Preliminary Tests With DDVP Vapor for Aircraft Disinsection

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EFFECTIVE disinsection of aircraft is essential to prevent the introduction of nonindigenous insects into the United States. Present disinsection procedures rely on the treatment of passenger and baggage compartments by means of aerosols. Despite the toxicity of such aerosols to insects, experimental treatments of the baggage compartments of planes have shown that the percentage kill of test houseflies is not adequate, even at levels 10 to 20 times the dosages normally used.

Other types of insecticidal applications have been studied as possible substitutes for the aerosol technique, but the only one of promise was that reported by Quarterman and Sullivan (*1*). They found that vapor from lindane-treated filters installed in the ventilating system of an aircraft gave excellent kill of free-flying houseflies at an exposure period of 30–60 minutes and at concentrations of 0.09 to 0.16 μg. of lindane per liter of air. Since that time, considerable work (*2*, *3*) has been done to explore the feasibility of using insecticidal vapor for aircraft disinsection. The toxicant used was DDVP. As one of the steps in this comprehensive study, a series of tests was conducted on the ground with commercial aircraft of the DC–6 and DC–7 types at the Miami International Airport in 1959.

The DDVP vapor was produced by experimental dispensers (see illustration), which consisted of a squirrel cage fan (10 cfm) attached to a polyethylene flask containing purified DDVP and a wick of coarsely woven fiberglass fabric (*4*). Air from the fan passed into the flask through a polyethylene tube inserted in the apex of the wick and then was discharged to the exterior through one or two side ports. The wick through which the air passed was saturated with DDVP.

Since initial tests indicated that the installation of such a vaporizer at each end of the passenger compartment did not provide adequate distribution of the DDVP vapor, the vaporizer was attached to the exterior of the plane so that the discharge of the vaporizer was directed into the intake of the ground ventilating system. During the course of each treatment, the ventilating system was in operation. According to information supplied by Pan American World Airways, Inc., the ground ventilating system provided approximately one exchange of air every 3 minutes.

Houseflies were exposed in tubular wire-screen cages (3.5 inches in diameter and 4 inches high) closed with paper covers. Twelve to sixteen cages, each holding approximately 200 flies of mixed sexes, were positioned from

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Dr. John Porter, Division of Foreign Quarantine, Public Health Service, Miami, Fla., obtained insectary facilities and was instrumental in making the cooperative arrangements with the Pan American World Airways, Inc. John C. O'Neal, facilitations superintendent, Pan American World Airways, Inc., made arrangements for the aircraft used in these tests and extended numerous other courtesies to the investigators.

the front to the rear of the passenger compartment as follows: in baggage racks, on the floor in relatively unprotected places, underneath and on seats, and in cloakrooms and lavatories. Generally three or more tests were run in the same plane before another plane was used. Following several of the tests, flies were placed in screen wall cages and exposed to various types of interior surfaces to ascertain the persistence of any DDVP residues thereon.

To determine concentrations of DDVP vapor, analysis was made of air samples collected 2 feet above floor level during the entire 30-minute test period (*5*). Thus, the air concentration data represent the average air concentration during the 30-minute fly exposure period.

Results

The data for six tests conducted in the passenger compartment of a DC–6B aircraft (3,600 cu. ft.) are given in table 1. Since the average kill of test 2 was less than 70 percent, the fan motor of the vaporizer for test 3 was insulated to increase the temperature of the air, thereby increasing the rate of DDVP vaporization. When only a slightly increased kill was obtained, two vaporizers with insulated motors were used in test 4. Despite the apparent absence of any increase in the average vapor concentration over that of test 3, the average mortality for test 4 was 96 percent.

In the second series of three tests (5, 6, and 7), in which two vaporizers also were employed, 100 percent kills were obtained at all sites except two, where the levels were 96 and 99 percent. Vapor concentrations were in a range of 0.11 to 0.28 µg. per liter of air. However, knockdown observations on the caged flies indicated a progressive increase in vapor concentration, the knockdown time (KDT$_{50}$) averaging 18.5, 18.0, and 14.9 minutes for tests 5, 6, and 7, respectively. Temperature rose from 74° to 81° during the sequence of the three tests.

Table 1. Average percent mortality of caged *Musca domestica* of mixed sexes exposed to DDVP vapor at 12 sites in the passenger compartment of a DC–6B aircraft, Miami, Fla.

Test No.	Temperature (°F.)	DDVP (microgram per liter)	Average 24-hour mortality (percent)
2	76	0.14	67
3	76	.28	75
4	77	.28	96
5	75	.28	100
6	74	.25	99
7	81	.11	100

Table 2. Average percent mortality of caged *Musca domestica* of mixed sexes exposed to DDVP vapor at 12 sites in the passenger compartment of a DC–7B aircraft, Miami, Fla.

Test No.	Temperature (°F.)	DDVP (microgram per liter)	Average 24-hour mortality (percent)	
			All sites	Exclusive of cage site in cloakroom
9	78	0.22	72	81
10	79	.17	75	85
11	79	.18	79	91
12	80	[1].31	87	96
13	85	.35	97	99

[1] Based on single air sample.

Data for the tests in a DC–7B passenger compartment (4,200 cu. ft.) are given in table 2. A single vaporizer was used in tests 9, 10, and 11, and two units in tests 12 and 13. Vapor concentrations were approximately the same in tests 9–11 with average fly mortality ranging from 72 percent to 79 percent. In tests 12 and 13 vapor concentrations were similar, the average kill in test 12 being 87 percent and in test 13, 97 percent.

The kills obtained in tests 11 and 12 were 80 percent or higher at all sites except in the cloakroom. The latter gave the lowest mortality in all tests, but in test 13, it showed a kill of 86 percent. The poor kills in the cloakroom chiefly arose from the fact that, in contrast to the DC–6B, this area in the DC–7B was not serviced by an air duct. If the cloakroom site is omitted, the average mortality is increased 9 to 12 percent in tests 9–12 (table 2).

Thirty minutes after three consecutive tests (5, 6, and 7), in a DC–6B determinations were made on the persistence of DDVP in the air and on the compartment surfaces. Flies were exposed in screened tubular cages and in wall cages fastened to vinyl plastic and stainless steel surfaces for this evaluation. The caged flies not in contact with a surface showed an average kill of 44 percent with a 40-minute exposure. With the same exposure time, wall cage tests gave an average kill of 60 percent. Most of the mortality obtained was due to the kill of the male flies. The concentration of DDVP was approximately 0.03 μg. per liter of air.

After each of tests 9–13, one or two wall cage tests were run on leather and on vinyl plastic surfaces using 30-minute exposures. Mortality ranged from 11 to 15 percent, 25 to 57 percent, 24 to 36 percent, 21 to 22 percent, and 5 to 38 percent, after tests 9, 10, 11, 12, and 13, respectively. Following 5 hours of ventilation of the aircraft after test 13, wall cage mortality on vinyl plastic and on leather was 0 to 5 percent.

Discussion

One of the significant points of these tests is the fact that DDVP vapor dispensed by an experimental vaporizer into the ventilating system of a commercial aircraft produced effective kills of the test specimens distributed at various sites and elevations in the passenger compartment. The dosages recorded indicate that against houseflies vapor concentrations of approximately 0.3 μg. per liter of air were highly effective. This concentration is somewhat higher than those reported from the tests in simulated aircraft (*3*), in which 0.15 μg. of DDVP per liter of air yielded a mortality of 95 percent or higher.

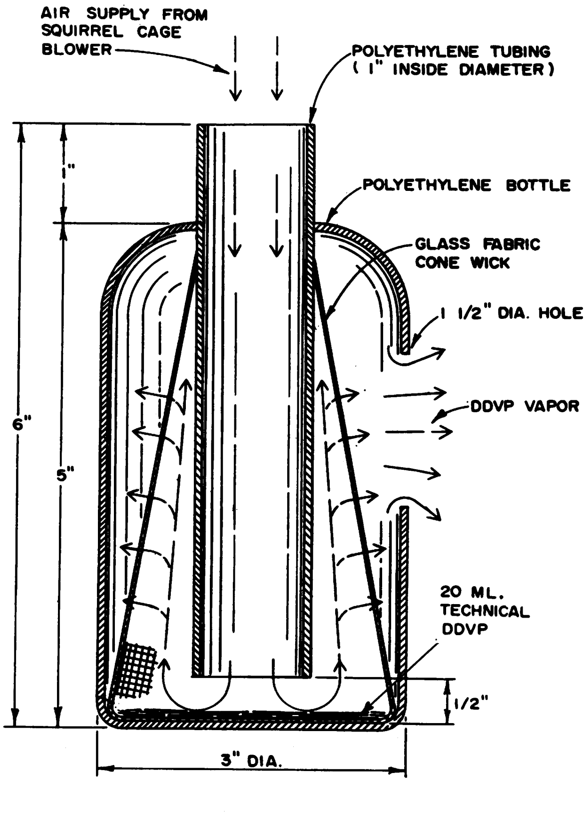
The relationship between KDT_{50} and 24-hour mortality was quite similar to that observed in earlier simulated field and laboratory tests (*3*). In these tests, a KDT_{50} of 18 minutes or less forecast female kills of more than 94 percent. During the present tests, a KDT_{50} of less than 18 minutes indicated 100 percent mortality of both sexes, a KDT_{50} of less than 23 minutes, 95 to 100 percent. At KDT_{50}'s between 26 and 30 minutes, the mortality was above 94 percent in only 2 of 15 observations.

Treatment of the aircraft with DDVP at the concentrations recorded was not perceptible to the workers after the initial minute. The four participants in this work remained in the passenger compartment during the entire period of all treatments and did not notice any adverse effects. The absence of any effects was expected in view of previous studies (*6*) in which six individuals exposed for 1 or 2 hours on each of 4 consecutive days to an average concentration of DDVP vapor of 2.1 μg. per liter of air showed no effect except for a questionable lowering of the plasma cholinesterase in two individuals. Under the same conditions an average concentration of 0.2 μg. of DDVP per liter of air was required for effective kill of houseflies exposed for 30 minutes.

Data from the persistence tests indicate that the vapor produces transient residues on the interior surfaces, which soon dissipate. The vinyl plastic surfaces tested retain vapor residues much more readily than do other surfaces, such as upholstery, carpet, and curtains (*4*).

The results of these tests indicate the feasibility of using an insecticidal vapor for the effective disinsection of aircraft. The principal advantage of such a method is that the toxicant can be dispersed throughout the passenger com-

Experimental DDVP vaporizer



partment area without depending upon crew or quarantine personnel for this operation. In addition, the preliminary data suggest that the vapor disinsection would be far less objectionable to the passengers and crews than the aerosol method currently used for that purpose.

Based on the present findings, future studies on the vapor method of disinsection should point toward the development of a dispensing unit that would be wholly mechanical in operation, that preferably would not employ the toxicant as a free liquid, and that would be suitable for permanent installation in the aircraft. Concurrent with or following such studies, detailed tests on the toxic hazard of such a unit would be required.

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Planning Long-Term Care Facilities

A joint committee to develop principles and recommendations for planning of facilities for long-term patient care has been formed by the American Hospital Association and the Public Health Service. The first meeting was held July 25–26, 1961, in Washington, D.C. The 17-member committee is headed by Ray E. Brown, superintendent of the University of Chicago Clinics and past president of the AHA.

According to State Hill-Burton hospital construction authorities, there is a national shortage of more than one-half million beds for long-term care. This number is expected to grow as the aged population increases. Moreover, many nursing homes are structurally below standard and do not provide all the necessary types of services and care.

Through the new committee, the American Hospital Association and the Public Health Service hope to establish guidelines that will help national, State, and local groups plan for adequate long-term care facilities coordinated with the community's health program.

Drinking Water Standards, 1961 Revision

The 1961 revision of the Public Health Service Drinking Water Standards includes for the first time limits for concentrations of radionuclides in water. Limits for several new chemicals, including some types of synthetic chemicals, also have been added. This revision, the first since 1946, is the work of a special advisory committee of physicians, scientists, engineers, and administrators, with assistance from a technical subcommittee of Public Health Service officers and a toxicological task force.

The Public Health Service Drinking Water Standards were first formulated in 1914 to protect the health of the traveling public. They have been revised at irregular intervals since that date, and their use has become widespread. In view of the accelerating pace of technological developments affecting water quality, the 1961 revision committee recommends that a mechanism be established for continual appraisal and appropriate revision of the standards.

Controls on Radioactivity

Recognizing that the effects on large population groups of chronic exposure to low concentrations of radioactive materials are not yet well defined, the committee set limits which it considers conservative, based on the best information now available. They may be adjusted upward or downward as new and better data become available.

The concentrations of radionuclides specified for drinking water, shown in the tabulation below, are intended to limit intake of these substances by this route so that total radiation exposure of population groups does not exceed the values given in the appropriate Radiation Protection Guides recommended by the Federal Radiation Council.

Radionuclide	*Concentration* ($\mu\mu c./l.$)
Radium 226	3
Strontium 90	10
Gross beta activity (strontium 90 and alpha emitters absent)[1]	1,000

[1] Negligibly small fraction of the above specific limits, where the limit for unidentified alpha emitters is taken as the limit listed for radium 226.

Concentrations of radionuclides which exceed, on the average, the specified values for 1 year constitute grounds for rejection of the water supply. However, where the total intake of radium 226 and strontium 90 from all sources has been determined, these values may be adjusted by appropriate authorities so that the total intake of radium 226 and strontium 90 will not exceed 7.3 $\mu\mu c.$ per day and 73 $\mu\mu c.$ per day, respectively.

When mixtures of radium 226, strontium 90, and other radionuclides are present, the specified values must be modified to assure that the combined intake is not likely to result in radiation exposure in excess of the values recommended by the Federal Radiation Council.

Limits for Chemical Substances

The new revision of the Drinking Water Standards includes two types of limits for chemical substances: limits which should not be exceeded when more suitable supplies are or can be made available at reasonable cost and limits which if exceeded are grounds for rejection of the supply.

The following concentrations should not be

The information presented here is taken from the report of the Advisory Committee on Revision of the Public Health Service 1946 Drinking Water Standards.

exceeded when in the judgment of appropriate authorities other more suitable supplies are available:

Substance	*Concentration* (mg./l.)
Alkyl benzene sulfonate (ABS)	0.5
Arsenic (As)	.01
Chloride (Cl)	250.0
Copper (Cu)	1.0
Carbon chloroform extract (CCE)	.2
Cyanide (CN)	.01
Iron (Fe)	.3
Manganese (Mn)	.05
Nitrate[1] (NO_3)	45.0
Phenols	.001
Sulfate (SO_4)	250.0
Total dissolved solids	500.0
Zinc (Zn)	5.0

[1] In areas where nitrate content of water is known to be in excess of the listed concentration, the public should be warned of the potential danger of using the water for infant feeding.

If concentrations exceed the values listed below, the water supply is subject to rejection:

Substance	*Concentration* (*mg/l.*)
Arsenic (As)	0.05
Barium (Ba)	1.0
Cadmium (Cd)	.01
Chromium (Cr^{6})	.05
Cyanide (CN)	.2
Lead (Pb)	.05
Selenium (Se)	.01
Silver (Ag)	.05

Recommended control limits for fluoride in water are based on air temperatures. When fluoride is naturally present in drinking water, the concentration should not average more than the appropriate upper limits in the table below. Presence of fluoride in average concentrations greater than two times the optimum values constitutes grounds for rejection of the supply. For water supplies that are artificially fluoridated, the average fluoride concentration must be kept within the upper and lower control limits.

	Fluoride concentration (*mg./l.*)		
Annual average maximum daily air temperature[1]	*Lower limit*	*Optimum level*	*Upper limit*
50.0–53.7	0.9	1.2	1.7
53.8–58.3	.8	1.1	1.5
58.4–63.8	.8	1.0	1.3
63.9–70.6	.7	.9	1.2
70.7–79.2	.7	.8	1.0
79.3–90.5	.6	.7	.8

[1] Based on temperature data for a minimum of 5 years.

The advisory committee considered the inclusion of limits for the more common chlorinated hydrocarbon and organophosphate insecticides, but the information available was not sufficient to establish specific limits. Moreover, the concentrations of these chemicals whereever they were tested have been below values that would constitute a known health hazard. The committee believes, however, that pollution of water supplies with such contaminants might become significant and urges that the problem be kept under close surveillance. The committee also recommends that regulatory actions be taken to minimize concentrations of such chemicals in drinking water.

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