SPRAY EQUIPMENT FOR C-47, UC-64, AND L-5 AIRPLANES [1]

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Spray booms were first attached under the wings of an airplane, a TBM, on Guadalcanal for the Navy [2] in the fall of 1944. This equipment gave a wider swath width, more uniform distribution, and a better droplet spectrum than previous equipment. Early in 1945 similar equipment was made for a TBM at the Banana River Air Base, Cocoa, Fla., and for an L-5 at the Orlando, Fla., laboratory of the Bureau of Entomology and Plant Quarantine. In March 1948 wing spray booms, which are now considered one of the standard types of installation (U. S. War Dept. 1946; U. S. Bur. Ent. and Plant Quar. 1946; and Husman, Longcoy and Hensley 1947), were designed for and installed on a C-47 plane. A similar installation had been made in 1947 on a Norseman (UC-64)[3] for use in Alaska. A check valve was also developed for the L-5 spray booms to prevent drainage of the spray bars when the supply valve was closed. A brief description of these installations and the calibration of each are given in this paper.

Equipment for C-47.—No structural changes in the C-47 plane were necessary for the installation of the spray boom, and it could be installed or removed in about 4 hours. The equipment caused no change in flight characteristics, but the drag therefrom reduced the cruising speed by 10 m.p.h.

The spray solution was carried in two rubber-lined, 375-gallon gasoline tanks mounted one behind the other in the front of the cargo compartment. Each tank was mounted on a separate wooden cradle, padded with rubber stripping. Each tank was secured to its cradle with cables and turnbuckles, and each cradle was bolted to the floor of the cargo compartment.

The spray system (fig. 1) consisted of two wing booms, each 18 feet long, and one center-section boom 8 feet 6 inches long constructed of chrome-molybdenum-steel tubing of 1.25-inch (o.d.) by 0.035-inch wall thickness. Spray-outlet holes of No. 52 wire-drill size (0.064 inch) were spaced 2½ inches apart the full length of each boom, on the back side. The booms were held securely in place by hanger brackets 18 inches below the wings and center section. The wing units were not rigid and therefore flexed with the wing. Drip-guard plates were installed on all hanger brackets to prevent spray material from working up the rear supports onto the ailerons.

The spray solutions were delivered from the tanks to the booms by five 24-volt, electric fuel-transfer pumps, each with a capacity of 850 gallons per hour at a pressure of 14 pounds per square inch. The pumps and an electric relay system were mounted on a platform secured to the cradle mount, two of the pumps being connected to each wing boom and one to the center-section boom. A switch box containing a control switch for each spray boom was mounted on the rear wall of the pilot's compartment within easy reach of the co-pilot. The supply line from each tank entered a manifold that had one outlet for each pump. A check valve was installed in the supply line from the rear tank to eliminate drainage from the front to the rear tank. Aluminum tubing, 1¼ inches in diameter, connected the mani-

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[3] Most of this installation was made for the Alaska research group by Captain W. C. Stevens, Fort Richardson, Alaska.

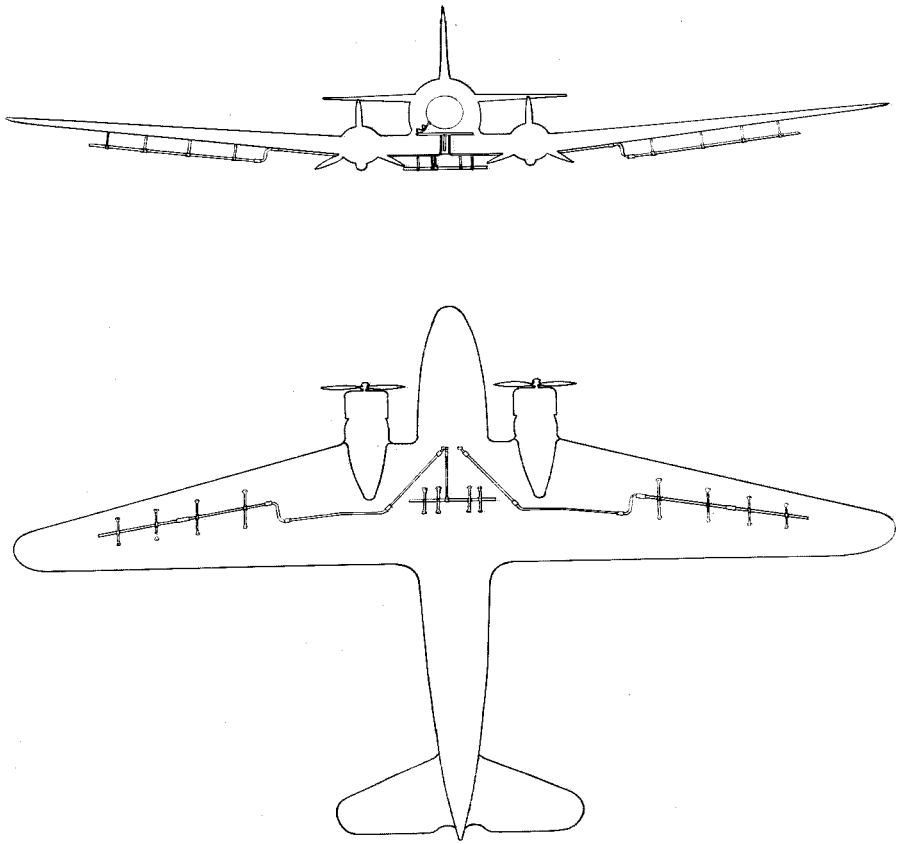

FIG. 1.—Schematic drawing of the wing-boom installation for the C-47 airplane.

fold to the spray booms. The connecting tubing extended through the radio-compartment floor and then through the deicer doors on the bottom of the fuselage, making it unnecessary to cut the fuselage skin. All tubing connections were made with oil-resistant rubber hose and clamps.

The equipment was calibrated by flying the plane directly into the wind at an altitude of about 50 feet. Calibration runs (fig. 2) were made with wind below 1 mile per hour at a delivery rate of 1 pint per acre. White squared paper and glass slides coated with magnesium oxide were placed every 100 feet at right angles to the line of flight so that the swath width, droplet size, and the number of droplets reaching the ground per square inch could be determined. The spray solution contained 0.5 percent of red dye for calibration purposes. The calibration data are given in Table 1.

The number of droplets per square inch visible on the paper, as determined from

TABLE 1.—Calibration data for the C-47, the UC-64, and the L-5, with and without an impinging plate. (Sprays containing 20% of DDT, 40% of Velsicol AR-50,[1] and 40% of fuel oil were used.)

Item	C-47	UC-64	L-5	
			With impinging plate	Without impinging plate
Air speed, miles per hour	140	120	90	90
Swath width, feet	800	300	100	100
Droplet size (mass median diameter), microns	136	156	98	224
Diameter of droplets (microns):				
0–50	18	17	39	23
51–100	59	45	52	33
101–150	9	24	8	20
151–200	6	16	1	17
201–250	.2	0	0	4
251–500	0	0	0	4
Delivery rate, gallons per minute	28.6[2]	9.1	2.3	2.3
Acres covered per minute	225.9	72.6	18.2	18.2
Pay load, gallons	600	100	42	42

[1] Chiefly mono- and dimethyl-naphthalenes.
[2] Two pumps in operation, each with a capacity of 14.3 gallons per minute.

an average of two calibration runs with the C-47, was as follows:

Stations (100-foot intervals)	Average number of droplets per square inch
0	4
100	4
200	24
300	48
400	100
500	88
Center	
600	160
700	160
800	128
900	44
1,000	32
1,100	0

The electrical connections were arranged so that each pump could be operated separately. Each pump was capable of delivering ½ pint per acre; thus the delivery rate could be adjusted easily to give dosages ranging from ½ to 2½ pints of solution per acre. When a dosage of ½ pint was applied, one pump was connected by a Y joint to both wing booms. In addition to this wide dosage range at the same air speed and swath width, the two supply tanks could be emptied independently. Therefore, two different spray solutions could be loaded at one time and sprayed in the same flight.

It was found that the center-section boom was not necessary to insure coverage of the central portion of the swath. Consequently, this boom was used only for applying the higher dosages.

In field tests the beginning of each swath was marked for the pilot by smoke bombs and the pilot then flew a straight line, using both a compass and scaled maps or scaled photographs. In each test a preliminary "dry run" was made to establish the compass course and to locate check points at the end of the run. This method not only proved satisfactory but was the only feasible way to maintain accurate swath intervals where runs were 4 to 5 miles long.

The original plans for construction of the equipment could not be followed because streamlined tubing and special solenoid valves were not available. The use of streamlined tubing for constructing the spray booms and hanger brackets would have minimized the drag and re-

FIG. 2.—C-47 plane distributing spray for the calibration of the equipment.

sulted in little loss of flying speed. In addition, a check valve similar to the one designed for the L-5 would stop drainage of the booms after the pumps are shut off, and thus prevent loss of spray material.

Equipment for UC-64.—The UC-64, or Norseman, plane was equipped with 12-foot spray booms mounted on the struts under each wing. Six holes, No. 48 wire-drill size (0.076-inch), were spaced equidistant along each boom. The insecticide was carried in a 200-gallon tank, which was mounted in a wooden cradle and bolted to the floor of the cargo compartment. An electrically driven fuel pump (Pesco G-10) with a maximum delivery rate of 450 gallons per hour was used for the pressure system. The pump was equipped with an adjustable pressure by-pass valve, making it possible to alter the output. A toggle switch to operate the pumps was mounted on the instrument panel within easy reach of the pilot.

The calibrations (Table 1) were made under the same conditions as for the C-47.

Equipment for L-5.—The L-5 plane was equipped with the standard spray-boom equipment. Each boom had 10 holes, No. 70 wire-drill size (0.028-inch), all of which were used for dosages of 1 pint per acre. When dosages of ½ pint were needed, half the holes were closed with hose clamps.

A ball check valve with an adjustable tension spring was designed and mounted on each boom to eliminate the drainage of the spray solution from the lines after the tank valve was closed. The unit could be adjusted to hold back pressures of 5 to 20 pounds per square inch, as needed.

The L-5 equipment was tested both with and without impinging plates on the booms. The impinging plates lowered the mass median diameter and reduced the number of undesirable large drops (Table 1).

Summary.—Spray-boom equipment was developed for a C-47, using electric fuel-transfer pumps for the pressure system. Five pumps were installed, each of which would deliver 14.3 gallons per minute or the equivalent of ½ pint of spray per acre for a swath of 800 feet. Swath-width and droplet-size calibrations were made with three planes, a C-47, a UC-64, and an L-5, using sprays containing 20 percent of DDT, 40 percent of Velsicol AR-50 (chiefly mono- and dimethyl-naphthalenes), and 40 percent of fuel oil, delivered at the rate of 1 pint per acre. The C-47, flown at 140 m.p.h., gave a droplet size of 136 microns mass median diameter. The UC-64, or Norseman, flown at 120 m.p.h. gave a 300-foot swath and a droplet size of 156 microns mass median diameter. Droplet size (mass median diameter) from the L-5 with the impinging plate was 98 microns and without the plate, 224 microns. A check valve was installed on the L-5 plane to prevent the drainage of the spray solution from the lines after the tank valve was closed.

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