Sanitation of Domestic Airlines

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COMMERCIAL AIRLINES of the United States have achieved a notable degree of progress in cleanliness and sanitation.

Today's air passenger is provided many more comforts than were available in earlier aircraft. Airline companies properly insist that practicable passenger conveniences unquestionably contribute to the continued success of air transportation. However, the installation of water systems, toilets, and galley facilities, such as are found on railway cars and ocean-going vessels (*1*, *2*), is necessarily adjusted to the primary considerations of safety of the passengers and crew and weight and space conservation in all phases of airline operation.

Mr. Megonnell, at present doing graduate work in public health at Harvard University, is a sanitary engineer in the Division of Sanitary Engineering Services, Public Health Service. He is co-author, with E. C. Garthe, of Dining Car Sanitation in the United States, published in the January 1955 issue of Public Health Reports (p. 25).

Mr. Chapman is co-author, also with Mr. Garthe, of Sanitation Aboard American Flag Vessels, which was published in October 1952 (p. 963), and was the first of the articles on the carrier-inspection functions of the Public Health Service. Mr. Chapman is Public Health Service regional engineer for Region IV (Atlanta).

The domestic scheduled airlines carried more than 32 million passengers in excess of 16 billion passenger-miles during 1954 (*3*). There was a tenfold increase in the number of passengers carried and the passenger-miles flown in the short span between 1942 and 1954. Nineteen scheduled lines operated 186 aircraft in 1942. Twelve years later there were 32 lines with 1,175 craft. Comparable figures are not available for nonscheduled lines, but their growth probably paralleled that experienced by the regular airlines.

Public Health Significance

All parts of the world can now be reached by air within the incubation period of the major infectious diseases.

Obviously, the rapid development of long-range air transportation is a source of much concern to public health authorities. It is the Federal Government's responsibility to institute protective measures aimed at preventing the introduction, transmission, or spread of communicable diseases from foreign countries to the United States, and in this country, from one State to another. When the Congress granted interstate quarantine authority to the Public Health Service in 1893 (*4*), however, only balloonists traveled by air.

The Service devoted little attention to the matter of airline sanitation until the early 1940's. In wartime, as swift transportation became vital to national survival, servicemen and defense workers took to the air in unprecedented numbers. To provide public health workers and carrier employees with necessary information and guidance in conforming to the Interstate Quarantine Regulations (*5*), the Service in 1942 published the Sanitation Manual for Land and Air Conveyances Operating in Interstate Traffic (*6*). Limited association with the airline industry up to that time and relatively long experience in railroad sanitation made it inevitable that the Service base the manual largely on land-carrier operations.

Before the war, the largest commercial airliner seated 21 passengers. The longest flight was approximately 800 miles and required about 4½ hours of flying time. After the war, the commercial airlines converted a number of military aircraft into passenger planes, designed to carry from 40 to 50 passengers on flights of several thousand miles. Subsequently, faster planes with additional passenger capacity were built.

The use of larger and faster conveyances results in two important factors of public health significance: (*a*) The carrying capacity creates in proportion the need for food, water, and beverage containers, wash water tanks, and toilet facilities, and (*b*) speed and flight range shorten the travel time between endemic disease areas and areas susceptible to infection. Airline personnel were applying to their sanitation problems the ingenuity typical of the industry, but there was little or no standardization of equipment or uniformity of operation among the carriers. The possibilities of disease transmission together with the growth of the air transport industry made apparent the need for a comprehensive handbook devoted exclusively to standards of interstate airline sanitation.

To meet this need, the Service published the Handbook on Sanitation of Airlines in 1952 (*7*). The Joint Committee on Airline Sanitation, a committee composed of caterers and representatives of the airlines associated with the Air Transport Association of America, collaborated closely with the Service in the preparation of the text. Representatives of other airlines and many State health departments reviewed the preliminary draft.

The publication sets standards on all facets of interstate airline sanitation for domestic air carriers. United States airlines operating in foreign traffic follow the same standards, whenever practicable, in their overseas operations.

The handbook is intended for the use of designers, builders, caterers, and servicing area personnel as well as operators of aircraft. Some day it may serve to stimulate the formu-

That Ridiculous Pork Chop

"I had a pork chop at a height of 8 miles above the earth's surface. . . . Find yourself slipping through space in a comfortable armchair at just under 500 miles per hour, your hat in the rack above your head and the nearest point of the earth's surface some 40,000 feet below you; it is hard to think of anything that could make you more acutely sensible of your singular situation. But a pork chop does it. Sizzling hot from the galley they brought it to me, and I looked at its homely outline and then out along the steady, silver wing into the deep blue dome of the sky, and I thought of the pitiless sub-sub-zero unbreathable air in which we hung and the long, long drop below—and then I looked back at my plate again and somehow, suddenly, the whole sweep and sublimity of man's miraculous achievements seemed to be summed up and crystallized in that ridiculous chop. What business had such a thing to be 8 miles up in the air? . . . It tasted—and I remember being surprised at that, too—much as usual."

—From H. F. Ellis, Meals in Motion, *The Atlantic*, August 1954, pp. 93–95.

lation of comprehensive international standards since sanitation, in common with other phases of airline operation, has universal application and importance.

Airline Food Service

In their efforts to attract and hold new business, aircraft operators vie with each other to provide tasty, attractive meals for passengers. This culinary spirit is probably not so keen in the United States as it is in other countries, where planes on epicurean flights at times go out of their way to provide time aloft for the eating of meals. Nevertheless, domestic scheduled airlines today are spending more money to feed their passengers than they spent not many years ago to fly them. The cost for complimentary meal service on scheduled airlines in 1954 was more than $22 million.

Overseas airlines are often equipped with galleys for the storage and preparation of precooked frozen foods. This type of service on domestic airlines is precluded by weight, space, and flight-time restrictions.

Foods and beverages for domestic aircraft are prepared in catering establishments or carrier-owned commissaries. Airline catering has become a specialized trade. Airline equipment has been devised for the packing, storing, and transporting of meals. As a precaution against contamination of food and drink from the time the meals are prepared to the time they are served aboard the plane, lightweight and compact mechanical refrigeration units have been developed for aircraft.

Meats, cooked vegetables, and other hot comestibles are placed in casseroles, where they are kept hot either in large, preheated vacuum jugs or in portable, electrically heated ovens.

Cold portions of meals, such as salad dressing, bread, butter, dessert, cream, and condiments, along with utensils and napkins, are placed on trays which are packed in carrying cases, with dry ice.

Beverages are stored and transported in stainless steel, constant-temperature containers, which often are chilled by dry ice placed in a recessed tube in the lid of the container.

After the meal, unconsumed foods and soiled utensils are returned on the individual serving trays to the carrying cases. Liquid and paper wastes are put in covered or enclosed metal receptacles. Tray carriers and waste containers are removed by catering personnel for emptying and cleaning, prior to re-use on later flights. Suitable refuse containers, storage areas, and container-cleaning facilities must be provided at the catering point.

It is not feasible to clean and destroy microbes on multi-use eating and drinkng utensils aboard aircraft, where water supplies and waste retention facilities are restricted by space and weight allowances. Since washing is necessarily performed at ground installations, enough utensils are needed on the craft to give each passenger a clean set.

Preventing Food Contamination

There has been a strong cooperative effort directed against the contamination of food. Galley equipment is designed to facilitate cleaning by the aircraft operator in compliance with food sanitation standards. Rounded corners, tight seams, and removable parts aid in preventing accumulation of dirt and harborage of vermin. Unless design and construction are combined with proper cleaning and mainte-

Foods and beverages are delivered in enclosed carts.

nance, insects and rodents may be attracted aboard aircraft by remnants of food in the cabin and in the galley area (*8*).

Despite precautions, few operating airlines have escaped at least one outbreak produced by food contamination although outbreaks reported have been relatively minor, both as to number of cases and seriousness (*8*, *9*).

Symptoms often develop within a short time after swallowing contaminated food. Unquestionably, a pilot suffering from severe nausea, vomiting, headache, diarrhea, or cramps would be strained to assure the safety of his plane, passengers, and crew. Thus, although the primary aim of sanitation is to prevent the spread of communicable disease, an immediate benefit of the program is to enhance safety by protecting the health of the pilots.

Serving of box lunches on commercial airlines has increased with the advent of tourist flights. Box lunches often are served during military movements and other chartered flights. Foods usually included in box lunches are particularly vulnerable to contamination. Aircraft have no equipment for keeping box lunches hot or cold to retard bacterial growth. The selection of food for a box lunch and its management require unusual consideration.

Two violent outbreaks which occurred simultaneously on planes of two domestic airlines in 1954 were traced to box lunches prepared by one caterer. Both outbreaks affected military personnel on charter flights.

Also in 1954, several crew members and about half of the passengers became violently ill aboard a United States plane operating in foreign traffic. Fortunately, the plane was returned safely to a stopover point. There the sick were hospitalized. Sandwiches served on this flight had been prepared at a foreign station and were found to be grossly infected with staphylococci.

Alerted by these experiences and aware of the inherent dangers to health in box lunch food service, the Joint Committee on Airline Sanitation sought the recommendations of the Service in preparing a specific sanitary guide for the safe preparation, storage, and handling of box lunches. The result was the Guide to Safe Airline Box Lunch Service, which the committee has recently issued to all airline caterers.

The prolific growth of pathogenic organisms in box lunches is generally attributable to inadequate refrigeration or lack of refrigeration. Recently, several catering chains have purchased portable, insulated, mechanically refrigerated carts in which to store lunches and transport them to the points of sale.

Aircraft Water Supply

The availability of safe, potable drinking water is no less important in the plane at 10,000 feet than it is at ground level in the cities and towns. Concern over the quality of drinking water prompted intensive activity in airline sanitation.

Bacteriologically unsatisfactory drinking water samples in alarming proportions were collected from aircraft in 1951. Extensive water sampling and bacteriological examinations revealed the condition to be widespread. Airlines, caterers, and the Public Health Service agreed that the observations pointed clearly to the need for close attention to sanitation, not only of drinking water supplies but of all aspects of airline operation.

Corrective measures were introduced without delay. Immediate action consisted of establishing continuous procedures for the detection and repair of structural flaws which develop through usage in portable water containers and for careful cleaning, filling, storage, and handling of the containers. Manufacturers were urged to improve the design of equipment to conform with sanitary construction standards.

Drinking water is usually supplied in 2-quart, 6-quart, or 8-quart stainless steel, constant-temperature containers, which are filled at catering establishments. The largest containers have recessed tubes, built integrally with the lids, into which ice can be placed for chilling the water. The apparent simplicity of this procedure belies the serious problems encountered by airlines in providing safe, palatable water.

Except in certain large planes, wash water is supplied from a separate system. This is usually of rudimentary design, consisting of a tank in, or near, the toilet room and a short length of pipe through which water flows by gravity to the draw-off point at the lavatory sink.

On older craft, the tanks are filled from buckets. The tanks on newer planes are filled by pumping water from a movable cart.

Waste water is discharged directly overboard from older aircraft. On pressurized planes, waste water generally is stored in retention tanks so as to avoid the complicated airlocks or similar devices which would be necessary to prevent pressure loss.

Indications are that the entire general system for supplying drinking water on domestic aircraft will be revised in the future.

Single Water Systems

The history of unsatisfactory bacteriological quality of drinking water in many constant-temperature containers, the extra handling involved, and the constant vigilance necessary to prevent chance contamination of the water when portable containers are used led the Public Health Service to advocate the installation on aircraft of single water systems which supply potable water for drinking, washing, and all other purposes. Single water systems are to be found on some air conveyances operating in international traffic, on some foreign aircraft, and on some planes of one domestic operator.

The many technologic problems to be considered in designing a satisfactory and sanitary water system for aircraft are complicated by space, weight, and safety considerations. In view of weight limitations, the amount of water permitted is small. However, water may be even more necessary aboard planes than it is on surface carriers because of the problem of maintaining ground temperature and humidity conditions in passenger cabins at operating heights (*8*, *10*).

Cumberland and Bowey (*10*) report the experience of British Overseas Airways Corporation, which might be considered in estimating water supply requirements on United States flights. On BOAC planes, 3.75 pounds of water per passenger has been found to be adequate for drinking and washing purposes on flights of 1 to 3 hours' duration; 6.88 pounds for day flights; and 9.38 pounds for night flights of 3 to 5 hours. Ten pounds per passenger is provided on flights from 5 to 12 hours long.

Comparable information on United States

Filling an aircraft water system at stopover point.

flights is not available. However, McFarland (*8*) estimates that the average water intake for a passenger on an air transport is about 1.4 pounds during each 6 hours of flight. Since one-half of this amount would be available in the food served aboard the plane, it would be necessary, if food is served, to provide only 0.7 pound of drinking water per person for a 6-hour flight.

Estimates of the amount of water required for washing are more variable. On large aircraft, the supply ranges from 5.0 to 6.7 pounds a person. United States transoceanic airlines supply at least 10 pounds of drinking and washing water for each person on overseas flights of approximately 12 hours.

These seemingly small water requirements account for a significant weight increment in larger craft. The problem has stimulated research on the possibility of recovering water by various means during flight. Water recovery from engine exhaust gases, reclamation of used ablution water, and recovery of water vapor condensate within the aircraft have been investigated as possibilities. Up to now, each of these leads has proved unsatisfactory because of engineering, hygienic, esthetic, or safety implications.

Design of Water Systems

Aircraft water systems in the past were designed after other equipment layout was completed. As a result, the amount of leftover space available determined the size, shape, and location of tanks, complicated their accessibility, and invited possible contamination. If the space for water tanks is allocated during the early design stages, the water system can be planned in relation to the entire plane and its intended use.

As with other engineering developments, simplicity generates dependability so that a well-designed water system is free of unnecessary, complicated parts which require maintenance and which are subject to breakdown. Simplicity makes the gravity-feed system desirable, but inflexibility of tank location sometimes makes it impracticable. Since there is usually little room in the roof of a passenger cabin to install tanks in keeping with the decor, it is often necessary to install an electric pump or other force type of feed which does not limit the tank size and location.

Sanitary design requires that the water tank have no interior cracks, open seams, or protuberances which might provide harborage for contaminants. Careful choice of materials for tanks can prevent subsequent corrosion as well as possible contamination of the water with metal salts which may be harmful to health or unpleasant to taste or smell. Equal care given to the selection of any required protective coatings will prevent possible toxic effects.

Prevention of freezing is the principal difficulty in assuring trouble-free installation of aircraft water systems. Direct contact between the fuselage skin and the water system is avoided by proper location or insulation of tanks and pipes. A completely drainable system which can be emptied easily may escape damage when the plane is standing idle in freezing weather. It is easy also to flush such a system periodically.

Sanitary design requires a distribution system protected against the introduction of contamination by backflow. A vacuum breaker should be installed in the supply line when the water delivery to fixtures is not through an air-gap.

Water drawn from any tap on the water system of an aircraft should be fit for human consumption, but it takes careful planning and good maintenance to adhere to this standard.

According to the Interstate Quarantine Regulations, water must be safe in quality and handled in a sanitary manner before it is considered acceptable for use aboard carriers. Therefore, the use of strainers or filters in aircraft water systems is not required by the Public Health Service.

When filtering devices are provided aboard aircraft, the Service recommends that they be easily accessible and so constructed that they can be cleaned and sterilized or replaced with sterilized units routinely. Otherwise, filtering devices tend to harbor bacteria. Sometimes use of the filter promotes a false sense of security to the extent that cleaning and sterilization are neglected.

Similarly, treatment of water aboard air conveyances is not required. However, a carrier's decision to practice supplemental treatment may be an added safeguard.

Along the international airways, there is interest in design of the water-servicing panel on the skin of the ship.

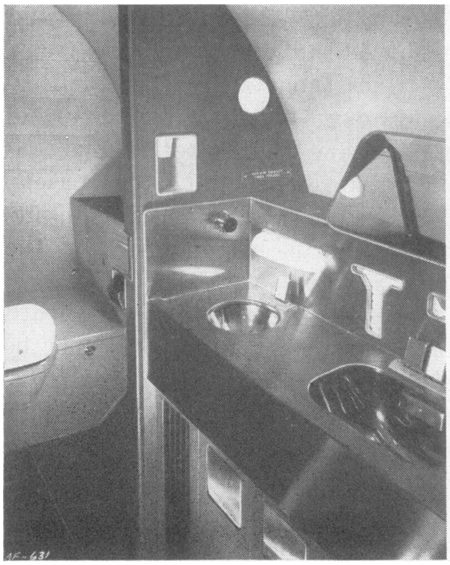
If the panel is opposite to the sewage and other servicing panels, there is less possibility of contaminating the water during the filling operation. This possibility is reduced still further when the water panel is clearly labeled and protected from dirt, oil, and other contaminants by a hinged cover. Connections should be quick-coupling and of a size different from other connections. They should be fitted with tight-sealing caps, with keeper chains.

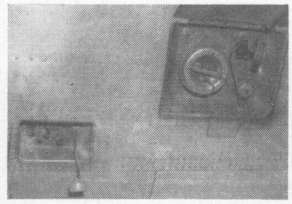
As airports lack hydrants on the ramps, water is usually transported to aircraft in carts. The Service recommends that these be of sanitary design, cleaned routinely, clearly labeled, and used for no purpose which could affect the quality of the water. A direct hose connection from a hydrant to the aircraft water tank would, of course, minimize water handling and chance contamination.

Aircraft Sewage Disposal

Commercial airlines rightly insist that toilet facilities on the planes be adequate, convenient,

Sewage Disposal on a Modern Airliner





Left: Compact toilet room. *Above:* External servicing panels with waste water valve and drain (left) and sewage outlet, flushing water inlet, and valve. *Right:* Large hose drains sewage into cart beneath plane. Small hose pumps flushing water and deodorant into toilet.

and inoffensive. Consequently, the design and installation of sewage facilities are now facets of the aeronautical sciences (*11*).

Both Interstate Quarantine Regulations and the International Sanitary Regulations (*12*) prohibit the discharge of excrement from aircraft in flight. None of the methods investigated for rendering sewage innocuous prior to disposal overboard have proved satisfactory from medical or engineering viewpoints (*8*, *11*, *14*). Sewage is stored aboard the plane pending disposal at servicing areas.

Present weight and space limitations preclude the provision for flushing water and storage tanks. A system employing waste wash water for toilet flushing, built into a few airplanes, was later removed because of operating difficulties.

On older aircraft a chemical toilet retains sewage wastes, and a small amount of deodorant-disinfectant solution is placed in a carry-out pail, housed in a vent chamber.

At the airport, a maintenance man carries the bucket through the passenger cabin to a cart or truck to be emptied into a sewer. The bucket is cleaned inside a closed cabinet connected to a sewer, recharged with chemical solution, and returned to the plane.

On newer planes, however, the toilet-servicing panel is recessed in the skin of the fuselage. The panel contains a waste discharge outlet, a flushing-water inlet, and valves. Couplings—a different size from the water couplings—permit easy attachment and release of hoses. Servicing pipes are sealed with removable blanking caps. Connections are tight to prevent leakage.

A crew empties the sewage by gravity flow through a large flexible hose into a cart or truck, flushes the aircraft sewage container with water from the cart or an auxiliary cart, and pumps fluid chemical into the toilet tank for recharging.

The carts with waste-receiving, flushing-water, and deodorant tanks for ground servicing are maintained separately from drinking water and food service equipment, by a separate crew.

Sewage Retention Capacity

The sewage retention capacity of toilet tanks depends on the number of passengers carried and the duration of the flight. For design purposes, the rate of body waste production per hour per person is estimated at from 0.014 to 0.019 gallon. Dejecta from airsick passengers is not overlooked in estimating waste retention capacity of toilets.

The volume of tanks is increased commensurately with seating capacity and length of flight.

Rounded corners and smooth seams and joints facilitate cleaning of toilet tanks. With external servicing, it was necessary to introduce valves, piping, and other fittings into the containers.

Odor Control, Incineration

Although odor-destroying substances are used in aircraft sewage retention tanks, the Public Health Service does not accept their use in lieu of effective cleaning. The product used must suppress sewage odors for prolonged periods over a wide range of temperatures, but it should not be a nuisance or a danger to the passengers or craft. It is important that it not mask odors of leaking gasoline, hydraulic fluid, oil, smoke, or other danger signals normally detected by the sense of smell.

It is required that the toilet room and galley be as distant from each other as possible. Vitiated air from toilet rooms is discharged overboard rather than recirculated in the plane's air-conditioning system. This system of ventilating is effective during flight, but not always at stopover points and terminals.

The airtight, watertight receptacle used by airsick passengers for containers should likewise be widely separated from the galley.

Current research and development appear to be concentrating on incineration of sewage and dejecta while the plane is in flight. An electric incinerator has been developed, but its power requirements may be excessive for present aircraft. Incineration by fuel or electricity is complicated by safety considerations.

Other Health Services

As with vessels and railroad passenger cars, the Public Health Service awards Certificates of Sanitary Construction for aircraft constructed in compliance with requirements of the Interstate Quarantine Regulations. Review of plans and specifications concerning features with health significance assures that defects which might require subsequent costly changes are not built into a plane. It is becoming general practice for carriers to specify that the manufacturer must obtain the certificate before delivery of a conveyance will be accepted.

To assure compliance with the Interstate Quarantine Regulations relating to the sanitation of food, water, milk, and frozen dessert supplies, a continual program of inspection is conducted in cooperation with State health departments. Subsequent to each inspection, a source is classified as approved, provisionally approved, or prohibited for use by interstate carriers.

Airlines are kept informed of the sanitary status of suppliers by the semiannual publications, the Official Classification of Airline Catering and Watering Points and the Official Classification of Milk and Frozen Dessert Sources.

Approximately 200 servicing areas are regularly inspected. Plans for construction or major reconstruction of terminal facilities are reviewed when public health is concerned, and inspection and consultation are continued during construction.

Public Health Service and State and local health department technicians are prepared to investigate disease outbreaks occurring on aircraft.

Service personnel of the regional offices are prepared to instruct airline employees in airline sanitation, to assist in developing visual aids and other educational material, and to interpret regulations for carriers as an aid in the formulation of company rules governing airline employees.

Service studies and investigations relating to airline sanitation are conducted to assure that equipment is designed and fabricated in accordance with standards and requirements of the Interstate Quarantine Regulations.

Problems faced by United States airlines which operate overseas are particularly perplexing. Most of these lines attempt to follow the standards established for interstate travel in the Handbook on Sanitation of Airlines. They conscientiously try, by the most appropriate means, to load only acceptable food, milk, and water supplies, and to provide adequate facilities and operating procedures for the safe and sanitary disposal of sewage and refuse. Their efforts, nonetheless, are greatly complicated by local customs, illness among native workers, and public health practices which are not consistent at all stations.

Aircraft sanitation services are fitting items for international standardization. The Public

Health Service standards are a contribution toward attainment of this objective.

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Note: The photographs have been supplied through the courtesy of American Airlines, Pan-American World Airways System, Sky Chefs, and Allied Aviation Services.

REFERENCES

(1) Megonnell, W. H., and Garthe, E. C.: Dining car sanitation in the United States. Pub. Health Rep. 70: 25–34, January 1955.

(2) Garthe, E. C., and Chapman, H. W.: Sanitation aboard American flag vessels. Pub. Health Rep. 67: 963–971, October 1952. Reprint No. 3208.

(3) U. S. Civil Aeronautics Administration: Statistical handbook of civil aviation. Washington, D. C., The Administration, 1955.

(4) 27 U. S. Stat. 449.

(5) Interstate Quarantine Regulations. 42 CFR 72.

(6) Sanitation manual for land and air conveyances operating in interstate traffic [adopted and promulgated by the U. S. Public Health Service, October 2, 1942]. Pub. Health Rep. 58: 157–193, Jan. 29, 1943. Reprint No. 2444.

(7) U. S. Public Health Service: Handbook on sanitation of airlines. Standards of sanitation for the construction and operation of commercial passenger aircraft and servicing and catering facilities. Public Health Service Pub. No. 308. Washington, D. C., U. S. Government Printing Office, 1953.

(8) McFarland, R. A.: Human factors in air transport design. New York, McGraw-Hill, 1946.

(9) McFarland, R. A.: Human factors in air transportation. New York, McGraw-Hill, 1953, ch. 13.

(10) Cumberland, C. H., and Bowey, G. S.: Water systems in civil aircraft. Aircraft Engineering 23: 322–329, November 1951.

(11) Bowey, G. S.: The design and installation of aircraft sanitary systems. Aircraft Engineering 25: 101–107, April 1953.

(12) International Sanitary Regulations. World Health Organization Regulations No. 2. Geneva, Switzerland, World Health Organization, 1951.

(13) Bell, H. E.: Handling and disposal of human waste aboard aircraft. Master's thesis. Cambridge, Massachusetts Institute of Technology, 1954.

PHS Staff Announcement

Abraham W. Fuchs, chief of the milk and food program of the Public Health Service from 1940 to 1952, retired on March 1, 1956, after 39 years with the Service, 26 of them as an engineer officer of the commissioned corps.

For the past year, Mr. Fuchs has been chief of the Field Party, United States Operations Mission, Kingston, Jamaica. He has returned to Jamaica as an adviser on environmental sanitation for the International Cooperation Administration.

In a distinguished career with the Public Health Service, Mr. Fuchs helped State and local agencies to develop milk and food sanitation ordinances and codes and to initiate cooperative programs with industry for the improvement of the sanitary quality of milk supplies. During World War II, his attention was directed toward adequate milk supplies for critical defense areas and demonstration classes for food handlers. His research focused on sanitary design and adequacy of pasteurization equipment. He developed basic design criteria for leak-protected valves on vat pasteurizers.

From 1952 to 1955, Mr. Fuchs was chief of the Health Division, United States Operations Mission to Israel. The Association of Milk & Food Technology awarded him its citation award last October. He had served as an associate editor of its journal since 1947, as president of the association in 1949, and as a member of the executive board for 6 years.

Mr. Fuchs obtained his civil engineering degree with a major in sanitary engineering at Cornell University in 1913.