Designation: E642 – 91 (Reapproved 2014)

Standard Practice for Determining Application Rates and Distribution Patterns from Aerial Application Equipment[1]

This standard is issued under the fixed designation E642; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers uniform procedures for determining and reporting application rates and distribution patterns from agricultural aircraft. This practice should not be used for making biological performance tests.

1.2 The procedures covered deal with both fixed and rotary-wing aircraft equipped with either liquid or dry material distribution systems.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E726 Test Method for Particle Size Distribution of Granular Carriers and Granular Pesticides

2.2 *ASAE Standard:*

ASAE S327.1 Terminology and Definitions for Agricultural Chemical Application[3]

3. Test Conditions

3.1 The physical characteristics of the liquid or dry material have an effect on the application rate and the distribution patterns. If inert test solutions for materials are substituted for the materials to be applied, they shall have physical characteristics similar to those of the material to be applied. If toxic materials are used in the tests, all safety precautions prescribed by the manufacturer and governmental authority for handling, loading, application, and disposal of toxic materials shall be observed.

3.2 Pattern tests shall be conducted, with wind speeds not exceeding 16 km/h (10 mph), measured 2.5 m (8.2 ft) above the land surface or crop canopy. If wind occurs, flights shall be made both into and with the wind to minimize the effects of wind velocity on ground speed. Flights shall be made parallel to or within 20° of the direction of the wind to minimize errors due to crosswinds. These restrictions do not apply to the output rate tests.

4. Procedure

4.1 A complete procedure shall consist of five parts:

4.1.1 Determination of the output rate from the aircraft system.

4.1.2 Determination of the swath distribution pattern by recovery of the applied materials from suitable collectors.

4.1.3 Determination of usable swath width for field applications.

4.1.4 Determination of the rate of application of the spray mixture or dry material, and

4.1.5 Determination of the uniformity of distribution of several swaths.

4.2 *Output Rate Determination:*

4.2.1 *Liquid Materials*—Determine the output rate by the amount of liquid discharged from the tank for a measured time interval while the aircraft is in flight under normal conditions. The time interval shall be sufficient to permit accurate measurement of liquid discharged and to minimize errors due to turning the system on and off. Run the system for at least 30 s and measure to the nearest 0.5 s. Measure the amount of liquid used by either refilling the tank to the initial level or by measuring the amount remaining in the tank and subtracting from the initial amount. Measurement precision shall be ±2 % of the amount discharged in the test. If the liquid dispersal system can be operated with the aircraft stationary, the test can be accomplished without actually flying the aircraft. Report

[1] This practice is under the jurisdiction of ASTM Committee E35 on Pesticides, Antimicrobials, and Alternative Control Agents and is the direct responsibility of Subcommittee E35.22 on Pesticide Formulations and Delivery Systems.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Society of Agricultural and Biological Engineers (ASABE), 2950 Niles Rd., St. Joseph, MI 49085, http://www.asabe.org.

output rate in litres per minute (gallons per minute), and note the nozzle (boom) pressure.

4.2.2 *Dry Materials*—If venturi distributors are used, determine the output rate by measuring the amount of material discharged from the hopper over a given time interval while the aircraft is in flight under normal conditions. Precision of measurement of time and materials as specified in 4.2.1 shall apply here. Run tests with the aircraft hopper filled to at least 25 % of capacity. Report the output rate, in kilograms per minute (pounds per minute), and the control settings used to achieve this rate.

4.3 *Swath Distribution Pattern Test:*

4.3.1 Conduct this test by flying the aircraft over the center of a collection line placed at a right angle to the line of flight. The collection line may be placed on the land surface or crop height (or any other height consistent with the purpose of the test), and shall permit collection of a representative sample of the distribution pattern for the dispersed material. Fly the aircraft at a height suited to the type of material applied and the purpose of the application. The airspeed shall be that for the intended application and the flight shall be level and straight. Extend the collection line at least 3 m (10 ft) beyond the ends of the pattern being tested. Measure ambient temperature, humidity, and wind speed and direction (with respect to the line of flight) at 1 to 3 m (3 to 10 ft) above the land surface or crop canopy. Note the height of flight and the airspeed.

4.3.2 Turn on the distribution equipment in the aircraft at least 100 m (300 ft) prior to crossing the collection line, and continue operating it the same distance beyond. Run three replications of each test. Make each replication with a separate single pass of the aircraft. Note the direction of flight with respect to wind direction.

4.3.3 *Spray Test Procedure and Target Collectors:*

4.3.3.1 An inert chemical or dye tracer material may be added to the contents of the spray tank, or the active chemical may be used as a tracer for the spray pattern tests. If inert materials are used, include suitable amounts of emulsifier, spreader-stickers, and other solvents and carriers to closely simulate the material to be applied.

4.3.3.2 The spray collection line may be composed of discrete targets or a narrow continuous surface. Quantitative analysis of the spray deposited on the target collector(s) may be accomplished by electronic scanning or by washing tracer material from the collector surface(s).

4.3.3.3 If the pattern is determined from the amount of tracer material recovered from the line, the surface of the collector(s) shall permit all or a constant percentage of the tracer to be removed by washing. If the tracer used degrades due to exposure to sunlight, age, or other factors, the results should be corrected to compensate for the degradation. If discrete targets are used, they may be flat sheets, or have raised edges to facilitate washing. The exposed flat surface (exclusive of raised edges) shall have an area of at least 50 cm^2 (7.8 $in.^2$). Spacing of descrete targets across the swath shall not exceed 1 m (3.3 ft).

4.3.3.4 For samples that are electronically scanned to measure deposition on the sample surface based on droplet size and numbers, an appropriate area must be scanned to obtain a true representation of the droplet-size distribution in the sample.

4.3.3.5 *Qualitative Spray Distribution Pattern Measurement*—A qualitative measure of the distribution pattern may be used to diagnose and correct distribution system deficiencies (plugged or worn nozzles, improper size nozzles, system leaks, improperly placed nozzles, and so forth). Qualitative distribution pattern measurement techniques may employ discrete sample targets or a continuous collector placed across the flight line of the aircraft. The measurement technique used should provide a relative or absolute measure of the deposition on the sample surfaces across the flight line.

4.3.4 *Dry Material Test Procedure and Collectors:*

4.3.4.1 Granular materials are normally tested by capturing samples of the swath in buckets or collectors that are high enough to prevent the particles bouncing into or out of the containers. Collect dust or other small particles on greased boards or other sticky surfaces, or in shallow pans. Weigh or count the material collected in these devices, or dissolve in a solution for analysis as appropriate.

4.3.4.2 The area of the top opening of the collectors shall be 0.1 m^2 (1 ft^2) or larger, to provide a representative sample of the deposit. Spacing of the collectors along the swath shall not exceed 1 m (3 ft).

4.4 *Sample Analysis and Conversion of Swath Distribution Pattern Data:*

4.4.1 *Spray Pattern Test:*

4.4.1.1 For quantifying spray deposits using tracer materials, any type of sample analysis may be used that is compatible with the spray tracer. Examples are photoelectric colorimetry, absorption or emission spectroscopy, and liquid or gas chromatography, where the sensitivity of the analysis shall be at least 2 ppm. After a collector is washed in accordance with 4.3.3, the concentration of tracer may be determined by use of a standard calibration curve developed for the tracer and the analytical method employed. The rate of spray deposit in litres per hectare (gallons per acre) may then be determined for each location across the collection line as follows:

$$D = (K \times V_t \times C_t)/(C_s \times A) \quad (1)$$

where:

D = deposit rate, L/ha (gal/acre),
K = constant, 10^5 (or 1657),
A = collector area, cm^2 ($in.^2$),
$_t$ = volume of solvent used to wash tracer from target, mL,
C_t = concentration of tracer washed from collector, mg/L, and
C_s = concentration of collector in original spray solution, mg/L.

4.4.1.2 Quantifying spray deposits using image scanning of discrete or continuous sample surfaces shall utilize sufficient size classes, preferably at least 20, to accurately define the droplet size distribution. A droplet size versus spread factor function covering the droplet size range encountered under test conditions (temperature and relative humidity) shall be developed for the sample surface material and test liquid and used in calculating the deposit volume per unit of area.