present, would necessitate extra sampling to determine their cause. In cases of suspected foodborne infections, emergency sampling will be necessary.

The attention of all those responsible for food sampling is drawn to chapter 7 of the above-cited Microorganisms in Foods (23). Instructions will be found therein for the correct way to collect, label, store and transport samples. It is vital that the sample should not be contaminated during collection and transport to the laboratory. In case of doubt, the sampling officer should discuss the matter with the laboratory director.
4.3 Categories of catering: general principles

The establishments in which food is prepared fall basically into two categories: (a) those that produce food served in airport restaurants, cafeterias and snack bars for consumption by passengers, air crew, members of the public and airport personnel, and (b) flight catering kitchens or inflight catering premises.

Airport catering establishments

The standards of hygiene, specifications, and handling techniques described in detail in the following pages for flight catering apply equally to ground catering.

The principal difference between the two categories of catering is that generally food for consumption on the ground is prepared more or less on demand, or only a short time before it is served. It is usually prepared and cooked in a part of the premises where it is to be consumed. On the other hand, food for aircraft meals is prepared in premises other than those in which it will be consumed—often thousands of miles away; many hours or, in the case of frozen meals, many weeks will elapse before it is eaten. However, with the increasing use of frozen meals, or, as the method is described, “cook freeze catering”, the two types of catering technique are drawing closer together.

Meals are prepared in a central production kitchen, or food factory, and transported to kitchens for regeneration. The food is prepared and cooked in the form in which it will be served—e.g., sliced meat or poultry, rather than large cuts of meat or whole birds. Some items, such as fruit pies, are prepared but not cooked. All food is then frozen. This system is to be commended from the point of view of hygiene. Strict control can be exercised over preparation and food can be “bacteriologically cleared” before consumption.

Certain precautions must be followed to ensure that the control and high standard reached in the production unit are maintained in the catering establishment. These precautions are:

1. Containers in which food is delivered should be stored in a clean dry area; they should not be used for any other purpose and should be returned at the time of the next delivery.
2. Caterers should be careful not to overstock, so that all food can be used within its shelf life.
3. Meals should be planned well in advance, which will assist in correct stock rotation.
4. All food must be used in strict rotation; packs should therefore be properly date-marked or coded with the date of production.
5. Meals that are to be frozen should be transferred to a deep freeze without delay.
6. Any foods whose temperature has risen to \(-10^\circ\text{C} (14^\circ\text{F})\) or above during storage should not be used until bacteriological and phy-
sical examination shows them to be satisfactory. Discs indicating temperature change can be helpful in this respect.

(7) For storage of up to 3 months, food should be kept at temperatures ranging between \(-18^\circ C (0^\circ F)\) and \(-23^\circ C (\sim -9^\circ F)\).

(8) When food is to be regenerated, frozen packs should be put straight into a convection oven or steamer after removal from the deep freeze.

(9) The number of meals placed in ovens should not cover an entire meal period but should be staggered to meet anticipated demand.

(10) Meals should be served as quickly as possible after the reheating cycle is completed.

(11) It must be realized that, once regenerated, frozen foods will deteriorate at the same rate as freshly cooked foods (or sometimes at an even faster rate).

(12) Any food prepared in excess of consumer requirements must not be reheated more than once.

**Flight catering kitchens or in-flight catering premises**

Flight catering should always be carried out quite separately and in a different building from ground catering, unless by structural arrangements effective separation can be achieved in one building. Aircraft meals are supplied by kitchens that are:

1. under the direct control of the airline; or
2. staffed and controlled by a catering concessionaire but permanently supervised by the airline; or
3. owned by a catering concessionaire and only partially supervised by the airline.

Category (1) is the most desirable arrangement but is not always feasible. Category (3) is not to be recommended except in instances where the food uplift is small and no other system is practicable.

Airlines, in addition to health administrations, have a duty to inspect and collect food samples for bacteriological and other examinations.

Quite frequently an airline finds itself in the position of having no choice in the selection of premises from which food can be uplifted—for instance, when a particular caterer holds a monopoly. This is a very unsatisfactory arrangement, and one that can easily result in poor hygienic standards. When an alternative caterer is available the competition provides an incentive to improve.

**Hotel restaurants**

Hotels in which crews and passengers are accommodated are another important source of food supplies, which should not be overlooked. It is pointless to demand high standards of food hygiene at airports and in flight catering, if contaminated food is eaten at hotels. In fact, a difficulty in investigating alleged foodborne illness occurring in flight or af-
ter arrival is to decide from which source the food was supplied. The standards of hygiene described in this chapter therefore apply equally to airport, flight and hotel catering.

**Vending machines**

Automatic coin-operated machines are being increasingly used for the sale and distribution of food and drink at airports.

Food sold in the machines should be prepared in premises that comply with the standards of hygiene prescribed in this Guide. The machines should be so designed and constructed that they are easy to clean and surfaces with which food is in direct contact are kept to a minimum. At all events, these surfaces should be made from materials that will have no harmful effects on the food (24). Vending machines should be sited in hygienic surroundings, and it should be possible to clean behind and underneath them. They should be kept at the correct temperature for the type of produce being sold. There should be adequate and efficient stock rotation based on the shelf life of the goods.

Personnel engaged in servicing the machines must conform to the standards of medical fitness and competence required of all food handlers.

Every machine should carry precise instructions for cleaning and sterilizing procedures, all of which should be followed. The frequency of cleaning will depend on the type of goods sold, but drink-vending machines should be cleaned at least once daily, and those selling foods, at least once every 48 hours and, in addition, on every occasion that the stock is replaced. The use of a detergent/sterilizing agent is recommended. A fresh solution should be mixed for each machine. Cleaning consists mainly of swabbing all surfaces with a cloth impregnated with this agent and using clean mains water (Fig. 2). A record card covering the last 7 days of operation should be kept in each machine and the date of each cleaning recorded.

Samples of food should be taken at intervals to check bacteriological quality. The frequency of sampling will depend on the type of food being sold.

### 4.4 Food premises: structural and other requirements

Premises where food or beverages are stored, prepared or served should be roomy enough to avoid congestion and allow for possible expansion of operations; they should be constructed in such a manner and of such materials that they can be kept scrupulously clean and provide protection against the ingress and harbourage of rodents and insects. Provision should be made for adequate lighting and ventilation, both natural and artificial, an adequate supply of potable water and drainage facilities.

Flight catering premises should be sited at airports or in their vicinity and as near as possible to the aircraft departure parking area.
Construction

The structure should be of brick, concrete, or some other substantial material. The building should be designed to permit easy and adequate cleaning, and kept in good repair. Partitions within the structure should be kept to a minimum in order to facilitate the use of mechanical cleaning equipment.

Floors

Floors must be even, impervious, without cracks or open joints, smooth (but not slippery), hard wearing and easy to clean. Cleaning is facilitated if junctions with walls are coved. Floors should slope evenly towards drainage outlets, a sufficient gradient being 2.5 cm in 3 m (1 inch in 10 feet). All drainage outlets should be trapped. Suitable materials for floors are terrazzo, quarry tiles or granolithic chips bedded in concrete. Light colours are recommended. They look attractive, reflect light and show up dirt.
Walls

Walls should be light coloured and made of a substantial, durable, smooth, impervious and washable material. They should be free from ledges or projections, which collect dust, and be tiled, preferably from floor to ceiling, but if this is not possible then to a minimum height of 1.5 m (5 ft) from the ground and coved at the top. Surfaces that are not tiled must be finished in plaster and painted (preferably in a washable mat finish). Gloss paint may be used in dry goods storerooms. The parts of walls surrounding sinks should be tiled.

Ceilings

The ceiling must not harbour dirt; it should be easy to clean and—most important—should absorb moisture. The most suitable ceiling is an underdrawn, plastered ceiling with a smooth continuous lower surface unbroken by beams. Junctions with walls should be coved. The ceilings of kitchens should be insulated. They can then be finished with a hard gloss paint. Paint must not be used on a ceiling that is not insulated. In this case an absorbent colour wash is recommended.

Joinery

All internal joinery should be of simple design. Joints should as far as possible be tight and flush-fitting. The woodwork surrounding doors, windows and other openings should be fixed to the internal wall surfaces so as to avoid open joints. All internal joinery work—which should be kept to a minimum—should be finished with a hard gloss surface.

Doors

Doors should be flush-fitting without panels or ledges. They should open outwards and be self-closing. The bottoms of doors should be protected on both sides with metal kicking-plates.

Windows

Windows should be so sited as to facilitate cleaning on both sides, and panes should be large rather than small. Internal window sills should be splayed at an angle to prevent their use as shelves.

Ventilation

Adequate ventilation is essential. A current of air sufficient to keep the room cool and remove the fumes and steam is required. Complete air conditioning is recommended wherever possible. Natural ventilation
may be sufficient only in certain kinds of weather, and artificial ventilation should therefore be available to supplement or replace it when necessary.

All cooking apparatus (e.g., steamers, fryers, grills, and ovens) should be fitted with hoods and extraction units to draw off fumes, steam and heat. These hoods should be constructed in such a way that they are easy to clean.

Wherever possible, ventilation ducts should be fitted flush with walls or ceiling; if this requirement cannot be met sufficient space should be left between the ducts and the wall to allow for all-round cleaning. Duct inlets should be insect-proof. Inlet screens should be removable for cleaning.

**Lighting**

All parts of the premises must be adequately lit so that there are no dark passages and corners. The window area should equal at least one-fifth of the floor area. Artificial lights should be so placed that both glare and shadow are avoided. A number of small points produce less glare than one large point.

There should be lights over food preparation tables, sinks, and all other kitchen working areas. Fluorescent lighting is recommended. Illumination should reach 200-400 lux for normal work and 400-600 lux for operations requiring closer examination—e.g., food preparation. In addition, it is important that the lighting over the whole area should be reasonably uniform, and it is recommended that the diversity ratio of minimum to maximum illumination should not be less than 0.7.⁶

**Protection against insects and rodents**

All windows, doors and other openings should be insect-proofed with material having at least 6 meshes per cm (16 meshes per inch). Plastic insect-proof screening is recommended. Kitchen entrances should have self-closing double doors opening outwards. All buildings should be rodent-proof.

Regular inspection and disinsecting should be practised to prevent the contamination of foodstuffs by flies, cockroaches, ants and other insects. Disinsecting may be carried out by spraying, fumigation, the treatment of walls with insecticidal paint, the use of repellent dispensers, or the use of electrically operated equipment that emits ultraviolet rays, thereby attracting insects, which are then killed by contact with an electrified grille.

All rodenticides, fumigants, insecticides or other toxic substances should be stored in locked cabinets and handled only by authorized persons to prevent the possibility of food contamination.

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Exclusion of domestic animals

Dogs, cats and other domestic animals should be excluded from all parts of the food premises.

Water supply

Adequate supplies of both hot and cold running water are essential. All water used in food preparation premises should be potable. As it is inadvisable to provide hot water for general purposes throughout the premises at temperatures above 60 °C (140 °F), provision must be made for the temperature to be raised to 82 °C (180 °F) for the sanitization of dishes and utensils.

Dish washing

Mechanical dish washing is recommended to enable the correct temperature of 82 °C (180 °F) to be achieved. Where dish washing is carried out by hand, two sinks, or preferably three, should be provided.

Sinks and draining boards should have a smooth, hard, even surface and be constructed of porcelain-finished fire clay, stainless steel, vitreous enamel or plastic. Wooden sinks and draining boards should not be used.

Pan washing

When pan washing is done manually, at least two, or preferably three, sinks of large capacity are required. The size of each should be at least 75 cm × 60 cm × 60 cm (30 in × 24 in × 24 in). Grease traps should be fitted to the drain taking the waste from the sinks. Alternatively, completely automatic washing machines may be used for the cleansing and sanitization of pots, pans, large baking utensils, etc. Several designs are available, but each type should provide for washing with a detergent solution at 60-70 °C (140-160 °F) and a rinse with clean hot water at 82 °C (180 °F).

Working surfaces

Surfaces should be impervious to liquids, smooth and easily cleaned. Those with which food comes into contact should be made of a material that is nontoxic and is not itself affected by such contact. Stainless steel, marble or laminated plastics are suitable materials. The bottom shelves of tables must be at least 15 cm (6 in) above the floor, to permit easy cleaning.

These furnishings should be of simple design and free from crevices, cracks and corners in which dust can collect. They should be mobile for easy cleaning and capable of withstanding repeated cleaning by normal methods.
Cupboards

Cupboards should be metal and simple in design. If the sides fit tight to the wall there should be no back. Otherwise they must be mobile so that the backs can be easily cleaned. The whole interior must be accessible for cleaning. Shelves should be removable for regular cleaning.

Cooking apparatus

Cooking apparatus should be located in the centre of the kitchen, with access all round. Supply and waste pipes, etc., must be so placed as to facilitate cleaning. The lagging of hot-water pipes should only be coated with substances that set hard and are not affected by temperature changes.

Refrigerators, cold-rooms, etc.

Refrigerators and cold-rooms should be as far away as practicable from sources of heat. The internal surface should be smooth, impervious and easy to clean. Each cold-room must have a readily visible means of reading the internal temperature and a warning device to prevent the door from being left open. A sealed trapped gulley should be provided to drain away liquid during defrosting. All racks should be removable and easy to clean. Internal surfaces and racks should be made of metal.

The temperature of refrigerators and cold-rooms should not exceed 4°C (40°F). Thermometers should be sited in the warmest zone of the refrigerated area. The temperature of deep freezers should not be above −18°C (0°F). For long-term storage (i.e., for periods of more than 3 months) the temperature should be between −26°C and −29°C (−15°F and −20°F).

Food storage

All food stores should be dry, well lit, well ventilated, vermin-proof and clean, and situated away from sources of heat, both natural and artificial. All racks and shelves should be easily removable for cleaning operations. The bottom shelf must be at least 15 cm (6 in) from the floor to allow air circulation. If the shelf is fixed and wider than 30 cm (12 in), it may need to be higher to permit cleaning. No foodstuffs must be stored directly on the floor, even if they are in boxes or cartons.

Drainage

Drainage should be sufficient to remove all waste water without the use of floor channelling. If channelling is unavoidable, it should be uncovered, constructed in glazed earthenware and self-cleaning. All drains must be large enough to carry peak loads. They should be adequately
trapped and ventilated. The drainage system should be so constructed as to allow no risk of the contamination of potable water supplies by liquid wastes. Drainage and disposal must conform to local and national bylaws and building regulations.

Garbage storage

Waste should be kept in covered bins or disposable paper or plastic sacks provided with a foot-operated hinged lid. Full bins or sacks should be removed from the kitchen promptly and their contents suitably disposed of. Bins must be covered at all times. If waste food is to be used for animal feed, it should be stored separately from garbage.

Provision must be made for the washing and disinfection of used garbage bins. Garbage bins should never be washed or stored in the vicinity of aircraft containers used for human excreta, since, when in use, they are placed near or inside food preparation areas and may be handled by catering staff.

Staff cloakrooms

Staff cloakrooms should provide, separately for each sex, toilets and wash-hand-basins, individual lockers for clothes and changing rooms with showers. The toilet areas should be well lit and ventilated and not open directly on to a food area. Kitchen staff should only be able to enter the food premises after passing through the changing rooms and wash rooms.

There should be 1 wash-hand-basin for every 10 persons, each basin being provided with hot and cold water, soap, nail brush and disposable towels. There should be 1 toilet for every 20 persons if the number of staff does not exceed 100, and 1 for every 25 persons if more than 100 are employed. For male workers the proportion of toilets may be slightly reduced if an adequate number of urinals are also available. Toilets for women staff should be provided with a satisfactory means for the disposal of sanitary towels. Notices must be fixed in conspicuous positions in all cloakrooms requesting persons to wash their hands after using the toilet. There should be at least 1 shower for every 75 persons, but in hot countries the proportion of showers should be increased.

In addition to facilities in cloakrooms, there must be an adequate number of wash-hand-basins conveniently located throughout the premises. At least one should be available in each section—e.g., in the bakery, cold kitchen, and meat preparation area. They should also be provided with hot and cold water, soap, nail brushes, and towels (preferably of the single-use disposable type). Liquid soap should be supplied from a metal or polyvinyl chloride dispenser, conveniently sited, vandal-proof, easy to clean, and delivering the correct quantity for adequate washing. Pedal-operated spray taps are an added precaution to prevent cross-contamination (Fig. 3).

Sinks in kitchen areas should not be used for washing hands.
4.5 Food handlers

Persons who either are suffering from a disease capable of being transmitted by food or water or are carriers of such a disease should not be employed in food preparation or food handling.

Food handlers should be kept under regular surveillance. Staff who have infected wounds or sores or are suffering from gastrointestinal illness or any other condition likely to cause the contamination of food or food contact surfaces, or who have been in contact with a person suffering from a food- or waterborne disease, should report immediately to the management; they should be excluded from food handling until given medical clearance to return to work.

All persons applying for jobs as food handlers should undergo a pre-recruitment medical examination and a professional assessment should be made of their clinical history. Only those who are free from infection and are proved not to be carriers should be engaged. While this will ensure that at the time of recruitment the food handler is healthy,
it is important to impress on employees their obligation to report any of the above-mentioned conditions should they occur during employment.

Training

All food handlers should receive training in food hygiene. Such training should be given by specialist officers employed by airlines, or by officers of the health authority, or by both. Lectures, supplemented by films and visual aids, should be arranged to suit the various grades and duties of the personnel.

Part of the catering labour force is by no means permanent, being composed of casual or seasonal workers. Thus, although all food handlers should receive instruction, more detailed and comprehensive training should be given to those in the supervisory grade, who are more permanent and therefore more likely to ensure that the principles imparted are put into practice.

Responsibility for food hygiene rests with top management. Without their full commitment to high standards of hygiene and cleanliness, very little will be achieved. Their policy must be made clear to all staff so that their instructions are implemented. Power can be delegated to catering managers, who should set an example to their staff, see that all regulations concerning the preparation and handling of foods are observed, and arrange for the further training of personnel in food hygiene and for refresher courses.

In order to enable a catering manager to fulfil his responsibilities, it is obvious that he himself will need training in food hygiene. A recently published guide on such training (26) outlines the distribution of responsibility according to job category, as follows:

1. Top management—responsible for establishing policies, practices and methods, and communicating these to the rest of the staff.
2. Lower management—responsible for implementing and maintaining policies and practices.
3. Food handlers—responsible for executing policies and practices in line with the standards set and using the prescribed methods.

The training of top management should embrace the study of hygiene as it pertains to catering premises, the general environment, plant, machinery and equipment, food ingredients, packaging and storage; staff health requirements and personal hygiene; personnel training; and the requisite standards and procedures for the preparation, handling, storage and transport of meals.

Lower management personnel and supervisor training should cover a similar syllabus but in less depth, concentrating more on the practical aspects. It should include such items as legal regulations, familiarity with the materials used in construction, knowledge of cross-contamination risks, methods of personnel training, knowledge of cleaning materials and equipment, and appreciation of hygiene factors in equipment construction.
All food handlers should receive basic instruction in hygiene in its application to the work they do, company regulations and procedures, health requirements, use of equipment, use of protective clothing, code of practice in handling food, reporting of sickness, personal hygiene, and general hygiene standards in working areas.

Those staff responsible for particular duties should receive additional instruction. For example, storekeepers must be taught about the practice and value of stock rotation and temperature control; cleaners should be taught correct practices for storing cleaning materials, techniques of using equipment and materials, the reasons for strict adherence to cleaning schedules, and the correct way to report faults; chefs, sous-chefs and chefs de parti, in addition to basic training, should learn the rudiments of bacteriology and how to prevent contamination.

Several short lectures, each of 30-45 minutes’ duration (including question time), or a series of short films, are much more effective than fewer and longer sessions, and more likely to have the blessing of management.

The above is but a brief outline of the sort of training needed; the content can be expanded or varied to suit particular needs. The important factor is to ensure that all those who can promote clean food practices receive basic training in food hygiene as part of their induction into the catering industry.

FIG. 4. MACHINE-WASHING OF LETTUCE. NOTE OPERATOR ADDING CORRECT QUANTITY OF SODIUM HYPOCHLORITE.
4.6 Food preparation

Raw materials should be washed to remove soil or other contaminants. Green salads should be soaked for 5 minutes in a 50 mg/l solution of sodium hypochlorite, and then thoroughly rinsed in running potable water. This is of particular importance when the produce concerned has been grown in countries where human excreta is used as fertilizer. The vegetables may be washed in an ordinary vegetable sink if the more sophisticated equipment illustrated in Fig. 4 is not available.

Meals should be prepared as near as possible to the time of consumption, unless they are to be deep frozen. However, except in very small units preparing food for one service at a time, flight meals have to be ready several hours before departure time. Special precautions must therefore be taken. In order to prevent the introduction of pathogenic organisms, or the proliferation of those already present, temperature control is vital (Fig. 5). After foodstuffs are removed from storage, they should be prepared and cooked as soon as possible. It is important that

FIG. 5. GROWTH OF BACTERIA IN RELATION TO FOOD HANDLING AND PROCESSING AND TEMPERATURE

Adapted from: North Carolina State Board of Health. School food service sanitation (27).
frozen raw foods—particularly poultry and seafood—must be completely thawed before cooking to ensure adequate heat penetration and the destruction of any pathogenic organisms present. Immediately after cooking, the food should be placed in the meal trays. For hot meals on short-haul operations, the trays should be put into hot ovens so that the temperature of the food never falls below 63 °C (145 °F). (It would be preferable if a temperature of 74 °C (165 °F) could be attained.) This applies when the aircraft departure is not more than, say 1 hour later. For later departures the meals, after having been cooled quickly (see page 51 with reference to cooling cupboards), should be placed in a cold-room in which the temperature is not more than 4 °C (40 °F). Here the food should remain until it is time to load the aircraft. It should then be placed in electric aircraft ovens already heated to above 85 °C (185 °F) (Fig. 6).

There is a potential risk in this type of aircraft meal, since if the food remains in the oven at 85 °C (185 °F) for too long it will become overcooked, dry and less palatable. The temptation therefore arises to switch off the ovens to prevent overcooking, with a consequent fall in temperature. Subsequent reheating, during which the temperature rises slowly, will cause a multiplication of staphylococci producing a thermos-stable toxin, if these organisms are already present in the food.

This problem arises because the type of oven on some short-haul aircraft is capable only of retaining meals at a given temperature—e.g., 85 °C (185 °F)—and will not reheat a meal from a chilled state to that temperature in less than approximately 2½ hours. As meals are often
served 15-30 minutes after departure, they must be placed in preheated ovens in flight catering.

For long-haul operations both hot and cold meals must be placed in a cold-room at 4 °C (40 °F) and remain there until required. Food is constantly being moved into and out of these cold-rooms, and there is a likelihood of the temperature rising because the doors are frequently opened. To counteract this, entrances should be protected by the installation of a cold-air curtain (Fig. 7), or double-door entrance, the former being preferable. Food should not be held longer than 24 hours in cold-rooms.

Meals should be transported at 4 °C (40 °F) to the aircraft. This temperature can be maintained by placing the trays in modules and surrounding them with dry ice. Meals that are to be served hot are transferred into ovens on the aircraft for rapid reheating. Aboard aircraft, cold meals should be held at temperatures below 10 °C (50 °F) and hot meals at temperatures above 63 °C (145 °F). If meals that are to be served hot are not to be heated shortly after take off, they must be kept at a temperature below 10 °C (50 °F) until they are placed in ovens.

FIG. 7. MEALS BEING TAKEN INTO COLD-ROOM (MAXIMUM TEMPERATURE: 4 °C (40 °F)). NOTE COLD-AIR CURTAIN OVER ENTRANCE.
Meals that are to be supplied in a frozen state either to the aircraft or in bulk to outstations should, as soon as possible after cooking and dishing, be stored in a deep freeze at a temperature not exceeding \(-18\, ^\circ\mathrm{C}\) (\(0\, ^\circ\mathrm{F}\)). Food for long-term storage should be kept at temperatures ranging between \(-26\, ^\circ\mathrm{C}\) and \(-29\, ^\circ\mathrm{C}\) (\(-15\, ^\circ\mathrm{F}\) and \(-20\, ^\circ\mathrm{F}\)).

**Cross-infection**

A potential hazard is the possible transference of bacteria from raw foods to cooked foods either by human contact or by contact with equipment.

Raw foods should preferably be handled by different personnel in a separate section and with different equipment from that used for cooked foods. If this is not possible, after raw food has been handled, the operative’s hands, and all knives, cutting boards, slicing machines, work surfaces and utensils and equipment must be washed and sterilized before contact is made with cooked foods.

### 4.7 Prevention of contamination

**Hands**

Hands are the most common medium by which pathogenic organisms are transferred to food from the skin, nose, bowel, etc., as well as from other foods. They should therefore be kept scrupulously clean, and be thoroughly washed not only every time after the toilet is used and after raw food (especially meat and poultry) is handled, but frequently throughout the day. It has been shown that the use of an efficient and approved bactericidal soap helps to reduce the number of pathogenic organisms on the hands (28, 29). Fingernails should be kept short and clean.

The handling of food, particularly cooked food, must be kept to a minimum and whenever possible tongs, spoons or forks should be used (Fig. 8), or the hands covered by disposable gloves (Fig. 9). Some handling of food is, however, inevitable, which again emphasizes the need for frequent hand washing. It is a worthwhile practice to swab food handlers’ fingers to check for organisms causing food poisoning in order to assess whether the hand-washing routine or other procedures can be improved.

Any cuts, septic conditions or abrasions on the hands should be appropriately treated and protected with a waterproof dressing. First-aid facilities should be provided to meet these contingencies. Food handlers should be forbidden to spit and to use tobacco in any form while in food premises. They should endeavour not to cough or sneeze in the vicinity of uncovered food.

No personal outer clothing and articles should be taken into food areas; they should be stored in the locker rooms provided. Food sto-
FIG. 8. FOOD HANDLERS USING TONGS, SPOONS, ETC., IN FLIGHT CATERING

FIG. 9. FOOD HANDLERS WEARING DISPOSABLE GLOVES IN FLIGHT CATERING
rage, preparation, and handling areas should not be used as changing rooms or sleeping quarters. Protective clothing, including suitable head gear (e.g., hair net or cap), must always be worn in food premises, and the clothing kept clean.

Equipment

All working surfaces should be kept clean. This includes not only tables, but articles such as slicing machines, cutting boards, pastry mixers, utensils of all kinds, crockery and cutlery—in fact anything with which food comes into contact. Equipment and utensils should be so designed as to prevent the accumulation of dirt and to permit easy and thorough cleaning. Wherever possible, equipment should be mobile so that it can be moved during cleaning operations (Fig. 10). Any equipment used for the storage of inedible or contaminating materials should be suitably identified so that it will not be used for storing edible products.

The use of disposable piping bags, gloves and head covers is recommended. Cutting boards and butchers’ blocks made from a synthetic
rubber compound (Fig. 11) are preferable to those made from wood, which often splits, thus providing an excellent bacterial breeding ground or causing splinters to penetrate the food.

Fixed equipment and fittings should be positioned in such a way that either there are no gaps which could harbour dirt or insects or every part is accessible for cleaning purposes (Fig. 12). Service pipes to equipment should either be enclosed in accessible columns or voids or be at least 15 cm (6 in) above ground level to enable the floor to be cleaned.

Most flight catering premises operate 24 hours a day 7 days a week. Equipment is often in continual use, and cleaning becomes a practical problem, particularly in the case of such items as ovens and grills. Another problem is created by congestion, because demand has in many instances outstripped production capacity. In such cases either a rota system must be introduced whereby equipment can be taken out of operation for cleaning, or duplicate equipment must be installed.

In countries where flies present a problem, all openings from catering premises to the external air should be screened with gauze, preferably nylon, with 6 meshes per cm (16 per in). Doors should be screened and self-closing. Cold-air curtains can be used at entrances instead of screens. However, insects may still get into buildings, so regular inspection and treatment are necessary. For flying insects electric exterminators, mentioned earlier, are very effective and have the advantage of retaining the dead insects in a tray. They do, however, attract flying insects and should be positioned near entrances. Another piece of automatic equipment, which dispenses an approved insecticide at

FIG. 11. BUTCHER'S BLOCK MADE FROM SYNTHETIC RUBBER COMPOUND (NON-SPLITTING)
regular intervals, has the advantage of repelling rather than attracting insects and can therefore be located inside the premises.

It is essential to institute some effective method of rodent control. This is best carried out by an expert pest control contractor, who must, however, be given a specification and schedule by which to operate.

4.8 Cleansing and sanitization of dishes and utensils

The cleansing and sanitization of nondisposable dishes and utensils in flight kitchens and airport restaurant and snack bar kitchens should be carried out, whether manually or mechanically, on a routine basis. If the water is naturally hard, it is both economical and advisable to install a water softener, particularly for mechanical dish washing, to prevent the furring of jet nozzles.

Washing by hand

For manual cleansing and sanitization of dishes and utensils preferably three large stainless steel or galvanized sinks, large enough to hold the biggest item, should be used. Only in very small establishments are
all utensils and dishes washed by hand. In larger establishments manual cleansing and sanitation are usually confined to cooking pots and pans, while items such as crockery, glasses, trays, and containers are cleansed and sanitized by machine.

The hot water supply should be abundant and delivered at approximately 60°C (140°F), so that a temperature of approximately 50°C (120°F) is available for the cleansing of dishes and utensils by hand.

Prior to cleansing, waste food from dishes and utensils should be scraped into covered waste receptacles. The dishes and utensils should then be soaked, scraped and pre-rinsed in the first sink, in order to remove remaining scraps of food, grease and other deposits. Soaking should be carried out at a temperature of approximately 45°C (115°F). A recommended concentration of an efficient detergent should be added to the water to emulsify fats.

Dishes and utensils should then be thoroughly cleansed in the second sink in water maintained at a temperature of approximately 50°C (120°F) (higher water temperatures may scald the operative’s hands). The water, which should be changed frequently, should contain an efficient detergent added at a concentration that should be suited to the mineral content of the water. Dishes and utensils should then be placed in long-handled wire baskets (required to prevent the scalding of the operative’s hands) for immersion, in the third sink, in clean hot water at a temperature of 82°C (180°F) for at least 2 minutes to ensure sanitization and to remove detergent residues. The dishes and utensils should then be removed and left to dry in the wire baskets. Drying towels are not necessary and should not be used, since when they become soiled they may spread contaminating materials to other dishes and utensils.

An alternative method is to use an efficient combined detergent/germicide for washing and partial disinfection, followed by rinsing and hot-water sanitization. The product is usually in such a concentrated form that it should be added by an automatic dispenser to ensure correct dilution. Use of excessive quantities of detergent is not only wasteful but may also irritate the operative’s skin. An efficient detergent/germicide should:

1. be safe to use;
2. be immediately and completely soluble in hard or soft water;
3. be unaffected by alkalinity, acidity or organic matter;
4. be chemically neutral;
5. prevent deposits of mineral matter in hard water; and
6. leave no residue after rinsing and draining.

Mechanical washing

With the exception of the pan wash (previously described), in larger establishments all items should be washed by machine.

There are many sophisticated machines available, but most operate in a similar manner (Fig. 13). Utensils are fed through the machine on
a moving belt. The first section is the wash tank, in which the temperature of the water should be 60 °C (140 °F). At a higher temperature food debris will tend to adhere to the utensil. Only a detergent of low spumescence should be added to this tank—usually by an automatic dispenser. The next tank is the rinse tank, in which water at a temperature of 82 °C (180 °F) is sprayed through fine-nozzle jets.

The addition of chlorine to remove stains—except in a concentration of less than 40 mg/l—is not recommended. It is unnecessary and may damage metal components and cutlery.

Machines should preferably have a third section—a hot-air drying chamber, operating at approximately 100 °C (212 °F). Utensils are dry on exit from the machine or within a few seconds. To help the drying process and to prevent water spots, a spirit-based rinse aid is added—usually by automatic means—to the rinsing water. The machine should be provided with temperature-indicating dials in all sections.

Water for dish-washing machines should, if necessary, be softened, since hard water will leave a deposit that causes a blockage of the jets. Dish-washing machines require regular maintenance by skilled personnel. Jet arms should be dismantled and cleaned daily.

All dishes, glasses and other articles should be inspected after washing. Any item that has not been satisfactorily cleaned should be reject-
ed. (The proportion of rejects may be as high as 25%). These items should be placed in a special soaking tank containing hot water and a detergent with chlorine added at a concentration of approximately 40 mg/l. After soaking, the utensils should pass once again through the dish-washing machine. Unsatisfactory washing may result if the machines used are faulty or badly maintained, if the type of material of which the dishes or utensils are made is unsuitable, or if their shape encourages the retention of debris in corners, etc.

Food containers and waste containers should also be washed by machine (Fig. 14), but at different times.

Cleansing of equipment

Fixed equipment, food preparation tables, shelves, etc., are washed by hand. The same detergent/germicide can be used, mixed with hot water and applied either by brush, where soiling is excessive, or by swabbing. For the latter procedure, strong-textured paper is recommended, which can be discarded after each piece of equipment is
cleaned. Fresh paper can then be used to dry and polish the cleaned surface.

All pieces of equipment that come into direct contact with food must be cleaned at least at the end of each working period, and also when the opportunity arises during break periods. All food-slicing machines should be thoroughly degreased and cleaned at the end of each working period with the use of a detergent/germicide. It may be necessary to degrease and clean cutting blades during working periods. All other surfaces should be cleaned at least once daily, and more frequently if necessary.

Mobile items such as trolleys should be removed to a cleaning bay for washing either by hand, or with mechanical equipment using steam or high-pressure hot water containing detergent. Trolleys should be washed in this way at least once a week, and at all other times kept clean by wiping.

Heavy equipment such as cooking stoves, fryers, grills, and griddles will need carbon removers and heavy duty detergents. They should be washed daily and deep-cleaned once a week. Machinery that can be dismantled should be taken apart and washed daily.

**Beverage flasks**

Beverage flasks are specifically provided for tea, coffee, soup, and fruit juices; occasionally they are filled with hot water for tea- or coffee-making, and some airlines use them as containers for drinking-water. After each flight, they should be subjected to a rigidly enforced cleaning and sterilizing procedure, of which the following is an example:

1. Empty contents.
2. Wash the flask, lid and gasket in an approved detergent/germicidal solution.
3. Rinse with clean hot water.
4. Dismantle the tap, clean and scour, using the solution described in (5), and replace the tap.
5. Fill the flask with water to which has been added 1 teaspoonful (5 ml) of 10% strength sodium hypochlorite.
6. Immerse the gasket in the solution.
7. Leave the solution in the flask for 15 minutes.
8. Rinse the lid with some of the solution and drain the rest through the tap.
9. After the lid has been disinfected, it must not be allowed to come into contact with anything before it is replaced.
10. Replace the gasket and lid.
11. Cover the tap with polyethylene fastened by a rubber band.
12. Place over the lid a strip of adhesive stamped “disinfected—tested”.
13. Leave the container empty until required.
14. Store the disinfected containers on shelves.
(15) Just before use, rinse with potable water to avoid a chlorinous taste permeating the beverage. Care is required to prevent recontamination.

As many airlines use the same type of flask, unofficial interchange is quite common. Because of this it is imperative that all airline caterers adopt a satisfactory method of cleaning and disinfecting.

One reason given for the use of beverage flasks to carry water for tea- or coffee-making is that some aircraft have insufficient water-boiling facilities to make tea and coffee simultaneously when carrying a full load of passengers, who have to be offered a choice of these beverages. The use of beverage flasks for carrying water should be discouraged.

4.9 Premises cleaning

To ensure effective cleaning, walls, floors, doors, windows, ceilings and all other parts of the structure must be kept in a good state of repair.

One person—preferably someone who is not involved in food production and can therefore be objective about priorities—should be made responsible for the cleanliness of the premises.

Cleaning may be carried out by persons employed directly by the airport authority, by contractual labour, or by a combination of the two types of worker. This last arrangement is the most common: usually floors, the lower parts of walls, and equipment are cleaned by airport employees, and all the high-level surfaces, windows, ventilation apparatus, trunking and extraction hoods, etc., by contractual cleaners.

An elementary but often overlooked requirement in catering establishments is a storeroom for cleaning equipment and materials. The storeroom should be conveniently sited and have a hot and cold water supply and a large sluice sink.

The cleaning of premises should be carefully planned so that every part is dealt with according to a schedule. The cleaners should be fully instructed in the use of cleaning tools and materials and in the dismantling of equipment; they should also be made aware of the hazards. Too often cleaners receive little or no training and therefore do their work in a perfunctory manner.

In a recent publication (30) it is pointed out that cleaning standards deteriorate if the cleaning apparatus and equipment themselves are not kept in a hygienic condition. This is a factor that is often overlooked. Equipment (such as mops and brushes) that is to be used repeatedly should be strong enough to withstand constant cleaning after use. Apparatus used for wet cleaning is likely to become heavily contaminated with bacteria unless it is disinfected by heat or chemicals. Normal washing will not remove all bacteria, and the organisms that remain may multiply. Next time the equipment is used, instead of removing bacteria from soiled surfaces, it will increase the bacterial load. The most
effective treatment for wet-cleaning apparatus is heat disinfection combined with laundering.

As previously mentioned, food preparation premises at airports operate on the basis of a 7-day week, so the cleaning schedule should be arranged accordingly. The following schedule is given only as an example; it may need to be varied to suit local circumstances.

<table>
<thead>
<tr>
<th>Location and task</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Locker rooms, restrooms, staff dining rooms:</strong></td>
<td></td>
</tr>
<tr>
<td>Clean tops of lockers; remove litter</td>
<td>Daily</td>
</tr>
<tr>
<td>Wipe clean tables, chairs and cupboards</td>
<td>Twice daily</td>
</tr>
<tr>
<td>Sweep and wash floors; remove litter</td>
<td>Twice daily</td>
</tr>
<tr>
<td>Move lockers, scrub floors, wipe clean all surfaces of lockers</td>
<td>Weekly</td>
</tr>
<tr>
<td>Wipe down walls and doors; clean windows and light fittings</td>
<td>Weekly</td>
</tr>
<tr>
<td><strong>Loading and unloading bays, swill area, refuse area:</strong></td>
<td></td>
</tr>
<tr>
<td>Sweep all areas; clear rubbish and remove to garbage store</td>
<td>Twice daily</td>
</tr>
<tr>
<td>Hose down outside areas, swill area and garbage store</td>
<td>Twice daily</td>
</tr>
<tr>
<td>Clean any offload conveyors</td>
<td>Daily</td>
</tr>
<tr>
<td>Wash walls, fittings and lights</td>
<td>Weekly</td>
</tr>
<tr>
<td><strong>Goods reception areas, staff entrances:</strong></td>
<td></td>
</tr>
<tr>
<td>Sweep and scrub floors</td>
<td>Twice daily</td>
</tr>
<tr>
<td>Remove litter</td>
<td>Twice daily</td>
</tr>
<tr>
<td>Wash walls, doors, light fittings and windows</td>
<td>Weekly</td>
</tr>
<tr>
<td><strong>Dish-washing section, equipment, laundry, all stores, passages, common-use areas:</strong></td>
<td></td>
</tr>
<tr>
<td>Sweep and wash floors (including the area underneath conveyors)</td>
<td>Twice daily</td>
</tr>
<tr>
<td>Remove rubbish</td>
<td>Twice daily</td>
</tr>
<tr>
<td>Wash and wipe clean all fixed equipment and machines, table tops, sinks, low level pipes, etc.</td>
<td>Daily</td>
</tr>
<tr>
<td>Wipe clean all walls, doors, etc.</td>
<td>Weekly</td>
</tr>
<tr>
<td>Clean all windows and light fittings</td>
<td>Monthly</td>
</tr>
</tbody>
</table>
Food preparation areas, kitchens, tray preparation, etc.

Sweep and wash all floors: remove rubbish . . . . Twice daily
Wash all food equipment, tables and working surfaces, Daily (some food equipment should be
including legs and undersides, sinks, cupboards, waste cleaned at the end of each shift)
stands, low level pipes, and trolleys . . . . . . .
Degrease and wash the inside and outside of extraction Weekly
hoods, ovens, fryers, griddles, grills, etc. . . . .
Wash the outside of boiling-tanks, proofers, steamers, Weekly
etc. . . . . . . . . . . . . . . . . . . . . . . .
Clean and degrease inside rising ducts, fan chambers, Monthly
etc. . . . . . . . . . . . . . . . . . . . . . .
Wash walls and doors Weekly
Wash windows and light fittings Monthly

Entire premises:

Wash down all high-level areas, ceilings, trunkings, 4-6 times annually
etc. . . . . . . . . . . . . . . . . . . . . . . according to need.

In addition to the above operations, kitchen cleaners must regularly remove waste food containers and litter, mop up any spillages, and keep all areas tidy between official cleaning times.

4.10 Food storage and transport

The proper storage of food at all stages from the arrival of raw materials to the departure of completed meals is most important, calling for constant and systematic care by management and staff. A recommended rule for storing food is: keep the quantity to an acceptable minimum, keep it clean, keep it cool, keep it covered.

Keeping stocks to a minimum reduces the length of storage time and the risk of deterioration. In all cases, however, stocks should be regularly inspected and a proper rotation system installed. Access to food storerooms must be restricted and subject to control.

The only food kept in food preparation areas should be that needed during the day. Everything else should remain in the storeroom.
Storerooms for nonperishable foods

The rooms should be clean, dry, well lit and ventilated, and vermin-proof. Ideally, the temperature should not exceed 16 °C (60 °F), so that, in many countries, some form of heat control or air conditioning will be called for.

All goods must be stored on shelves or racks and not stacked on the floor. Mobile racking is strongly recommended and this should be constructed of metal, preferably stainless steel. The lowest shelf should be at least 25 cm (9-10 in) from the floor. If mobile racking is not used, then shelves should be so arranged that access is available all round to facilitate cleaning and inspection.

Equipment storerooms

Conditions should be similar to those in storerooms for nonperishable foods, except that temperature control is not required, though in tropical countries it is desirable.

Storage of perishable items

Perishable items must be kept under refrigeration—i.e., in cold storage or deep-freeze storage.

(1) Cold storage

Cold storage facilities can be either free-standing cabinets for small quantities of food or walk-in rooms for larger amounts. In each case the temperature should be such that the food is kept at or below 4 °C (40 °F). This means that the refrigeration plant must be capable of reducing the temperature to approximately 1 °C (34 °F). All refrigerators should be provided with a thermometer, which should be sited in the warmest zone of the refrigerated space.

Separate refrigerators should be provided for the various types of food. Thus there should be one each for (a) dairy products, (b) meat, (c) fish, (d) fruit, (e) vegetables, and (f) confectionary. To avoid the risk of cross-contamination, cooked foods should not be stored in the same refrigerator as uncooked foods.

Refrigerators should not be so crowded as to prevent good air circulation. (This is particularly important in the storage of vegetables.) They should always be kept clean and tidy, but should be cleared out and thoroughly washed at least once a week. Disinfectants should not be used, as they may taint the food. Cleaning should coincide with defrosting, although most modern refrigerators defrost automatically.

In flight catering, refrigerated transit and holding rooms are necessary. The former room is for the purpose of holding the food prior to placing it on meal trays, and the latter for holding the completed meals (on trays placed in containers) while awaiting transport to the aircraft.
(2) Deep-freeze storage

The temperature of the food in deep freezes should never rise above 
$-18\,^\circ\text{C} (0\,^\circ\text{F})$, and it should be possible to decrease the temperature to as 
low as $-40\,^\circ\text{C} (-40\,^\circ\text{F})$ for much longer-term storage. Again, thermometers are necessary. To prevent rises in temperature when the door 
is opened, access to the deep freeze must be carefully restricted. In addi-
tion, there should be an anteroom to provide an airlock, which, if con-
trolled at a temperature not exceeding $4\,^\circ\text{C} (40\,^\circ\text{F})$, will provide an addi-
tional cold-room.

Proper stock rotation is necessary in order to avoid leaving food in 
the deep freeze for such long periods that its nutritional value is lowered 
or physical changes occur (e.g., loss of colour). The length of time that 
food should be kept in the deep freeze varies with the composition of 
the food, but for stock rotation 3 months could be a standard for all air-
craft meals.

The complete defrosting and cleaning of a deep freeze are a major 
task, and an alternative store will be required in which to place the food 
removed during this procedure. It should therefore coincide with a 
time when stocks are at their lowest, and once a year is probably suf-
icient. Automatic defrosting is essential to keep the deep freeze oper-
ating efficiently.

Hot food should not be placed in refrigerators or deep freezes till it 
have been cooled to a temperature not exceeding $30\,^\circ\text{C} 
(85\,^\circ\text{F})$. Otherwise the temperature of food already present might be 
raised and condensation produced, which reduces the efficiency of the 
refrigerator. The time this cooling takes is critical, because at tempera-
tures between $30\,^\circ\text{C}$ and $50\,^\circ\text{C} (86\,^\circ\text{F} and 120\,^\circ\text{F})$ bacterial multiplication 
is very rapid.

The cooling period should not exceed 2 hours. As far as meat is con-
cerned, the larger the cut the longer it takes to cool; smaller cuts are 
therefore recommended. Mobile cooling cupboards are available to 
speed up the cooling procedure. Hot foods should be placed in these 
cupboards, cooled down to temperatures of $4\,^\circ\text{C} (40\,^\circ\text{F})$ and then placed 
in refrigerators, if not immediately required for service.

Prepared food, including aircraft meals, that is to be deep frozen for 
later use, should be cooled to the storage temperature of $-18\,^\circ\text{C} (0\,^\circ\text{F})$ 
as quickly as possible to minimize the evaporation of its water content. 
This loss will be much reduced if the meal trays are covered with 
vapour-proof material. The internal temperature of the food should drop to 
$-18\,^\circ\text{C} (0\,^\circ\text{F})$ within 90 minutes of the completion of cooking. To 
help to achieve this rapid cooling, blast freezers are usually installed. Air 
at temperatures as low as $-35\,^\circ\text{C} (-30\,^\circ\text{F})$ is blown over the food. On 
removal from the blast freeze, the food should go straight into the deep 
freeze.
Laboratory facilities

In addition to any control by the health authorities, it is desirable that all large food production concerns, especially flight catering establishments, should possess their own laboratory. This will enable all meals supplied to aircraft to be subjected to bacteriological control. Individual items and processes can be checked as necessary, and at the time of production. In spite of their most willing cooperation, national laboratories often have only limited resources, and full control can only be achieved if a laboratory is provided at a flight catering unit.

Transport of food

Aircraft meals have to be transported from the preparation premises to the aircraft, and special vehicles are necessary in order to service all types of aircraft (Fig. 15).

For hygienic reasons, the walls, ceiling, floor and doors of all vehicles used for transporting food should be lined with metal or of some other approved smooth impervious material (Fig. 16). In tropical countries where the flight catering premises are not at or adjacent to the airport, vehicles should be refrigerated. All vehicles should be kept in good repair and in a clean condition.

After clean equipment and food have been loaded on to the aircraft, the same vehicles are frequently used to bring away offloaded equipment, surplus and waste food remaining in the containers. They should not be used to carry away rubbish—for example, the contents of waste bins. The catering vehicle should be washed out each time used equipment is offloaded and prior to servicing other aircraft. In addition, at the end of each day, the interior of the vehicle should be washed with a detergent/germicide solution.
4.11 Food on aircraft

Food for service to passengers is stored in the galley or pantry areas. The number of pantries varies with the size and type of aircraft, but there is usually a separate galley for first-class passengers. The types of galley also vary: a typical galley on a short-haul aircraft is illustrated in Fig. 17.

Meals may consist of: (a) cold food served on the trays previously laid out in flight catering; on the aircraft they should be kept either in refrigerated modules or in containers holding a small slab of dry ice; (b) hot meals on short-haul aircraft, which should be kept in heat-retaining ovens and served almost immediately after take-off; or (c) hot meals on long-haul aircraft, which should be either frozen or chilled and reheated in a variety of ovens, quite rapidly, so that they can be served, if necessary, shortly after take-off.

The following types of aircraft oven are commonly in use:

(1) Mobile heat-retaining ovens that will keep food hot to a maximum temperature of 85 °C (185 °F). They should not be used to heat frozen or chilled meals, since this process may take up to 3 hours, and such slow heating can be a potential risk.

(2) Conventional fixed ovens that will reheat chilled food to 85 °C (185 °F) in 45 minutes. Another 15 minutes must be allowed for heating frozen food to the same temperature.

(3) Fixed convection ovens that will reheat chilled food to 85 °C (185 °F) in 18-20 minutes. Another 5 minutes must be allowed for frozen food.

(4) Microwave ovens that will thaw frozen food in 35 seconds and heat to 85 °C (185 °F) in a further 35 seconds. Some basic rules must be followed when using microwave ovens (31):
(a) Before use, keep all frozen food at a temperature of not more than $-18\, ^\circ C$ ($0\, ^\circ F$).

(b) Before replacing in the oven, after the food has been thawed, allow 5 minutes for the temperature to stabilize.

(c) Never use metal foils or metal items of any description in the oven.

(d) Serve all food as soon as possible after cooking.
Microwave ovens should be checked at regular intervals by the manufacturer or by an authorized agent to ensure that high-frequency emission from the oven does not exceed the recommended safety level. In the case of excessive escape the oven should be withdrawn from use.

Ovens of all kinds must be kept clean, but before cleaning it is important to make sure that all electricity has been switched off. Microwave ovens should be cleaned in accordance with the makers' instructions, which should be displayed near the oven. Some precautions are necessary in the use of fixed aircraft ovens, in order to eliminate the risk of food being held for some time at a temperature favouring the rapid multiplication of pathogens and the possible production of heat-stable toxins.

Where a hot meal has been served an hour or so before arrival at a transit airport, the ovens, though switched off, may retain a temperature of 38 °C (100 °F) or more for at least another hour. If, at the transit airport, meals for service on the next sector are placed in these warm ovens, in which the temperature can remain between 29 °C (84 °F) and 38 °C (100 °F) for more than 2 hours, any bacteria in the food will multiply rapidly. To prevent this possibility (a) ovens should be cooled down after use by fans, or by some other available means, and (b) food placed in ovens must be at a temperature of less than 10 °C (50 °F), which will help to reduce further the oven temperature. As requirement (b) cannot always be fulfilled—particularly if the airport is at some distance from flight catering—then requirement (a) becomes essential. The potential danger is greatly reduced if the hot meal is served soon after take-off, which would involve switching on the ovens shortly after loading.

Most long-haul aircraft are equipped with a small refrigerator, in which items such as milk, cream and butter are stored. Many short-haul aircraft have no such facilities. As previously mentioned, wide-bodied aircraft have refrigerated modules, but these frequently operate at temperatures above 10 °C (50 °F). Because of this, it is advisable to serve cold meals as soon as possible after take-off.

When there is an unexpected delay after the food is loaded, a time limit should be set, after which all meals should be discarded. The period may vary according to the type of food served, but on average a limit of 4 hours is suggested.

All equipment in galleys should be maintained in a serviceable condition and kept scrupulously clean. Galleys should be designed and constructed to facilitate cleaning and servicing, and the same high standards of hygiene applied as in any other food area.

Cabin crew should follow the same code of practice as food handlers on the ground. In addition, they should wash their hands before serving food and again if they have handled any article liable to be contaminated—e.g., an airsickness bag. They should not touch food with their hands; ice cubes should always be picked up with an imple-
ment. Fingers should not be placed inside cups or glasses, and cutlery should be picked up by the handle.

Only ice cubes manufactured from potable water and delivered to the aircraft in sealed polyethylene bags should be put into drinks. Broken block ice must only be used for chilling bottles and cans.

Cabin crew should keep a careful watch for insects, especially cockroaches, and examine each tray, including the underside, as it is taken from the container. The presence of insects should be reported to the airline's medical service. If flying insects are seen on board, cabin crew should spray with an approved insecticide aerosol.

Each galley should have a small supply of detergent/germicide available for use if any odd item of equipment has to be washed in flight. Normally this will not be necessary, as a sufficient supply of clean crockery, glasses and cutlery should be provided to make re-use unnecessary.

All galleys should have a sufficient number of waste bins provided in which to deposit wastes produced during a flight.

At each airport from which food is uplifted, all used equipment, surplus meals and waste should be offloaded and replaced with a complete set of clean equipment and fresh meals.

Crew meals

Cabin crew are normally supplied with special meals, or receive an allowance to buy food on arrival. When flight deck personnel eat during the flight, it is absolutely essential that the captain should be given a completely different meal from that served to the co-pilot, prepared from food obtained from different sources. The same principle must apply if they eat in ground catering premises a few hours before take-off. This is an essential safety precaution to reduce the possibility of their both eating food contaminated by a pathogen that causes a disease with a short incubation period to which they might succumb during the next flight.

Passenger illness

In addition to the usual epidemiological precautions, if any passenger or crew member becomes ill during the flight or on arrival at an airport, and it is alleged or suspected that aircraft food might be the cause, the airline concerned should be notified immediately and supplied with detailed information.

To assist cabin crew to obtain the correct information, a questionnaire should be supplied with the aircraft documents. This should be completed by the chief steward or purser. It is important that unconsumed portions of the suspected meal, together with three of each of the other meals—or, if no spare meals are available, then three partly eaten meals—should be returned under refrigeration to the airline hygiene officer. If no such officer exists, these samples should be sent to the most appropriate person at the airline's base station, as quickly as possible, to-
gether with the completed questionnaire. Specimen questionnaires are shown in Annexes 2 and 3.

If a passenger is found to have an infectious disease or is suspected of being infected, the health authority should be notified immediately.

4.12 New types of flight catering

Double or return catering

The practice is increasing of supplying food from the parent station for both outward and return flights. This is described as double or return catering. Originally introduced because of unacceptable standards of hygiene or quality of food available at some outstations, this procedure is attractive mainly because it is economical. It is only suitable for flights of fairly short duration—i.e., not more than 2 hours.

Meals for the return flight should be placed in containers, and where refrigerated accommodation is inadequate these should be stowed in the hold, with dry ice added, so that the food will remain at a temperature below that which would encourage the proliferation of bacteria.

It should be noted that dry ice is classified as a hazardous article and some safety precautions are necessary. Normally the quantity of dry ice used for refrigerating food in an aircraft hold will be well below 200 kg (440 lb). It is therefore sufficient to ensure that packages containing dry ice are marked as such, stowed away from other items of cargo, and not placed in the same hold as live animals. If the amount of dry ice exceeds 200 kg (440 lb), then other precautions, described in the IATA Restricted Articles Regulations (32), are necessary.

Return catering is acceptable from a hygiene aspect only if meals that are to be served cold are held in flight at temperatures below 10°C (50°F) and hot meals are held above 63°C (145°F). However, if hot meals are held at this temperature for too long, the meal will be overcooked and unacceptable. The alternative method is to keep the hot meals chilled—i.e., below 10°C (50°F)—for reheating on the return flight. This will then require ovens capable of reheating chilled meals rapidly—that is to say, in not more than 45 minutes. Unfortunately this type of oven is not available on all types of short-haul aircraft. If aircraft possess adequate refrigeration for the storage of cold meals the problem of bacterial growth is reduced. Strict temperature control must, however, be exercised.

The potential danger in return catering occurs if there is a considerable delay at the outstation, giving rise to the temptation to use food that under normal circumstances would have been discarded. Alternative arrangements should be available to meet emergencies of this kind. The length of delay considered acceptable depends mainly on the ambient temperatures.
Seat-back catering

Seat-back catering has found great favour with nonscheduled charter flight operators, being economical in cost, labour, space and equipment. The meals, which consist invariably of a variety of cold meats or meat pie with salad, are packed into two disposable plastic trays or cartons. The food is covered with plastic wrap. The cartons are placed in two recesses behind each passenger seat. One meal is for the outward journey and the other for the return flight.

The potential risks of seat-back catering are the following:

1. Outward flight passengers may tamper with and contaminate food for the return journey.
2. The temperature of the food is not controlled, though certain airlines have attempted to achieve some degree of control by providing dry-ice pellets. The meal may be in the seat-back compartment at ambient temperatures for 8 hours or more, not including delays.
3. Often flights are made to countries where the temperature is high, the situation then being ideal for bacterial growth. If there should be any substantial delay on the ground before the return journey, this risk would be increased.

Though reasons for this type of catering are commercially valid, measures should nevertheless be taken to reduce the risk of foodborne illnesses. Provided the meal is loaded at temperatures not exceeding 4°C (40°F), specially fitted insulated containers would keep the food for several hours below the temperature at which effective bacterial multiplication occurs. The containers might be too costly to produce as a disposable item. However, washing should be a relatively easy operation.

4.13 Food wastes

After offloading from the aircraft, waste food, including left-over unserved whole meals, which will be on trays and in meal containers, or in modules on wide-bodied aircraft, should be brought back to flight catering without delay. Offloading should commence as soon as possible after the aircraft lands, so that the galley can be cleaned before fresh equipment and food is loaded.

All used equipment and waste food should be brought to an unloading bay, which should be separate from the loading bay from which the clean equipment and aircraft meals are dispatched. This is necessary to prevent any cross-contamination between waste and fresh food.

The waste food must not remain in flight catering. Disposal by whatever method should be rapid, safe and hygienically executed. All meal trays should be removed from the containers for stripping. Before re-use, the containers must be thoroughly washed, which is most efficiently done in a container washing machine. This should incorporate a wash tank operating at 60°C (140°F) with added detergent, and a rinse tank operating with clean water only at a temperature of 82°C
Fig. 18. Food waste from aircraft in polyethylene sacks placed in metal containers for removal from flight catering.

(180°F). All re-usable equipment and utensils should be separated and passed to the dish-washing section for either manual or mechanical cleaning.

The stripping of meal trays can be done entirely by hand, all waste matter being placed in metal or plastic containers of various kinds. As soon as these are full they should be emptied into a larger container for removal and final disposal, in the same way as other airport waste (see chapter 7, which deals with solid wastes disposal).

If the small waste containers are not disposable, adequate washing facilities are required, and the containers must be cleaned before being returned to flight catering. Manual stripping can be assisted by a conveyor-belt system on to which the contents of the meal trays are emptied, and as they travel along the belt, all re-usable items of equipment such as cutlery, crockery and glassware are removed. This leaves the waste, which can be removed in containers (Fig. 18) or by mechanical waste disposal units that grind it into segments for discharge into sewers.¹

The stripping belt should be so designed and constructed that it can be effectively cleaned without dismantling, otherwise it will quickly be-

¹ In some countries the approval of the health authority is required before waste can be discharged into sewers.
come a breeding ground for bacteria. Regular maintenance is necessary to prevent breakdowns. If these occur, alternative means of disposal must be readily available.

Garbage grinders also require regular maintenance. Metal objects, such as cutlery, must not be allowed to enter the unit, since they damage the grinding blades, which will quickly put the mechanism out of action. This can be prevented if operators are vigilant and screens are provided.

If waste food is stored while awaiting collection, it should be compacted mechanically in the bulk container so that its volume is reduced considerably. This system is usually operated by contractors who supply the compacting unit and bulk containers. The containers should be housed in a separate room, which—especially in warm climates—should be air-conditioned. Provision must be made for washing the walls and floor of the garbage room.

If waste chutes are used, they must be constructed in a smooth, non-absorbent material, such as stainless steel, and their design must ensure that the waste passing through meets no obstruction. Provision should be made for washing the chute at least once daily.

Another method of disposal is the automatic reduction of all waste to a pulp by a wet process system. Waste is introduced into a steel tank housing a rotating impeller plate studded with grinding teeth and filled with water. It is reduced to pulp, suspended in water as slurry. This is pumped through pipes to a water press. In the water press most of the moisture is removed, converting the slurry to a moist pulp amounting to about 20% of its original volume. The water is recycled in a closed system. The pulp is odourless and ready for removal and disposal by conventional methods. The advantages of this system, as claimed by the manufacturers, are that it eliminates air pollution and improves sanitation, and that the pulp is unattractive to insects, rodents, and other vermin. Waste handling is reduced, and the installations are easy to clean. The principles of the system are illustrated in Fig. 19.
All waste food offloaded from aircraft must be destroyed by one of the approved methods. In some countries all food scraps and unserved meals are taken from the unloading bay direct to an incinerator within the airport perimeter or within easy access of the airport. Other kinds of rubbish produced in food premises—boxes, cartons, bottles, cans, jars, etc.—should be stored in covered containers while awaiting collection, which must be done at least once daily. No offloaded food wastes should be allowed to be used for animal feed.

This prohibition does not, however, apply to fresh food waste produced during the preparation of meals. It should be kept separate from other rubbish and stored in a special swill area, which should be sited well away from food supplies and food utensils. The waste should be stored in covered bins and collected at least once daily. The bins should be clearly marked and kept for this use only.

The swill storage area should be kept clean and facilities for washing the area should be provided. After being emptied, the bins should be washed and disinfected, preferably by heat. A more satisfactory arrangement is to engage the services of a swill contractor to take away the bins and replace them with clean ones. To prevent the spread of animal diseases such as foot-and-mouth disease, many countries require waste food to be sterilized by boiling and stipulate that such food wastes can only be sold to producers who have the necessary facilities.

4.14 Inspection

All food premises should be inspected regularly and frequently by health authority officers and, where applicable, by airline hygiene officers. The former should have enforcement authority. Where an airline employs specialist officers, the health authority can devote more time to airport food preparation premises, knowing that the airline officer will be monitoring flight catering. The health authority and airline hygiene officers should work in close liaison.

The frequency of inspection will depend on the operating standards found—i.e., it will be increased when conditions are unsatisfactory and decreased when they are good. Detailed inspections, in which note is made of all structural defects and faulty methods of food preparation and handling techniques, should be carried out on average at monthly intervals, with revisits as necessary to see that recommendations have been implemented. In addition, frequent *ad hoc* visits should be made just to check handling practices. This monitoring is invaluable, however short the visit, and should be used as an opportunity to impart health education. Any faults seen can often be rectified immediately, and a few minutes' conversation with food handlers in their working environment is often more beneficial than a training lecture. This is an advantage that an airline hygiene officer has over his health authority colleague, since, being on the spot, he can make daily or, if necessary, even more frequent *ad hoc* visits.
In order to get a balanced assessment, the times and days of inspection should be varied. It is recommended that some inspections should take place outside normal working hours—i.e., at night or during the week-end. It is not wise to form an opinion after one inspection, which may have been carried out at a time when conditions were either abnormally good or abnormally bad. It is sometimes helpful when making a detailed inspection to use a check sheet (see Annex 4 for an example), although this can never replace an officer's informed opinion based on his own experience and knowledge.

4.15 Distribution of responsibilities and suggested areas of concern, by authority or agency

A. Distribution of responsibilities

<table>
<thead>
<tr>
<th>Authority or agency</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health administration</td>
<td>Approval of source of food (Article 14.2).</td>
</tr>
<tr>
<td>Health authority</td>
<td>Inspection of all food premises in and outside airports that supply food to airports or airlines (Article 14.2).</td>
</tr>
<tr>
<td></td>
<td>Medical examination of airport food handlers.</td>
</tr>
<tr>
<td></td>
<td>Training of all food handlers employed in the area of jurisdiction.</td>
</tr>
<tr>
<td></td>
<td>Collection and sampling for examination of food supplied to airports or airlines (Article 14.2).</td>
</tr>
<tr>
<td></td>
<td>Safe disposal of all waste and condemned food (Article 14.3).</td>
</tr>
<tr>
<td></td>
<td>If a case of cholera is discovered or has occurred on board, supervision of the removal and safe disposal of food considered to be contaminated, and disinfection of food handling equipment (Article 63.1).</td>
</tr>
</tbody>
</table>

B. Suggested areas of concern

<table>
<thead>
<tr>
<th>Authority or agency</th>
<th>Area of concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airport authority</td>
<td>Provision of hygienic airport food premises.</td>
</tr>
<tr>
<td></td>
<td>Cooperation in the training and medical examination of airport food handlers.</td>
</tr>
</tbody>
</table>

* The article numbers cited refer to the International Health Regulations.
Airlines

Inspection of premises supplying food for passengers and crew both aboard aircraft and at airports and hotels.
Training and medical examination of flight catering food handlers.
Provision of safe food on aircraft.
Quality and bacteriological control of aircraft food.
Maintenance of high standards of hygiene on aircraft.

Airline caterers

Maintenance of good hygiene standards in their premises.
Cooperation in the training and medical examination of food handlers.

Aircraft manufacturers

Design and construction of galleys that are easy to clean.
Provision of adequate water boilers to meet all needs at peak periods.
Design of rapid-heating ovens and the fitting of all aircraft with them.
Provision of adequate and efficient refrigeration facilities.
Fitting of all aircraft with hand-washing facilities for crew.

Catering equipment manufacturers

Design and manufacture of dish-washing machines that will remove all food debris and stains from utensils, or—alternatively—production of utensils from which food debris and stains can be removed without immersion in pre-soak and post-soak tanks.
5. WATER

5.1 General

Waterborne diseases that are still being transmitted in many parts of the world include cholera, the enteric fevers (Salmonella), bacillary and amoebic dysentery and other enteric infections. Many airlines operate through countries in which these diseases are either endemic or occur from time to time, and in which the standard of sanitation may be low. Aircraft often cannot carry sufficient water to last throughout the complete flight and must therefore replenish supplies from sources in many different countries. If the source is contaminated, it is clear that, unless adequate precautions are taken, disease can be spread through the medium of aircraft water.

As Whittingham (33) has observed, the amount of water carried on aircraft has to be limited as far as is practicable. Normally, the quantity required (for all purposes) is worked out on the basis of number of passengers and duration of flight. The quantities given by Whittingham in UK pints are shown below along with their conversions into metric and US measures:

<table>
<thead>
<tr>
<th>Duration of flight</th>
<th>Quantity of water per passenger</th>
<th>Litres</th>
<th>US gallons</th>
<th>UK pints</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 3 hours</td>
<td></td>
<td>1.70</td>
<td>0.45</td>
<td>3.0</td>
</tr>
<tr>
<td>3 - 5 hours</td>
<td></td>
<td>3.12</td>
<td>0.82</td>
<td>5.5</td>
</tr>
<tr>
<td>5 - 12 hours</td>
<td></td>
<td>4.55</td>
<td>1.20</td>
<td>8.0</td>
</tr>
</tbody>
</table>

In practice the capacity of aircraft water systems varies considerably. Examples of variations in the drinking-water carrying capacities of different aircraft are given below:

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Quantity of water per passenger</th>
<th>Litres</th>
<th>US gallons</th>
<th>UK gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boeing 707 and 747</td>
<td></td>
<td>3.64</td>
<td>0.96</td>
<td>0.80</td>
</tr>
<tr>
<td>Lockheed L1011</td>
<td></td>
<td>1.36</td>
<td>0.36</td>
<td>0.30</td>
</tr>
<tr>
<td>Trident 3</td>
<td></td>
<td>0.91</td>
<td>0.24</td>
<td>0.20</td>
</tr>
</tbody>
</table>
Food preparation areas, kitchens, tray preparation, etc.

Sweep and wash all floors: remove rubbish . . . . Twice daily
Wash all food equipment, tables and working surfaces, Daily
including legs and undersides, sinks, cupboards, waste
stands, low level pipes, and trolleys . . . . . . (some food
equipment should be cleaned at the end of each shift)

Degrease and wash the inside and outside of extraction Weekly
hoods, ovens, fryers, griddles, grills, etc.
Wash the outside of boiling-tanks, proofers, steamers, Weekly
etc.
Clean and degrease inside rising ducts, fan chambers, Monthly
etc.
Wash walls and doors Weekly
Wash windows and light fittings Monthly

Entire premises:
Wash down all high-level areas, ceilings, trunkings, 4-6 times annually
etc. according to need.

In addition to the above operations, kitchen cleaners must regularly remove waste food containers and litter, mop up any spillages, and keep all areas tidy between official cleaning times.

4.10 Food storage and transport

The proper storage of food at all stages from the arrival of raw materials to the departure of completed meals is most important, calling for constant and systematic care by management and staff. A recommended rule for storing food is: keep the quantity to an acceptable minimum, keep it clean, keep it cool, keep it covered.

Keeping stocks to a minimum reduces the length of storage time and the risk of deterioration. In all cases, however, stocks should be regularly inspected and a proper rotation system installed. Access to food storerooms must be restricted and subject to control.

The only food kept in food preparation areas should be that needed during the day. Everything else should remain in the storeroom.
Storerooms for nonperishable foods

The rooms should be clean, dry, well lit and ventilated, and vermin-proof. Ideally, the temperature should not exceed 16 °C (60 °F), so that, in many countries, some form of heat control or air conditioning will be called for.

All goods must be stored on shelves or racks and not stacked on the floor. Mobile racking is strongly recommended and this should be constructed of metal, preferably stainless steel. The lowest shelf should be at least 25 cm (9-10 in) from the floor. If mobile racking is not used, then shelves should be so arranged that access is available all round to facilitate cleaning and inspection.

Equipment storerooms

Conditions should be similar to those in storerooms for nonperishable foods, except that temperature control is not required, though in tropical countries it is desirable.

Storage of perishable items

Perishable items must be kept under refrigeration—i.e., in cold storage or deep-freeze storage.

1 Cold storage

Cold storage facilities can be either free-standing cabinets for small quantities of food or walk-in rooms for larger amounts. In each case the temperature should be such that the food is kept at or below 4 °C (40 °F). This means that the refrigeration plant must be capable of reducing the temperature to approximately 1 °C (34 °F). All refrigerators should be provided with a thermometer, which should be sited in the warmest zone of the refrigerated space.

Separate refrigerators should be provided for the various types of food. Thus there should be one each for (a) dairy products, (b) meat, (c) fish, (d) fruit, (e) vegetables, and (f) confectionary. To avoid the risk of cross-contamination, cooked foods should not be stored in the same refrigerator as uncooked foods.

Refrigerators should not be so crowded as to prevent good air circulation. (This is particularly important in the storage of vegetables.) They should always be kept clean and tidy, but should be cleared out and thoroughly washed at least once a week. Disinfectants should not be used, as they may taint the food. Cleaning should coincide with defrosting, although most modern refrigerators defrost automatically.

In flight catering, refrigerated transit and holding rooms are necessary. The former room is for the purpose of holding the food prior to placing it on meal trays, and the latter for holding the completed meals (on trays placed in containers) while awaiting transport to the aircraft.
(2) Deep-freeze storage

The temperature of the food in deep freezes should never rise above 
$-18 \, ^\circ C \,(0 \, ^\circ F)$, and it should be possible to decrease the temperature to as 
low as $-40 \, ^\circ C \,(-40 \, ^\circ F)$ for much longer-term storage. Again, thermo-
meters are necessary. To prevent rises in temperature when the door is 
opened, access to the deep freeze must be carefully restricted. In ad-
dition, there should be an anteroom to provide an airlock, which, if con-
trolled at a temperature not exceeding 4 $^\circ C \,(40 \, ^\circ F)$, will provide an ad-
ditional cold-room.

Proper stock rotation is necessary in order to avoid leaving food in 
the deep freeze for such long periods that its nutritional value is lowered 
or physical changes occur (e.g., loss of colour). The length of time that 
food should be kept in the deep freeze varies with the composition of 
the food, but for stock rotation 3 months could be a standard for all air-
craft meals.

The complete defrosting and cleaning of a deep freeze are a major 
task, and an alternative store will be required in which to place the food 
removed during this procedure. It should therefore coincide with a 
time when stocks are at their lowest, and once a year is probably suffi-
cient. Automatic defrosting is essential to keep the deep freeze oper-
ating efficiently.

Hot food should not be placed in refrigerators or deep freezes till it 
has first been cooled to a temperature not exceeding 30 $^\circ C \,(85 \, ^\circ F)$. Otherwise the temperature of food already present might be 
raised and condensation produced, which reduces the efficiency of the 
refrigerator. The time this cooling takes is critical, because at tempera-
atures between 30 $^\circ C$ and 50 $^\circ C \,(86 \, ^\circ F \text{ and } 120 \, ^\circ F)$ bacterial multiplication is 
very rapid.

The cooling period should not exceed 2 hours. As far as meat is con-
cerned, the larger the cut the longer it takes to cool; smaller cuts are 
therefore recommended. Mobile cooling cupboards are available to 
speed up the cooling procedure. Hot foods should be placed in these 
cupboards, cooled down to temperatures of 4 $^\circ C \,(40 \, ^\circ F)$ and then placed 
in refrigerators, if not immediately required for service.

Prepared food, including aircraft meals, that is to be deep frozen for 
later use, should be cooled to the storage temperature of $-18 \, ^\circ C \,(0 \, ^\circ F)$ 
as quickly as possible to minimize the evaporation of its water content. 
This loss will be much reduced if the meal trays are covered with 
vapour-proof material. The internal temperature of the food should drop 
to $-18 \, ^\circ C \,(0 \, ^\circ F)$ within 90 minutes of the completion of cooking. To 
help to achieve this rapid cooling, blast freezers are usually installed. Air 
at temperatures as low as $-35 \, ^\circ C \,(-30 \, ^\circ F)$ is blown over the food. On 
removal from the blast freezer, the food should go straight into the deep 
freeze.
Laboratory facilities

In addition to any control by the health authorities, it is desirable that all large food production concerns, especially flight catering establishments, should possess their own laboratory. This will enable all meals supplied to aircraft to be subjected to bacteriological control. Individual items and processes can be checked as necessary, and at the time of production. In spite of their most willing cooperation, national laboratories often have only limited resources, and full control can only be achieved if a laboratory is provided at a flight catering unit.

Transport of food

Aircraft meals have to be transported from the preparation premises to the aircraft, and special vehicles are necessary in order to service all types of aircraft (Fig. 15).

For hygienic reasons, the walls, ceiling, floor and doors of all vehicles used for transporting food should be lined with metal or of some other approved smooth impervious material (Fig. 16). In tropical countries where the flight catering premises are not at or adjacent to the airport, vehicles should be refrigerated. All vehicles should be kept in good repair and in a clean condition.

After clean equipment and food have been loaded on to the aircraft, the same vehicles are frequently used to bring away offloaded equipment, surplus and waste food remaining in the containers. They should not be used to carry away rubbish—for example, the contents of waste bins. The catering vehicle should be washed out each time used equipment is offloaded and prior to servicing other aircraft. In addition, at the end of each day, the interior of the vehicle should be washed with a detergent/germicide solution.
4.11 Food on aircraft

Food for service to passengers is stored in the galley or pantry areas. The number of pantries varies with the size and type of aircraft, but there is usually a separate galley for first-class passengers. The types of galley also vary: a typical galley on a short-haul aircraft is illustrated in Fig. 17.

Meals may consist of: (a) cold food served on the trays previously laid out in flight catering: on the aircraft they should be kept either in refrigerated modules or in containers holding a small slab of dry ice; (b) hot meals on short-haul aircraft, which should be kept in heat-retaining ovens and served almost immediately after take-off; or (c) hot meals on long-haul aircraft, which should be either frozen or chilled and reheated in a variety of ovens, quite rapidly, so that they can be served, if necessary, shortly after take-off.

The following types of aircraft oven are commonly in use:

(1) Mobile heat-retaining ovens that will keep food hot to a maximum temperature of 85 °C (185 °F). They should not be used to heat frozen or chilled meals, since this process may take up to 3 hours, and such slow heating can be a potential risk.

(2) Conventional fixed ovens that will reheat chilled food to 85 °C (185 °F) in 45 minutes. Another 15 minutes must be allowed for heating frozen food to the same temperature.

(3) Fixed convection ovens that will reheat chilled food to 85 °C (185 °F) in 18-20 minutes. Another 5 minutes must be allowed for frozen food.

(4) Microwave ovens that will thaw frozen food in 35 seconds and heat to 85 °C (185 °F) in a further 35 seconds. Some basic rules must be followed when using microwave ovens (31):
(a) Before use, keep all frozen food at a temperature of not more than $-18\,^\circ C$ (0°F).
(b) Before placing in the oven, after the food has been thawed, allow 5 minutes for the temperature to stabilize.
(c) Never use metal foils or metal items of any description in the oven.
(d) Serve all food as soon as possible after cooking.
Microwave ovens should be checked at regular intervals by the manufacturer or by an authorized agent to ensure that high-frequency emission from the oven does not exceed the recommended safety level. In the case of excessive escape the oven should be withdrawn from use.

Ovens of all kinds must be kept clean, but before cleaning it is important to make sure that all electricity has been switched off. Microwave ovens should be cleaned in accordance with the makers' instructions, which should be displayed near the oven. Some precautions are necessary in the use of fixed aircraft ovens, in order to eliminate the risk of food being held for some time at a temperature favouring the rapid multiplication of pathogens and the possible production of heat-stable toxins.

Where a hot meal has been served an hour or so before arrival at a transit airport, the ovens, though switched off, may retain a temperature of 38°C (100°F) or more for at least another hour. If, at the transit airport, meals for service on the next sector are placed in these warm ovens, in which the temperature can remain between 29°C (84°F) and 38°C (100°F) for more than 2 hours, any bacteria in the food will multiply rapidly. To prevent this possibility (a) ovens should be cooled down after use by fans, or by some other available means, and (b) food placed in ovens must be at a temperature of less than 10°C (50°F), which will help to reduce further the oven temperature. As requirement (b) cannot always be fulfilled—particularly if the airport is at some distance from flight catering—then requirement (a) becomes essential. The potential danger is greatly reduced if the hot meal is served soon after take-off, which would involve switching on the ovens shortly after loading.

Most long-haul aircraft are equipped with a small refrigerator, in which items such as milk, cream and butter are stored. Many short-haul aircraft have no such facilities. As previously mentioned, wide-bodied aircraft have refrigerated modules, but these frequently operate at temperatures above 10°C (50°F). Because of this, it is advisable to serve cold meals as soon as possible after take-off.

When there is an unexpected delay after the food is loaded, a time limit should be set, after which all meals should be discarded. The period may vary according to the type of food served, but on average a limit of 4 hours is suggested.

All equipment in galleys should be maintained in a serviceable condition and kept scrupulously clean. Galleys should be designed and constructed to facilitate cleaning and servicing, and the same high standards of hygiene applied as in any other food area.

Cabin crew should follow the same code of practice as food handlers on the ground. In addition, they should wash their hands before serving food and again if they have handled any article liable to be contaminated—e.g., an air-sickness bag. They should not touch food with their hands; ice cubes should always be picked up with an imple-
ment. Fingers should not be placed inside cups or glasses, and cutlery should be picked up by the handle.

Only ice cubes manufactured from potable water and delivered to the aircraft in sealed polyethylene bags should be put into drinks. Broken block ice must only be used for chilling bottles and cans.

Cabin crew should keep a careful watch for insects, especially cockroaches, and examine each tray, including the underside, as it is taken from the container. The presence of insects should be reported to the airline’s medical service. If flying insects are seen on board, cabin crew should spray with an approved insecticide aerosol.

Each galley should have a small supply of detergent/germicide available for use if any odd item of equipment has to be washed in flight. Normally this will not be necessary, as a sufficient supply of clean crockery, glasses and cutlery should be provided to make re-use unnecessary.

All galleys should have a sufficient number of waste bins provided in which to deposit wastes produced during a flight.

At each airport from which food is uplifted, all used equipment, surplus meals and waste should be offloaded and replaced with a complete set of clean equipment and fresh meals.

Crew meals

Cabin crew are normally supplied with special meals, or receive an allowance to buy food on arrival. When flight deck personnel eat during the flight, it is absolutely essential that the captain should be given a completely different meal from that served to the co-pilot, prepared from food obtained from different sources. The same principle must apply if they eat in ground catering premises a few hours before take-off. This is an essential safety precaution to reduce the possibility of their both eating food contaminated by a pathogen that causes a disease with a short incubation period to which they might succumb during the next flight.

Passenger illness

In addition to the usual epidemiological precautions, if any passenger or crew member becomes ill during the flight or on arrival at an airport, and it is alleged or suspected that aircraft food might be the cause, the airline concerned should be notified immediately and supplied with detailed information.

To assist cabin crew to obtain the correct information, a questionnaire should be supplied with the aircraft documents. This should be completed by the chief steward or purser. It is important that unconsumed portions of the suspected meal, together with three of each of the other meals—or, if no spare meals are available, then three partly eaten meals—should be returned under refrigeration to the airline hygiene officer. If no such officer exists, these samples should be sent to the most appropriate person at the airline’s base station, as quickly as possible, to-
gether with the completed questionnaire. Specimen questionnaires are shown in Annexes 2 and 3.

If a passenger is found to have an infectious disease or is suspected of being infected, the health authority should be notified immediately.

**4.12 New types of flight catering**

**Double or return catering**

The practice is increasing of supplying food from the parent station for both outward and return flights. This is described as double or return catering. Originally introduced because of unacceptable standards of hygiene or quality of food available at some outstations, this procedure is attractive mainly because it is economical. It is only suitable for flights of fairly short duration—i.e., not more than 2 hours.

Meals for the return flight should be placed in containers, and where refrigerated accommodation is inadequate these should be stowed in the hold, with dry ice added, so that the food will remain at a temperature below that which would encourage the proliferation of bacteria.

It should be noted that dry ice is classified as a hazardous article and some safety precautions are necessary. Normally the quantity of dry ice used for refrigerating food in an aircraft hold will be well below 200 kg (440 lb). It is therefore sufficient to ensure that packages containing dry ice are marked as such, stowed away from other items of cargo, and not placed in the same hold as live animals. If the amount of dry ice exceeds 200 kg (440 lb), then other precautions, described in the IATA Restricted Articles Regulations (32), are necessary.

Return catering is acceptable from a hygiene aspect only if meals that are to be served cold are held in flight at temperatures below 10°C (50°F) and hot meals are held above 63°C (145°F). However, if hot meals are held at this temperature for too long, the meal will be overcooked and unacceptable. The alternative method is to keep the hot meals chilled—i.e., below 10°C (50°F)—for reheating on the return flight. This will then require ovens capable of reheating chilled meals rapidly—that is to say, in not more than 45 minutes. Unfortunately this type of oven is not available on all types of short-haul aircraft. If aircraft possess adequate refrigeration for the storage of cold meals the problem of bacterial growth is reduced. Strict temperature control must, however, be exercised.

The potential danger in return catering occurs if there is a considerable delay at the outstation, giving rise to the temptation to use food that under normal circumstances would have been discarded. Alternative arrangements should be available to meet emergencies of this kind. The length of delay considered acceptable depends mainly on the ambient temperatures.
Seat-back catering

Seat-back catering has found great favour with nonscheduled charter flight operators, being economical in cost, labour, space and equipment. The meals, which consist invariably of a variety of cold meats or meat pie with salad, are packed into two disposable plastic trays or cartons. The food is covered with plastic wrap. The cartons are placed in two recesses behind each passenger seat. One meal is for the outward journey and the other for the return flight.

The potential risks of seat-back catering are the following:

1. Outward flight passengers may tamper with and contaminate food for the return journey.
2. The temperature of the food is not controlled, though certain airlines have attempted to achieve some degree of control by providing dry-ice pellets. The meal may be in the seat-back compartment at ambient temperatures for 8 hours or more, not including delays.
3. Often flights are made to countries where the temperature is high, the situation then being ideal for bacterial growth. If there should be any substantial delay on the ground before the return journey, this risk would be increased.

Though reasons for this type of catering are commercially valid, measures should nevertheless be taken to reduce the risk of foodborne illnesses. Provided the meal is loaded at temperatures not exceeding 4°C (40°F), specially fitted insulated containers would keep the food for several hours below the temperature at which effective bacterial multiplication occurs. The containers might be too costly to produce as a disposable item. However, washing should be a relatively easy operation.

4.13 Food wastes

After offloading from the aircraft, waste food, including left-over unserved whole meals, which will be on trays and in meal containers, or in modules on wide-bodied aircraft, should be brought back to flight catering without delay. Offloading should commence as soon as possible after the aircraft lands, so that the galley can be cleaned before fresh equipment and food is loaded.

All used equipment and waste food should be brought to an unloading bay, which should be separate from the loading bay from which the clean equipment and aircraft meals are dispatched. This is necessary to prevent any cross-contamination between waste and fresh food.

The waste food must not remain in flight catering. Disposal by whatever method should be rapid, safe and hygienically executed. All meal trays should be removed from the containers for stripping. Before re-use, the containers must be thoroughly washed, which is most efficiently done in a container washing machine. This should incorporate a wash tank operating at 60°C (140°F) with added detergent, and a rinse tank operating with clean water only at a temperature of 82°C.
(180°F). All re-usable equipment and utensils should be separated and passed to the dish-washing section for either manual or mechanical cleaning.

The stripping of meal trays can be done entirely by hand, all waste matter being placed in metal or plastic containers of various kinds. As soon as these are full they should be emptied into a larger container for removal and final disposal, in the same way as other airport waste (see chapter 7, which deals with solid wastes disposal).

If the small waste containers are not disposable, adequate washing facilities are required, and the containers must be cleaned before being returned to flight catering. Manual stripping can be assisted by a conveyor-belt system on to which the contents of the meal trays are emptied, and as they travel along the belt, all re-usable items of equipment such as cutlery, crockery and glassware are removed. This leaves the waste, which can be removed in containers (Fig. 18) or by mechanical waste disposal units that grind it into segments for discharge into sewers.¹

The stripping belt should be so designed and constructed that it can be effectively cleaned without dismantling, otherwise it will quickly be-

¹ In some countries the approval of the health authority is required before waste can be discharged into sewers.
come a breeding ground for bacteria. Regular maintenance is necessary to prevent breakdowns. If these occur, alternative means of disposal must be readily available.

Garbage grinders also require regular maintenance. Metal objects, such as cutlery, must not be allowed to enter the unit, since they damage the grinding blades, which will quickly put the mechanism out of action. This can be prevented if operators are vigilant and screens are provided.

If waste food is stored while awaiting collection, it should be compacted mechanically in the bulk container so that its volume is reduced considerably. This system is usually operated by contractors who supply the compacting unit and bulk containers. The containers should be housed in a separate room, which—especially in warm climates—should be air-conditioned. Provision must be made for washing the walls and floor of the garbage room.

If waste chutes are used, they must be constructed in a smooth, non-absorbent material, such as stainless steel, and their design must ensure that the waste passing through meets no obstruction. Provision should be made for washing the chute at least once daily.

Another method of disposal is the automatic reduction of all waste to a pulp by a wet process system. Waste is introduced into a steel tank housing a rotating impeller plate studded with grinding teeth and filled with water. It is reduced to pulp, suspended in water as slurry. This is pumped through pipes to a water press. In the water press most of the moisture is removed, converting the slurry to a moist pulp amounting to about 20% of its original volume. The water is recycled in a closed system. The pulp is odourless and ready for removal and disposal by conventional methods. The advantages of this system, as claimed by the manufacturers, are that it eliminates air pollution and improves sanitation, and that the pulp is unattractive to insects, rodents, and other vermin. Waste handling is reduced, and the installations are easy to clean. The principles of the system are illustrated in Fig. 19.

FIG. 19. AUTOMATIC SYSTEM FOR WASTE PULPING
All waste food offloaded from aircraft must be destroyed by one of the approved methods. In some countries all food scraps and unserved meals are taken from the unloading bay direct to an incinerator within the airport perimeter or within easy access of the airport. Other kinds of rubbish produced in food premises—boxes, cartons, bottles, cans, jars, etc.—should be stored in covered containers while awaiting collection, which must be done at least once daily. No offloaded food wastes should be allowed to be used for animal feed.

This prohibition does not, however, apply to fresh food waste produced during the preparation of meals. It should be kept separate from other rubbish and stored in a special swill area, which should be sited well away from food supplies and food utensils. The waste should be stored in covered bins and collected at least once daily. The bins should be clearly marked and kept for this use only.

The swill storage area should be kept clean and facilities for washing the area should be provided. After being emptied, the bins should be washed and disinfected, preferably by heat. A more satisfactory arrangement is to engage the services of a swill contractor to take away the bins and replace them with clean ones. To prevent the spread of animal diseases such as foot-and-mouth disease, many countries require waste food to be sterilized by boiling and stipulate that such food wastes can only be sold to producers who have the necessary facilities.

4.14 Inspection

All food premises should be inspected regularly and frequently by health authority officers and, where applicable, by airline hygiene officers. The former should have enforcement authority. Where an airline employs specialist officers, the health authority can devote more time to airport food preparation premises, knowing that the airline officer will be monitoring flight catering. The health authority and airline hygiene officers should work in close liaison.

The frequency of inspection will depend on the operating standards found—i.e., it will be increased when conditions are unsatisfactory and decreased when they are good. Detailed inspections, in which note is made of all structural defects and faulty methods of food preparation and handling techniques, should be carried out on average at monthly intervals, with revisits as necessary to see that recommendations have been implemented. In addition, frequent ad hoc visits should be made just to check handling practices. This monitoring is invaluable, however short the visit, and should be used as an opportunity to impart health education. Any faults seen can often be rectified immediately, and a few minutes’ conversation with food handlers in their working environment is often more beneficial than a training lecture. This is an advantage that an airline hygiene officer has over his health authority colleague, since, being on the spot, he can make daily or, if necessary, even more frequent ad hoc visits.
In order to get a balanced assessment, the times and days of inspection should be varied. It is recommended that some inspections should take place outside normal working hours—i.e., at night or during the week-end. It is not wise to form an opinion after one inspection, which may have been carried out at a time when conditions were either abnormally good or abnormally bad. It is sometimes helpful when making a detailed inspection to use a check sheet (see Annex 4 for an example), although this can never replace an officer's informed opinion based on his own experience and knowledge.

4.15 Distribution of responsibilities and suggested areas of concern, by authority or agency

**A. Distribution of responsibilities**

<table>
<thead>
<tr>
<th>Authority or agency</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health administration</td>
<td>Approval of source of food (Article 14.2).^</td>
</tr>
<tr>
<td>Health authority</td>
<td>Inspection of all food premises in and outside airports that supply food to airports or airlines (Article 14.2).</td>
</tr>
<tr>
<td></td>
<td>Medical examination of airport food handlers.</td>
</tr>
<tr>
<td></td>
<td>Training of all food handlers employed in the area of jurisdiction.</td>
</tr>
<tr>
<td></td>
<td>Collection and sampling for examination of food supplied to airports or airlines (Article 14.2).</td>
</tr>
<tr>
<td></td>
<td>Safe disposal of all waste and condemned food (Article 14.3).</td>
</tr>
<tr>
<td></td>
<td>If a case of cholera is discovered or has occurred on board, supervision of the removal and safe disposal of food considered to be contaminated, and disinfection of food handling equipment (Article 63.1).</td>
</tr>
</tbody>
</table>

**B. Suggested areas of concern**

<table>
<thead>
<tr>
<th>Authority or agency</th>
<th>Area of concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airport authority</td>
<td>Provision of hygienic airport food premises.</td>
</tr>
<tr>
<td></td>
<td>Cooperation in the training and medical examination of airport food handlers.</td>
</tr>
</tbody>
</table>

^ The article numbers cited refer to the International Health Regulations.
Airlines

Inspection of premises supplying food for passengers and crew both aboard aircraft and at airports and hotels.

Training and medical examination of flight catering food handlers.

Provision of safe food on aircraft.

Quality and bacteriological control of aircraft food.

Maintenance of high standards of hygiene on aircraft.

Airline caterers

Maintenance of good hygiene standards in their premises.

Cooperation in the training and medical examination of food handlers.

Aircraft manufacturers

Design and construction of galleys that are easy to clean.

Provision of adequate water boilers to meet all needs at peak periods.

Design of rapid-heating ovens and the fitting of all aircraft with them.

Provision of adequate and efficient refrigeration facilities.

Fitting of all aircraft with hand-washing facilities for crew.

Catering equipment manufacturers

Design and manufacture of dish-washing machines that will remove all food debris and stains from utensils, or—alternatively—production of utensils from which food debris and stains can be removed without immersion in pre-soak and post-soak tanks.
5. WATER

5.1 General

Waterborne diseases that are still being transmitted in many parts of the world include cholera, the enteric fevers (*Salmonella*), bacillary and amoebic dysentery and other enteric infections. Many airlines operate through countries in which these diseases are either endemic or occur from time to time, and in which the standard of sanitation may be low. Aircraft often cannot carry sufficient water to last throughout the complete flight and must therefore replenish supplies from sources in many different countries. If the source is contaminated, it is clear that, unless adequate precautions are taken, disease can be spread through the medium of aircraft water.

As Whittingham (33) has observed, the amount of water carried on aircraft has to be limited as far as is practicable. Normally, the quantity required (for all purposes) is worked out on the basis of number of passengers and duration of flight. The quantities given by Whittingham in UK pints are shown below along with their conversions into metric and US measures:

<table>
<thead>
<tr>
<th>Duration of flight</th>
<th>Quantity of water per passenger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Litres</td>
</tr>
<tr>
<td>1 - 3 hours</td>
<td>1.70</td>
</tr>
<tr>
<td>3 - 5 hours</td>
<td>3.12</td>
</tr>
<tr>
<td>5 - 12 hours</td>
<td>4.55</td>
</tr>
</tbody>
</table>

In practice the capacity of aircraft water systems varies considerably. Examples of variations in the drinking-water carrying capacities of different aircraft are given below:

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Quantity of water per passenger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Litres</td>
</tr>
<tr>
<td>Boeing 707 and 747</td>
<td>3.64</td>
</tr>
<tr>
<td>Lockheed L.1011</td>
<td>1.36</td>
</tr>
<tr>
<td>Trident 3</td>
<td>0.91</td>
</tr>
</tbody>
</table>
Water supplied to air travellers should be palatable and as attractive as possible to the consumer. It should be odourless, colourless, and free from turbidity, pathogenic organisms, and excessive amounts of chemical substances. The pH level should be within the range of 7.0-8.5: excessively acid water may cause the dissolution of toxic metals from tank pipes and fittings. All water carried on aircraft should be potable. The custom of having a small quantity of "drinking-water" and another supply labelled "unsuitable for drinking" must be regarded as bad sanitary practice.

Since speed is the main advantage of air travel, no time can be spent at transit stops on draining and cleaning before refilling the aircraft water system. Normally, the amount of water uplifted is equivalent to the quantity used on the previous sector. A problem may be created if water cannot be uplifted because of its unsuitability. It is thus imperative that every airport should comply with Article 14.2 of the International Health Regulations and be provided with pure drinking-water from a source approved by the health administration. (See International Standards for Drinking-Water (34).)

5.2 Airport water supply

The piped water supply delivered to airports should be obtained from well-operated public water supply systems that conform to acceptable standards. Surveillance or continuous and vigilant assessment of drinking-water supplies is necessary to ensure that each component of the system—source, treatment, storage and distribution—operates without risk of failure (35). Water treatment by itself is not a safeguard if the distribution system is contaminated through faulty facilities or cross-connexions. Conversely, an excellent distribution system will not offer protection if the water distributed receives insufficient treatment.

If any sample does not conform to acceptable standards, there should be an immediate investigation into the efficiency of the purification process, the distribution system and the method of sampling. A second sample should be taken forthwith if organisms or concentrations of chemical substances that may be a hazard to health are detected. The distribution system should be safeguarded from cross-connexions (36) and back-siphonage (37), which might occur during "shutdown" times or periods of low pressure. If the quality of water at an airport is lower than acceptable standards, effective precautionary disinfection measures should be applied.

Frequency of sampling

The frequency of sampling of airport water supplies for bacteriological examination should be considered within the overall framework of the water distribution system as a whole; it would depend on such factors as the quality of the water source, the number of water sources, the risk of contamination, the complexity and length of the distribution system,
the possibility of the spread of epidemics, and the size of the population to be served.

The International Standards for Drinking-Water (34) propose maximum intervals between the taking of successive samples and the minimum number of samples that should be examined monthly from the whole distribution system (see Annex 5). The actual number of samples examined and the frequency of sampling are, however, a matter to be decided by the responsible authority in the light of local conditions.

Complete chemical examination of water is required much less frequently. Generally, once, or at most twice, yearly should be sufficient, unless the source of supply is changed or there is reason to suspect contamination. In these circumstances, extra sampling should be undertaken (see again Annex 5). Where the mains water is disinfected by chlorination, a daily test should be made to ensure that residual chlorine remains at the correct level.

The results of all examinations should be recorded for permanent reference; these observations should be supplemented at least twice a year by an on-the-spot inspection by engineering and health personnel acting on behalf of the responsible authority.

Sampling procedures

It is important that extreme care should be exercised in collecting samples to avoid accidental contamination. Sample collectors must be trained for the work. When several samples are being collected from the same source at the same time, the sample for bacteriological examination should be taken first. Only sterilized glass jars or bottles, fitted with ground glass stoppers or metal screw caps, should be used. During sampling the stopper and neck of the bottle must not come into contact with anything. When the water is taken from a tap, the tap should be cleaned and sterilized by flaming. It should then be cooled by flushing the line, so that a true sample can be obtained. If the water contains chlorine a neutralizing substance, such as sodium thiosulfate, should be added to the sampling jar. This can be done by a laboratory, from which all sampling equipment should be obtained.

After sampling, immediately secure the stopper, label clearly with all the details required, and transmit the sample without delay to the laboratory. Since the content of Escherichia coli and other organisms in water samples changes during storage, the samples should be examined as soon as possible after reception and always within 24 hours of collection. During the period between collection and arrival at the laboratory the sample should be held at a temperature as close as possible to that of the water at the time of collection.

It is possible to examine samples immediately after collection by means of a portable field laboratory, using the membrane filter technique. After the water is pumped by pressure through the membrane it is placed on an absorbent pad saturated with the correct medium. The membrane and pad are put in a closed container, which is
then placed in a small incubator incorporated in the portable laboratory. Results can be read 20 hours later.

5.3 Passenger buildings

A supply of pure drinking-water must be provided for air crews, ground staff, passengers and the general public in all terminal buildings.

Drinking-water fountains, suitably labelled and in convenient locations, should be so designed that drinking utensils are not required. If utensils are supplied they should be of the disposable type contained in a dispenser adjoining the fountain, with a receptable at hand for their disposal after use. Drinking-water fountains should never be sited inside toilet compartments. The fountain should be supplied direct from the mains supply and, wherever possible, refrigerated, which not only reduces the possibility of bacterial growth but also improves palatability. Drinking-water fountains are not recommended if the supply is from containers that have to be filled elsewhere, owing to the risk of contamination.

Installations for drinking-water fountains should be constructed of stainless steel or glazed porcelain and at all times be kept scrupulously clean.

FIG. 20. MANUFACTURE OF ICE CUBES FROM MAINS WATER. CUBES BEING SCOOPED INTO POLYETHYLENE BAGS, WHICH ARE THEN SEALED FOR DELIVERY TO AIRCRAFT
clean. The jet should be designed to prevent any back flow and set above the overflow level so that it cannot be submerged in case of blockage; it should be provided with a guard to prevent contact with the user's mouth and adjusted to prevent splashing.

Drinking-water and ice supplied to customers in restaurants or bars must also be pure. The ice must be made in machines supplied direct from the mains. It should not be handled, but should be picked up with tongs or spoons (Fig. 20). Ice should be sampled with the same frequency as water and comply with the same standards of purity.

5.4 Aircraft water supply: general principles

All personnel whose duties are concerned with drinking-water supplies for aircraft should satisfy medical fitness requirements. Separate staff must be engaged for aircraft toilet servicing.

Drinking-water for aircraft should be obtained from the airport mains supply. If the appropriate facilities exist, it can be conveyed direct from the supply point to the aircraft; if not, it can be transported in a water servicing vehicle.

The mains supply point from which aircraft water is obtained should be above ground level and under cover to protect it from contamination (Fig. 21). It should never be sited in such places as toilets or wash-
rooms. If possible, each airline should have a separate supply point and be responsible for maintaining its cleanliness. If, however, the supply point is shared by several airlines or servicing agents, then the airport authority should be responsible for control and maintenance. The supply point must be used exclusively for aircraft drinking-water and should be situated at least 30 metres (100 feet) away from the supply point for toilet servicing vehicles. The hydrant hose should have a self-sealing non-return valve coupling. The diameter of the supply hose should be different from that of the hose supplying water to toilet servicing vehicles.

5.5 Water servicing vehicles

Water servicing vehicles vary from a simple, hand-propelled, manually operated pump type with a capacity of approximately 250 l (60 gal (US); 50 gal (UK)) to an automatically propelled, hydraulic pressure operated pump type with a capacity of 3000 l (850 gal (US); 700 gal (UK)) or more (Fig. 22).

Regardless of the type and size of these vehicles, their standard of hygiene is governed by the same principle. They should be used for no other purpose, and must be so designed and maintained that water in

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**FIG. 22. SUPPLYING DRINKING-WATER TO AIRCRAFT FROM SERVICING VEHICLE**
transit between the filling point and the aircraft water storage system cannot come into contact with any external matter or be affected by handling. The amounts of chemicals required prior to bringing water service vehicles into operation are given in Annex 6.

Tanks should be constructed of smooth, strong, corrosion-resistant material, and so designed that they will not retain sediment when full drainage is required. All corners should be rounded. Covers should be provided which, on removal, will permit full access to the interior for cleaning and maintenance. Tank overflows and ventilation pipes must terminate in such a position that direct aspiration of exhaust fumes, etc., cannot take place during operation. A tap should be fitted to the main tank to permit the taking of samples. Inlet and outlet valves should be self-sealing, non-return, and of the quick-release type. They should be provided with caps for fitting when the vehicle is not in operation.

The hoses should be made of nontoxic, impervious and durable material that will not leave a taste in the water. When the hoses are not in use, all nozzles should be protected from contamination, either by a cover or by immersing them in a container of hyperchlorinated water. Before supplies are delivered to the aircraft the hose should be flushed out by pumping a small quantity of water through it.

Regardless of the purity of the water supply, all water servicing vehicles must be cleansed and disinfected frequently and regularly. One suggested procedure is to fill the vehicle tanks once a week with a 50 mg/l solution of residual chlorine, which should remain for a minimum period of 30 minutes. The vehicle should then be emptied through the delivery hose—not the drain plug. Afterwards, the drain plug should be removed, and the tank flushed out with potable water through the valve coupling.

To obtain the above strength of residual chlorine it is necessary to know the percentage strength of the sodium hypochlorite or calcium hypochlorite used. (The use of chlorhexidine is not recommended.) With a 10% strength, a simple rule is 300 ml to 500 l of water (0.5 pt/100 gal). This produces about 60 mg/l, but allowing for slight deviation it should reach approximately 50 mg/l after a few minutes. If the strength is only 5% then the amount of sodium hypochlorite or calcium hypochlorite used should be doubled—i.e., 600 ml/500 l (1 pt/100 gal). If more convenient the strength of the solution can be increased to 200 mg/l. Contact time can then be reduced to 3 minutes.

Once a month the interior of the water vehicle tank should be scoured to remove any deposits. This can be done either by using a stiff-bristled brush soaked repeatedly in a strong hypochlorite solution or, when convenient, by steam jet, flushing out the tank with clean water, and then repeating the treatment with hypochlorite described above.

Instructions for the cleansing and disinfecting of water vehicle tanks should be affixed to the vehicle for the benefit of operators (Fig. 23). The dates of cleansing treatments should be recorded.
5.6 Treatment of aircraft water

Even if the purity of an airport water supply can be guaranteed, it is still necessary to introduce extra precautionary measures to prevent possible contamination during the transfer of water to the aircraft and in the aircraft water system itself. Thus, prior to being loaded on aircraft, all water should be treated to ensure that the level of residual chlorine is maintained at 0.3 mg/l.

The treatment of water vehicle tanks can be carried out either manually or mechanically. In older models it is a manual operation involving the introduction of small quantities of chlorine to produce the required level. Since only a low concentration is required, care must be exercised to prevent over-chlorination, which might give rise to complaints from passengers about the taste of the water. Chlorine is quick-acting, but unstable and produces an objectionable taste if the residual is in excess of 0.3 mg/l.

An alternative sometimes used is chloramine (C₂H₃ClNNaO₃S), which is much more stable than chlorine, though slower-acting, requiring 30 minutes’ contact time. It should be added to water in a concentration of 16 mg/l. At 32 mg/l a slight taste might be detected, but at 128 mg/l the taste is readily perceptible. Chloramine is normally supplied in powder form and must be dissolved and mixed thoroughly with the water at least 30 minutes before the supply is loaded on the aircraft.

When water is conveyed direct to aircraft from the mains supply point, dosing may be carried out automatically by using portable or fixed chlorinating units at the supply point. One type of portable chlorinator
is shown schematically in Fig. 24. The chlorinator has a chamber divided into two sections, of which the lower contains air. Water containing 7 ml (0.20 fl oz (US); 0.25 fl oz (UK)) of sodium hypochlorite is poured into the upper section in sufficient quantity to fill it. This solution will produce a level of 0.5 mg/l of chlorine for 700 l (180 gal (US); 150 gal (UK)) of water passing through the chlorinator.

With this equipment all the water from the supply point to the point of delivery passes through the chlorinator. Part of the water is fed to the lower air chamber. As the water level rises air is compressed and released to the top chamber. This compressed air forces down the level of liquid, then draws the water up a 6-mm (1-inch) pipe, through the control valve and back into the main delivery. When the solution chamber is empty, the chlorinator should be disconnected and completely drained.

Depending upon the water pressure and the setting of the control valve, the solution chamber will empty at the required rate, for a maximum period of 20 minutes. It is necessary to find a satisfactory rate of feed, and to do this one needs to know the delivery rate in litres per minute, the requisite level of chlorination in milligrams per litre, and the strength of the disinfecting agent. After the feed rate has been determined the control valve lock-nut is tightened so that the flow is uniform.

Fixed chlorinating units may utilize chlorine gas, supplied in cylinders, or liquid as the agent. The former is the most common method, but strict rules must be observed in the interests of safety:
(1) The cylinder should not be moved unless the valve protection cap is screwed on tightly.
(2) Cylinders should be located where they will not be bumped or damaged.
(3) A safety chain should be placed around the cylinder and secured to a support.
(4) If the cylinder is located outdoors, when temperatures exceed 38 °C (100 °F) it should be protected from direct sunlight.

Fig. 25 illustrates an automatic fixed unit chlorinator, for a pressurized supply, which will raise the level of residual chlorine from 0.1 mg/l to 0.5 mg/l at a rate of 140 l (36 gal (US); 30 gal (UK)) per minute.

It is essential to check that the water has been treated in accordance with the airline’s recommendations. A simple method of determining the approximate amount of residual chlorine should be available to ground servicing engineers, cabin crew and catering officers, all of whom should be given the responsibility of testing at appropriate times.

The ground engineer should ensure that the water is tested for the presence of residual chlorine before it is supplied to the aircraft. The cabin crew should also test the water on board the aircraft before any passenger has had the opportunity of drinking it. The catering officer should test any water supplied for drinking purposes from the catering establishment. The test should be simple and quick to perform, so that there is no excuse for noncompliance.

One such test merely involves putting a diethyl-p-phenylene diamine tablet in a small quantity (about 10 ml (0.3 fl oz)) of water. Colour changes give an idea of the level of chlorination: a pink colour indicates satisfactory treatment, no colour change indicates inadequate treatment, and any colour other than pink indicates over-treatment and the presence of excess chlorine. By means of this test complaints from pas-

**FIG. 25. AUTOMATIC FIXED UNIT CHLORINATOR UTILIZING CHLORINE GAS**
sengers can be averted, because when water is found to be over-chlorinated, tablets that neutralize the taste of chlorine can be added by the cabin crew. All aircraft should carry a supply of water-testing and taste-neutralizing tablets. The latter can only be added to water drawn from the aircraft system, because there is no access to storage tanks during flight.

5.7 Aircraft water systems

In modern aircraft all water is stored in tanks. These should be constructed of welded stainless steel or reinforced fibreglass. They feed, either by pressure or by gravity, all aircraft water outlets—i.e., wash-hand-basins, galley taps, drinking fountains, and water boilers.

The tanks should be designed to drain completely. If the aircraft has only one tank, or if several tanks are located together, there will be a single fill/overflow point; if, on the other hand, the tanks are located in different parts of the aircraft each will have its own fill point. In all cases the fill points must be separated from the toilet servicing panels to avoid cross-contamination.

Drinking-water points should be sited outside toilet compartments. The water should be cooled by passing through automatic coolers. A dispenser and receptacle for disposable cups should be installed near the water point.

All waste water should drain overboard. Waste water tanks are not recommended.

All components in the water system must be corrosion resistant and suitable for use with hyperchlorinated water. On some aircraft, filters are fitted for the prime purpose of neutralizing the chlorine content. On occasions these are wrongly and misleadingly described as purifying filters. Quite often they have the reverse effect, since if they are not serviced regularly, the cartridges will disintegrate and contaminate the water. Also, once the chlorine content has been removed, the water has no protection against bacteria introduced downstream from the filter. Such filters should therefore be fitted at each water outlet.

A more satisfactory filter, and one that can be accurately described as a purifier, is a pore filter with a pore size not greater than 0.22 μm. This will arrest all pathogenic organisms and should be placed downstream from the main tanks. It is not meant to replace chlorination but to provide an extra safety measure.

In some aircraft water is stored in portable flasks, or the supply contained in the aircraft tanks is supplemented by an extra quantity in flasks. This practice is not to be recommended—particularly in the case of drinking-water—because of the great risk of contamination of flasks, since these are offloaded at all airports and may not always be properly disinfected before being refilled.
Disinfection

If all water supplied to aircraft is pure and contains residual chlorine at the correct level, the aircraft water tanks and system need not be disinfected so frequently. The recommended frequency is at intervals not exceeding 8-12 weeks. This period can be extended if an airline is certain that only chlorinated water is carried. Where airlines do not request or ensure treatment of water, then the disinfection must be much more frequent—i.e., at least every 4 weeks. The reason for the flexibility in disinfecting aircraft water systems is to enable airlines to coordinate the procedure with a convenient aircraft maintenance check. Nevertheless, whenever a sample collected from an aircraft gives an unsatisfactory bacteriological result then disinfection of the system is necessary.

Aircraft water systems are usually never drained at outstations, except where temperatures are very low and freezing must be prevented. On return to maintenance base the system should be drained and the tanks only refilled just prior to departure.

At the allotted time for disinfecting, the aircraft tank should be filled with water containing residual chlorine at a level of 50 mg/l, which should be left in the system for a minimum of 30 minutes. Alternatively, a 200 mg/l solution may be left in for a period of 3-5 minutes. The tanks should then be drained, flushed out completely with potable water, to make sure that the hyperchlorinated solution is completely removed, and then refilled with treated water.

When the use of portable flasks is unavoidable, these must be cleaned and disinfected in the same way as beverage flasks (see chapter 4, pages 46-47).

5.8 Aircraft water sampling

In addition to the samples collected from the airport supply, health authorities and airlines should take samples from water servicing vehicles, aircraft systems and portable flasks for bacteriological examination. While health authorities should take samples from departing aircraft, the airlines should collect samples from arriving aircraft. If these latter samples are unsatisfactory, the airline personnel should investigate and take steps to rectify any defects in treatment and also arrange for disinfection of the aircraft system.

The frequency of sampling will depend upon the results obtained, closer attention being directed to aircraft arriving from airports where unsatisfactory results have previously been reported. At all events, sampling by airlines should be carried out not less than 4 times a year for each airport supplying water, and the frequency should be increased if the need arises. Whenever the result of a bacteriological examination of a drinking-water sample shows the presence of pathogenic organisms, a second sample should be collected and examined to take care of accidental contamination.
If the quality of water in water servicing vehicles and aircraft systems is lower than acceptable standards, effective precautionary disinfection measures should be applied.

5.9 Distribution of responsibilities and suggested areas of concern, by authority or agency

A. Distribution of responsibility

<table>
<thead>
<tr>
<th>Authority or agency</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health administration</td>
<td>Approval of source of water supply (Article 14.2).&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Health authority</td>
<td>Periodic inspection of installations.</td>
</tr>
<tr>
<td></td>
<td>Collection of water and ice samples for bacteriological examination (Article 14.2).</td>
</tr>
<tr>
<td></td>
<td>Maintenance of records on the quality of drinking-water supplied at airports.</td>
</tr>
<tr>
<td></td>
<td>If a case of cholera is discovered on arrival or has occurred on board, responsi-</td>
</tr>
<tr>
<td></td>
<td>bility for supervising the removal and safe disposal of any water and disinfection of</td>
</tr>
<tr>
<td></td>
<td>water tanks (Article 63.1).</td>
</tr>
<tr>
<td>Airport authority</td>
<td>Provision of an adequate supply of pure water to airport:</td>
</tr>
<tr>
<td></td>
<td>(1) at all terminal buildings;</td>
</tr>
<tr>
<td></td>
<td>(2) for aircraft supplies.</td>
</tr>
</tbody>
</table>

B. Suggested areas of concern

<table>
<thead>
<tr>
<th>Authority or agency</th>
<th>Area of concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airlines</td>
<td>Ensuring that all water for aircraft is treated to contain residual chlorine.</td>
</tr>
<tr>
<td></td>
<td>Ensuring that all water servicing vehicles are in a clean condition.</td>
</tr>
</tbody>
</table>

<sup>a</sup> The article numbers cited refer to the International Health Regulations.
Ensuring that water storage tanks in water servicing vehicles and aircraft are regularly disinfected.

Medical examination of all personnel concerned with water supplies.

Collection of water samples from vehicles and aircraft.

 Provisioning of aircraft with ice made from potable water.

Aircraft manufacturers  
Elimination of the need for all portable water flasks.
6. TOILET SANITATION
AND LIQUID WASTES DISPOSAL

Passengers, ground staff and members of the public visiting airports may be carriers of intestinal disease. Meticulous cleanliness of toilets at airports and on aircraft, together with the sanitary treatment, handling and disposal of toilet wastes, is therefore of the utmost importance.

6.1 At airports

It has frequently been stated that an airport should be the show window of a country, because it is often the first contact a traveller makes with that country. As tourism is playing such a vital economic role in many countries, a favourable impression is important—apart from health considerations. Toilet facilities provided at airports should therefore be of the highest standard and maintained at the maximum level of cleanliness.

The following minimum requirements are suggested for passenger toilet blocks at airports.

General features

Screening. When the entrance door is open the interior of the toilet block should not be visible.

Floors. These should be of terrazzo or ceramic tiles with coved skirting to walls (the coving having a 5-cm (2-in) radius), sloping down from compartments at a gradient of 2.5-5 cm in 3 m (0.5-1 inch in 10 feet) to facilitate cleaning.

Drainage. Floor drainage should discharge into the drainage system through a properly trapped gully. Floor gully grids should be flush with the floor surface, of suitable design to allow easy access, and capable of preventing blockage of the gully by waste material. All fittings should be individually trapped.

Walls. These should be covered from floor to ceiling with tiles or other approved materials and finishes. “Hygiene notices” (“You are invited in the interest of hygiene to wash your hands after using this toilet”), inscribed in glazed tile or on a hard plastic material, should be fitted in toilet compartments and above urinals.

Ceilings. Ceilings should be finished with washable material and should not be perforated.


Lighting. Toilets, cleaners' compartments and urinals should be adequately lit. Light fittings should be flush with the ceiling, accessible and easily maintained. (For lighting standards, see chapter 4, page 28.) Supplementary lighting for mirrors and above wash-hand-basins should be provided if necessary.

Windows. Where there are windows in toilet accommodation they should be fitted with translucent laminated glazing, and the window sills angled at 45° down from the window frames.

Ventilation. Ventilation should comply with the requirements of local building bylaws and sanitary or other regulations currently in force. Where local authority requirements do not include the provision of a "ventilated lobby" or "intervening ventilated space" it should nevertheless be provided. Where natural ventilation is not available, an adequate and efficient mechanical means of ventilation must be provided.

Toilets and related facilities

Compartments:

1. In general, compartment walls should not reach the ceiling, and there should be a space of 15 cm (6 in) between the lower edge and the floor. The end of the compartment wall should abut tightly against the main wall to eliminate the possibility of a dirt trap. Compartment wall surfaces should be nonabsorbent, scratch-proof and easy to clean.

2. Toilet doors should be of durable material with a smooth surface and easy to clean. They should not reach the ceiling, and there should be a space of 15 cm (6 in) between the lower edge and the floor. The inner side should be fitted with a combined doorstop and coat-hook (with rubber buffer).

Fittings:

1. Toilets should be low-level, cantilever-type pedestals allowing easy cleaning of the floor beneath, or any other type approved by the health authority. They should be white or pastel-coloured. Seats should be made of an impervious material to facilitate cleaning. Toilet-roll holders should be of a thief-proof type.

2. Urinals may be the "open-slab" or individual bowl type, according to requirements. For the "open-slab" type of urinal a "step-up" 15 cm (6 in) high and not less than 30 cm (12 in) wide, slightly sloped to the channel but not overhanging it, should be provided. Urinals should be equipped with an adequate automatic flushing mechanism.

3. Wash-hand-basins should be of the cantilever-type allowing easy access beneath for floor cleaning. If cantilevered, the basin should either be recessed or be fitted to allow a space of not less than 10 cm (4 in) between the back of the basin and the wall. Wash-hand-basins may be in a continuous row, but where separated the intervening space should be not less than 15 cm (6 in). Hot and cold running water must
be supplied to each basin. Coathooks should be provided at a conve-
nient spot adjacent to the basins.

(4) Wall mirrors should generally be provided, but should not be
placed above wash-hand-basins. They should be adequately lit.

(5) In women’s toilets handbag shelves should be sited below wall
mirrors.

(6) Hand-drying facilities should generally consist of disposable paper
towels or hot-air dispensers. Where paper towels are made available,
free-standing metal receptacles should be provided for their disposal after
use.

(7) Soap may be in either liquid or powder form, and the dispenser
should usually be sited within the width of the wash-hand-basin, but
towards the right-hand side of it.

(8) All women’s toilets should have the following facilities provided
for the disposal and supply of sanitary towels:

(a) Incinerators of an approved type, which should not be sited in
separate toilet compartments but be available to all users of the toilet
block. The incinerator units should be safe, of sturdy construction,
foolproof in operation, and a complete range of spare parts should always
be available. Incinerator flues should be so constructed as to ensure a
suitable updraught and adequate access for cleaning and maintenance.

(b) An approved waterborne disintegration disposal unit.

(c) A container servicing system operated by an approved company.

(9) Drinking-water fountains should preferably be situated outside
but adjacent to toilet suites. The water supply should be from a rising
mains supply, and the jet from the fountain unit should emit an arc of
water.

(10) In or adjoining large toilet blocks provision should be made for
a cleaners’ locker room complete with sluice. In all other toilet blocks,
a cleaners’ storeroom should be provided.

The number of toilets required will, of course, depend upon the
number of persons using the airport, account being taken of increased
demand at anticipated peak periods. Facilities must be provided in the
arrivals, departure and transit areas, restaurants and all other sections
open to the public. Provision should be made for toilets specially
equipped for handicapped and infirm passengers.

Cleaning

Toilets that are in constant use should have a permanent attendant
whose main function is to service the unit. He or she should replenish
soap, towels, toilet paper, etc., as required, and generally keep the place
tidy, cleaning any fitting that becomes soiled. A cleaning schedule
should be prepared for all toilet units, whether the work is done by air-
port employees or by contractual labour. The person responsible for
maintaining the toilets should appraise the efficiency of the cleaning
materials used and make sure that they do not damage surfaces. The
toilets should be kept in a good state of repair and decoration.
Regular inspections by health authorities at intervals not exceeding one month are advisable, but the frequency may be varied according to the conditions found on inspection.

A cleaning schedule should include the following tasks:

1. Remove all soiled towels and other rubbish to refuse store.
2. Clean wash-hand-basins, taps, shelves, mirrors, pipework, metalwork and all fittings.
3. Clean and disinfect all toilet pans, urinals and drain gullies.
4. Wash floors, splashbacks, pedestals and seats, including undersides.
5. Replenish towels, soap, toilet paper and sanitary towels.
6. Wash walls, doors, windows and light fittings.

The frequency of cleaning will depend on the length of time the toilets are kept open and the frequency of usage. For example, tasks (1) to (5) should be carried out at least once daily, but if toilets blocks are permanently open to the public, the frequency should be increased to 3 times every 24 hours. Task (6) should be performed once or twice a week, according to circumstances.

Included in the cleaning materials should be an efficient detergent/germicide/odour-counteragent. There are several products that fulfil this requirement. The detergent should be non-ionic synthetic and combined with a compatible quaternary ammonium compound. The latter not only is an efficient disinfectant but also enhances the cleaning power of the detergent. In addition, it would be advantageous if the product contained essential oils, which have the property of removing or counteracting the odours normally present in toilets. The product in question should be only mildly alkaline—i.e., with a pH of about 8-8.4. If the detergent is strongly alkaline, not only will salts be deposited on surfaces after cleaning, but these salts may have a damaging effect, especially on terrazzo and marble. Roughness and pitting result from the use of strong alkaline cleaners.

The frequency of cleaning should be flexible, and extra cleaning—i.e., over and above the requirements specified earlier—should be carried out on demand if an inspection reveals the need.

6.2 On aircraft

Although toilets on modern aircraft incorporate a complex electrical flushing mechanism, a filter and a recirculating system—in contrast to the simple portable container on earlier aircraft—they are still basically chemical closets and are provided with retention tanks. The capacity of the toilets should be sufficient to hold all the waste produced by the maximum number of passengers on the longest sector.

The capacity therefore varies according to the type of aircraft but can be calculated from the following data. The average amount of body wastes produced by each passenger during air journeys of different durations is estimated as follows:
### Table

<table>
<thead>
<tr>
<th>Duration of flight</th>
<th>Urine only</th>
<th>Urine plus faeces</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 hours</td>
<td>250 g (9 oz)</td>
<td>300 g (10.5 oz)</td>
</tr>
<tr>
<td>6 hours</td>
<td>375 g (13.5 oz)</td>
<td>450 g (16 oz)</td>
</tr>
<tr>
<td>8 hours</td>
<td>495 g (17.5 oz)</td>
<td>595 g (21 oz)</td>
</tr>
<tr>
<td>10 hours</td>
<td>625 g (22 oz)</td>
<td>740 g (26 oz)</td>
</tr>
</tbody>
</table>

It is thus a simple matter to determine the total tank capacity required, but it must be remembered that the chemical fluid solution with which each toilet is initially charged occupies between one-sixth and one-quarter of the tank, and allowance must be made for this.

The ratio of number of toilets to number of passengers is also important. For long-range aircraft it should be in the region of 1 to 25. With the advent of the 400-plus seater, the proportion of toilets has decreased to approximately 1 for every 30-35 passengers. In short-range aircraft it is much lower, and care must be taken not to decrease it even further. In calculating the total number of toilets to be provided, consideration must be given to the fact that the greater space available in wide-bodied aircraft allows passengers to leave their seats more easily, which has tended to increase the passenger utilization of toilet facilities.

Where aircraft toilets are of the portable type the containers should be enclosed for aesthetic reasons, but be easily removable for emptying, cleaning and recharging with chemicals.

The modern toilet with a fixed retention tank should be so designed that (a) the bowl will be cleaned with each flushing operation; (b) its contents cannot be discharged in flight; (c) the discharge control valves prevent leaking and consequent soiling of the service area or of the personnel engaged in emptying the toilets; and (d) the contents of the tank can be completely drained during servicing operations.

Fig. 26 shows the different components of a typical aircraft toilet and their relationship with the service panel. It is easy to see that there are various areas in the waste tank where solids can remain during the normal emptying operation, one of them being around the drain valve seating.

Either one small tank can receive the discharge from a single toilet, or a larger tank can be used for several toilets. The latter arrangement simplifies the toilet servicing by reducing the number of drain outlets to be connected; in designing the larger tanks it is easier to ensure that solids are not retained when the contents are discharged. The compartment in which the toilet is housed must be constructed of materials that are nonporous and easily cleaned. The joints between floor and walls should be coved. Drinking-water points should be sited outside toilet compartments. Toilet compartments vary in design on different aircraft, but all have similar facilities. A typical unit is shown in Fig. 27.

A wash-hand-basin in stainless steel, with hot and cold running water, soap and disposable towels, should be provided. There should be suitable receptacles for soiled towels and other rubbish. Smoking in aircraft toilets is strictly forbidden, and suitable warning notices should be
FIG. 26. TYPICAL AIRCRAFT TOILET SHOWING MAJOR COMPONENTS AND RELATIONSHIP BETWEEN TOILET AND SERVICING PANEL

FIG. 27. TYPICAL AIRCRAFT TOILET COMPARTMENT
displayed requesting passengers not to put cigarette stubs—or, for that matter, any other rubbish—into the toilet, as these cause obstruction and blockage.

6.3 Aircraft toilet fluids

The retention tank without the addition of any chemical would, in effect, be a cesspool, simply holding sewage until the contents are discharged at the next airport. If any passenger using the toilet has an intestinal infection, there is a risk that the disease will be transmitted when the toilet tank is emptied. It is therefore advisable to use an additive, which should satisfy the following minimum requirements:

1. In the presence of faeces and urine, it should be powerful enough at the recommended concentrations to kill pathogenic organisms within 15 minutes.
2. It should prevent the development of faecal and ammoniacal odours for at least 24 hours from the charging of the closet, and itself be free, charged or uncharged with organic matter, of any unpleasant or irritant odour, even at tropical temperatures.
3. It should have detergent properties and facilitate the cleaning of the closet after emptying.
4. It should be constant in formulation and composition, consistent in performance and stable in storage for 12 months at temperatures ranging between 1 °C and 54 °C (34 °F and 130 °F).
5. It should not corrode aluminium and its alloys (with or without phenolic finishes) or stainless steel: nor should it craze Perspex, Plexiglas and similar substances. Ideally, the formula should not contain zinc chloride.
6. As far as possible, it should not be permanently staining and should be easily washed off.
7. It should not irritate the normal human skin and mucous membranes; this is particularly important in tropical climates, where changes of sensitization are greater in susceptible individuals.
8. The diluted fluid should prevent the formation of obnoxious or explosive gases from excreta. It should not give rise to explosive or otherwise injurious gases at a pressure of 16.7 kPa (125 mmHg) and at a temperature of 27 °C (80 °F), nor should the fluid have a flash-point lower than 66 °C (150 °F).
9. It should not cause the wastes, when disposed of after normal aircraft usage, to be detrimental to the correct biological working of sewage treatment plants.
10. The colour of the diluted fluid, which should be distinctive and aesthetically acceptable in appearance, should, at all stages of use as recommended by the manufacturer, be such that other contents of the closet are obscured.
11. At the maximum dilution in a fully loaded toilet it should retain its bactericidal properties.
The chemical may be added automatically, as a fluid or a powder, through a charging connexion on the aircraft service panel (Fig. 28) or, where this is impracticable, manually via the toilet pedestal.

Servicing aircraft toilets

When removed from aircraft, portable toilets should be covered and spillage prevented during transport to the disposal area. The contents should be discharged into a main sewerage system. The portable toilets must then be washed and disinfected. On return to the aircraft they must be charged with the appropriate quantity of chemicals at the recommended concentration.

Toilet wastes from retention tanks should be discharged either directly into a sewer, where a connexion to the sewer is situated in an aircraft parking area, or into a toilet waste vehicle. Aircraft are provided with a service panel in the fuselage. In the panel are a waste tank drain and cap, a flush port for flushing and recharging and a drain valve handle (Fig. 29).

Toilet waste vehicles vary from simple manually operated single-tank vehicles with a capacity of 230-900 l (60-240 gal (US); 50-200 gal (UK)) to
large mechanically operated vehicles with a capacity of 2700 l (720 gal (US); 600 gal (UK)) (Fig. 30).

These units should have sufficient capacity for the full draining, flushing and chemical precharging of all the toilets on at least two wide-bodied aircraft, without having to unload and restock.

The unit shown in Fig. 30 has three tanks, with the following capacities:

<table>
<thead>
<tr>
<th></th>
<th>Litres</th>
<th>US gallons</th>
<th>UK gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste tank</td>
<td>2300</td>
<td>600</td>
<td>500</td>
</tr>
<tr>
<td>Clean water tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>for flushing</td>
<td>1150</td>
<td>300</td>
<td>250</td>
</tr>
<tr>
<td>Undiluted chemical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fluid tank</td>
<td>40</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

Some of the general performance features are as follows:

1. The unit is capable of removing effluent from aircraft as quickly as possible without the need for operator assistance.
2. The unit is capable of flushing and precharging aircraft tanks with a minimum delivery rate of 114 l/min (30 gal (US)/min; 25 gal (UK)/min) at a maximum pressure of 207 kPa (30 lbf/in²) at the aircraft fitting.
(3) The unit is able to approach all toilet servicing points on the aircraft and allow easy reach by the operators to all such servicing points, which range in height from 1.8 to 4.8 m (6 ft to 15 ft 8 in).

(4) The unit is capable of being emptied by free fall into a site sewerage installation (this operation must be accomplished with minimum inconvenience to the operator).

(5) The unit is capable of easy replenishment with disinfectant fluid and water supplied from mains.

(6) The unit is operable both by night and by day.

(7) Tanks are fitted with quantity indicators. On the waste tank the indicator is such that the level of the contents can be clearly observed at all times without recourse to frequent cleaning and servicing.

(8) The waste tank is fitted with a 10-cm (4-in) inlet and dump outlet. The dump outlet is located at the rear of the vehicle on its centre line, and unobstructed by the rear axle or structure. The operating handle is located in a convenient and easily accessible position, and there should be no possibility of the operators' being splashed during the dumping operation.

(9) Automatic metering of disinfectant into the delivery line when charging the aircraft is provided. For this purpose, the undiluted fluid is carried on the vehicle and metered into the service line when re-
quired. Stowage for two standard 23-l (6-gal (US); 5-gal (UK)) drums of disinfectant is provided where replacement and coupling-up can be accomplished without the use of tools. The charging mixture at the aircraft should be in compliance with the requirements for the disinfectant fluid used as recommended by the manufacturers.

(10) A flow meter is provided with "pre-set reset" characteristics, whereby a predetermined quantity of clean water or disinfectant-charged water can be delivered with automatic cut-off on completion of delivery.

(11) The waste hose should be 10-cm (4-in) bore non-collapsible flexible tubing terminating in a 10-cm (4-in) coupling.

(12) Waste removal and disposal is accomplished by means of a vacuum/pressure system that operates through the waste tank and induces the two functions as required.

- Maximum pressure allowable . . . . . . . 69 kPa (10 lbf/in²)
- Maximum vacuum allowable . . . . . . . 33.8 kPa (254 mmHg)

Safeguards are provided in the system to limit these requirements. Protective devices are installed to prevent the inadvertent extraction of effluent by the exhauster pump. A pressure/vacuum gauge is provided. A deodorizer pack is embodied in the exhauster pump outlet.

(13) Accommodation is provided for two waste bins, which should be stowed within the enclosure behind doors or behind a roller shutter and be freely accessible.

(14) Stowage space for cleaning materials is also available.

**Special servicing**

When servicing is done in countries that experience very low temperatures, the addition of 10% glycol ethylene to the chemical fluid minimizes the possibility of the freezing of the toilet outlet valve, except in severe conditions.

Normal servicing of retention tanks does not always remove all the accumulated solids from the tanks and around the flushing spray rings. It is therefore recommended by aircraft manufacturers that, after draining, the toilets should be filled to capacity with clean water and flushed. In addition, at intervals of 3 months the tanks should be filled with water containing a 1-2% heavy duty detergent. The solution should be left in the system over night, or longer if possible. During this period the mixture should be agitated by operating the flushing mechanism. The tank should be drained and recharged in the normal way.

Another possible way of dealing with this problem is to increase the proportion of detergent in the chemical fluid, but care is required to ensure that this does not affect the fluid’s bactericidal efficiency or damage the toilet structure.

If a toilet is so constructed that normal servicing does not completely remove the contents of the retention tank, it seems logical to suggest
that the design is at fault. If this is the case, it would be better to improve the design so that the tank can be completely emptied rather than introduce special cleaning procedures, which are costly and time-consuming.

6.4 Personnel and equipment handling

As previously mentioned, in order to eliminate the possibility of cross-infection, personnel engaged in toilet servicing should not be employed in handling food or drinking-water equipment. Toilet servicing staff should wear protective clothing, which should be removed before they eat their meals.

Hose pipes and connexions for toilet servicing vehicles and water servicing vehicles should be of different dimensions. Toilet servicing vehicles should not be parked in the same area as water servicing vehicles. A different and distinctive colour scheme will make it easy to distinguish toilet servicing vehicles and equipment from vehicles and equipment used for water and food services. The water supply point for replenishing the toilet servicing unit must be at least 30 m (100 ft) away from the supply point for the drinking-water vehicle.

Disposal of liquid wastes

The contents of the toilet servicing vehicles should be discharged into a main sewerage system, to which all airports should, whenever possible, be connected. If such connexion is not feasible, an airport sewage treatment plant should be provided. Discharge of liquid wastes into open watercourses or on to the land should be prohibited.

Uncontrolled dumping of toilet wastes is both a health risk, if the chemical fluid used is not sufficiently bactericidal, and a safety hazard to aircraft, if the dump is near the runway or flight path, as birds are attracted to such dumps. It is recommended that samples of aircraft toilet wastes should be collected regularly for bacteriological examination, to check the effectiveness of the chemical fluid used.

A separate reception chamber connected to the main sewer should be constructed to receive the contents of toilet servicing vehicles. This chamber should be covered, have a surrounding concrete floor sloping towards it, and be provided with facilities for hosing down after each use. To safeguard drinking-water supplies, wash-down facilities should have adequate back-flow protection. The reception hopper should have a screening device to prevent objects such as bottles and cans from entering the sewer and causing a blockage. There should also be adequate space available on all sides of the toilet servicing vehicle so that it can be washed down and the soiled water can enter the sewer.

The sanitation block, as it is often described, should be sited at a conveniently accessible point so that the toilet servicing vehicles do not have to travel long distances; it must not, however, be nearer than 30 m (100 ft) to food preparation premises, water supply servicing points or air-
port terminal buildings. Toilets, hand-washing facilities and locker rooms should be provided solely for the use of personnel handling the disposal of wastes. Such facilities should be kept clean and in good repair.

6.5 Distribution of responsibilities and suggested areas of concern, by authority or agency

A. Distribution of responsibilities

<table>
<thead>
<tr>
<th>Authority or agency</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health administration</td>
<td>Ensuring the provision of a satisfactory airport sewerage system and disposal facilities for toilet wastes (Article 14.1).¹</td>
</tr>
<tr>
<td></td>
<td>Ensuring the provision of an adequate number of high-standard airport toilet facilities.</td>
</tr>
<tr>
<td>Health authority</td>
<td>Regular and frequent inspection of aircraft toilet waste disposal facilities and airport toilet accommodation.</td>
</tr>
<tr>
<td></td>
<td>Regular sampling of aircraft toilet wastes.</td>
</tr>
<tr>
<td></td>
<td>If a case of cholera is discovered on arrival or has occurred on board, responsibility for supervising the removal and safe disposal of human dejecta and waste water (Article 63.1).</td>
</tr>
<tr>
<td>Airport authority</td>
<td>Provision of an effective system for the removal and safe disposal of excrement and waste water (Article 14.3).</td>
</tr>
</tbody>
</table>

B. Suggested areas of concern

<table>
<thead>
<tr>
<th>Authority or agency</th>
<th>Area of concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airport authority</td>
<td>Maintenance of toilet accommodation provided at airports in a hygienic condition and in good repair.</td>
</tr>
</tbody>
</table>

¹ The article numbers cited refer to the International Health Regulations.
| Airlines                                      | Provision and maintenance of toilet servicing vehicles.  
|                                              | Provision of a bactericidal toilet fluid.  
|                                              | Satisfactory servicing and maintenance of aircraft toilets.  
| Aircraft manufacturers                       | Provision of an adequate number of toilet facilities to meet passenger requirements.  
|                                              | Design of aircraft toilets which will not retain any waste after normal cleaning and servicing, and which can be emptied without premature discharge of faecal matter before the outlet hose is attached.  |
7. SOLID WASTES

Garbage and other dry waste matter emanate from many sources at an airport, including terminal restaurants, warehouses, offices, and workshops, as well as from the aircraft themselves. The storage, transport, and final disposal of solid wastes must be carried out with care to prevent nuisance, health hazards and—indirectly—danger to aircraft.

7.1 Storage

On the ground

An adequate number of covered receptacles constructed in metal or some other nonabsorbent material should be sited at strategic points in the airport—i.e., in convenient locations for all buildings in which refuse is produced. The size of the receptacles may vary from the conventional 0.1-m³ (3.5-ft³) dustbin, where the quantity of refuse is small, to purpose-built containers of a much larger capacity. Some of these containers should be placed in convenient positions to receive the dry waste taken from aircraft during transit. It is essential that the containers should be covered at all times to prevent the scattering of litter and dust by the wind, the breeding of flies and the attraction of rodents, scavenging dogs, and birds. For this reason refuse awaiting disposal should never be stored in an open compound.

Where it is absolutely impossible to obtain covered containers, any compound that has to be used for the retention of solid wastes must be roofed and screened. The floor of such a compound must be of concrete and kept in good repair. Facilities for washing down the floor should be provided. The floor should slope towards a trapped drain gully connected to the foul-drainage system of the airport.

On aircraft

Dry waste accumulating on aircraft should be stored in containers made of light-weight impervious material—e.g., polyethylene. Polyvinyl chloride should not be used, owing to the toxic fumes produced when it is burnt. Some of these containers will be purpose-made and fit into galley units as an integral part.

The waste containers should be emptied at each transit stop and washed with a detergent/disinfectant solution before being returned. The recommended practice is for each airport to stock a spare
set of interchangeable galley waste containers, washed and disinfected, which can immediately replace the full ones offloaded. After being emptied, these soiled containers should be taken to a unit for washing either by hand or by machine. The use of disposable polyethylene liners will help to prevent undue soilage of waste containers, but must never be a substitute for washing, as the liners get torn and spillage results. Ideally, containers should be disposable, waterproof and resistant to tearing.

Waste containers may either be washed with hot water and detergent solution supplied at high pressure from a mobile machine, cleaned by steam, also under pressure, or passed through a container washing machine, as shown in Fig. 14 (chapter 4, page 45).

7.2 Collection and transport

In transporting dry wastes from aircraft or airport buildings to the covered storage containers, care must be taken to avoid spillage and other nuisances. The wastes should therefore be transported in covered vehicles or containers. The same principle applies when waste is taken from the storage area for final disposal. Special purpose-built vehicles with dustless loading facilities should always be employed, and open vehicles strictly prohibited. Strong winds are prevalent at some airports and the scattering of litter during collection and transport causes not only a nuisance but, in some circumstances, a health risk and a safety hazard.

7.3 Disposal

The disposal of wastes calls for careful planning. This has been emphasized by a WHO Scientific Group, which stated:

"The disposal of wastes must take place within a closed environment comprising only earth, air, and water. When the liquid, solid, or gaseous residues from waste treatment are disposed of, they must be discharged into one or more of these phases of the environment. Any or all of the phases may be polluted, and any solution to the general problem of the disposal of wastes therefore involves a decision as to which part of the environment can accept residues with least damage to the whole. In other words, in deciding on a site for the disposal of residues, their total effect on the environment must be studied. Wastes must no longer be transferred from one environmental phase to another without adequate study. This is particularly important in view of the fact that some residues persist permanently." (39)

In connexion with the disposal of waste from airports, apart from the possible spread of disease by flies and rodents, which are attracted to disposal areas, there is the additional risk to aircraft from bird strikes during take-off.

Birds are attracted by organic wastes, and it is vital that the disposal site should be carefully planned well away from runways and flight paths, in order to prevent a bird hazard problem. The land around airports is increasingly being used as a site for garbage dumps and sanitary
landfills because of the readily available property at a relatively low cost. The United States Federal Aviation Administration has recently issued guidelines aimed at banning the location of garbage dumps or sanitary landfills within 3000 m (10 000 ft) of airport runways used by turbo-jet aircraft and within 1500 m (5000 feet) of those used by piston-engine aircraft.

The action is intended to minimize the hazards to airport flight operations posed by large numbers of birds attracted to the dumps or landfills. Birds striking aircraft can damage critical control surfaces, and if they are drawn into turbine engines a loss of power results. Fig. 31 illustrates this potential hazard, caused by the siting of rubbish dumps near airport runways. Damage can also be caused by large items of litter being sucked into aircraft engines. In deciding on the location of the disposal site, the direction of the prevailing wind should therefore be taken into account.

The site must be well away from food preparation premises to prevent the migration of flies and rodents, which breed on organic wastes. In selecting a site it must be remembered that flies can travel up to distances of approximately 10 km (6 miles) or maybe even further when assisted by the wind. However, regardless of distance from the airport, disposal must be efficiently controlled to prevent nuisance and health hazards. If waste matter is indiscriminately deposited on the ground or in bodies of water, breeding places for rodents and insects will be created. Uncontrolled or incomplete combustion of solid wastes will release undesirable pollutants into the atmosphere. It may also produce large volumes of smoke, which if close to a runway could be distracting to pilots.

**FIG. 31. LARGE FLOCKS OF BIRDS RISING FROM A RUBBISH DUMP ADJACENT TO AN AIRPORT RUNWAY**
Inefficient incineration may give rise not only to smoke but also to dust or grit emission. Acceptable disposal methods include:

1. Incineration in a mechanical plant designed, equipped and operated to prevent air pollution.
2. Pulverization controlled as above.
3. Controlled tipping or, as it is also described, sanitary landfill.

The residue from methods (1) and (2) may also be finally disposed of by controlled tipping. This procedure basically consists in depositing the waste on low-lying land from which the topsoil has been removed. The waste is placed in layers not exceeding 2 m (6 ft 6 in) in depth, compacted, and then at the end of each day covered with the previously removed topsoil to a depth of not less than 15 cm (6 in). The area must also be provided with screens to arrest litter scattered by the wind.

The sanitary landfill system of disposal reduces insect and rodent breeding but does not eliminate it entirely, especially in tropical regions, where the high temperature and humidity increase the rate of decomposition and accelerate breeding. It is therefore vital that effective vector and rodent control measures at airports should be extended to waste disposal sites.

7.4 Special wastes

At airports the need frequently arises to dispose of toxic, noxious or polluting wastes, which may be either solid, semi-solid or liquid. The disposal of these hazardous wastes must be strictly controlled. At no time should they be disposed of indiscriminately. Airports should make special arrangements, in conjunction with the health authority, for the collection and disposal of any material considered hazardous. There may also be occasions when condemned food requires disposal. This again should be done under the direction and supervision of the health authority.

7.5 Distribution of responsibilities and suggested areas of concern, by authority or agency

A. Distribution of responsibilities

<table>
<thead>
<tr>
<th>Authority or agency</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health administration</td>
<td>Ensuring the provision of an efficient system at airports for the storage, removal and safe disposal of refuse, condemned food and other matter dangerous to health (Article 14.1).*</td>
</tr>
</tbody>
</table>

* The article numbers cited refer to the International Health Regulations.
Ensuring the provision of facilities for vector and rodent control at waste disposal installations.

Health authority: Carrying out regular and frequent hygiene inspections of airports and installations.

Airport authority: Providing for the storage, removal and safe disposal of solid wastes (Article 14.3).

### B. Suggested areas of concern

<table>
<thead>
<tr>
<th>Authority or agency</th>
<th>Area of concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airlines</td>
<td>Removal of waste from aircraft and transport to waste storage.</td>
</tr>
<tr>
<td></td>
<td>Cleaning and disinfecting aircraft waste containers.</td>
</tr>
<tr>
<td>Airport authority</td>
<td>Ensuring the provision of an adequate number of litter containers, ashtrays, etc., throughout the airport and the frequent removal of the contents.</td>
</tr>
<tr>
<td>Aircraft manufacturers</td>
<td>Designing suitable and acceptable waste disposal receptacles for aircraft.</td>
</tr>
</tbody>
</table>