



Designation: **E2798–11** ~~E2798–11~~ **E2798–19**

# Standard Test Method for Characterization of Performance of Pesticide Spray Drift Reduction Adjuvants for Ground Application<sup>1</sup>

This standard is issued under the fixed designation E2798; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method is used to characterize the performance of pesticide spray drift reduction adjuvants with respect to spray droplet size spectra, volume of fines, and other use parameters under simulated field ground application conditions. This test method does not include any procedures to evaluate if pump shear degrades the performance of the spray drift reduction adjuvant.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

NOTE 1—This method uses industry-standard units. The following conversions to SI units are provided for convenience: 1 mph = 1.61 kph; 1 in = 2.54 cm; 1 gal/acre = 9.36 L/hectare.

~~1.3 This test method 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.~~

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1.4 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

[D3825 Test Method for Dynamic Surface Tension by the Fast-Bubble Technique](#) (Withdrawn 2016)<sup>3</sup>

[E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods](#)

[E456 Terminology Relating to Quality and Statistics](#) [7741b38-1a61-4c9e-a39d-42d901ba70d2/astm-e2798-19](#)

[E609 Terminology Relating to Pesticides](#)

[E799 Practice for Determining Data Criteria and Processing for Liquid Drop Size Analysis](#)

[E1260 Test Method for Determining Liquid Drop Size Characteristics in a Spray Using Optical Nonimaging Light-Scattering Instruments](#)

[E1519 Terminology Relating to Agricultural Tank Mix Adjuvants](#)

[E1620 Terminology Relating to Liquid Particles and Atomization](#)

[E2408 Test Method for Relative Extensional Viscosity of Agricultural Spray Tank Mixes](#)

### 2.2 ASABE Standards:<sup>4</sup>

~~[ASAE S572.1/ANSI/ASAE S572.2 Spray Nozzle Classification by Droplet Spectra, March 2009](#)~~ [July 2018](#)

### 2.3 NFPA Standards:<sup>5</sup>

[NFPA 30 Flammable and Combustible Liquids Code](#)

[NFPA 33 Standard for Spray Application Using Flammable or Combustible Materials](#)

<sup>1</sup> This test method 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from American Society of Agricultural and Biological Engineers (ASABE), 2950 Niles Rd., St. Joseph, MI 49085, <http://www.asabe.org>.

<sup>5</sup> Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

### 3. Terminology

3.1 Definitions for terms used in this test method can be found in Terminologies E456, E609, E1519, and E1620.

### 4. Summary of Test Method

4.1 This test method provides guidelines for the measurement of parameters pertaining to the performance of drift reduction adjuvants under simulated field ground application conditions. The measurements can be made in a wind tunnel or spray chamber. The method describes the preparation, composition, and test/application conditions for droplet size and spray pattern measurements. Exact selection of application conditions, such as nozzle type and tank mix partners, may vary according to intended use conditions. This test method has not been verified for aerial and orchard airblast pesticide applications.

### 5. Significance and Use

5.1 Pesticide regulations for the minimization of drift during pesticide application often require active ingredient (a.i.) product use under defined droplet size conditions. Spray performance with respect to transport and deposition of droplets and particles at target surfaces and product efficacy for desired applications are also affected by droplet size spectra. The effect of drift reduction adjuvants on droplet size spectra should be understood in this context. The present test method describes standard tests that can be conducted to investigate the performance of pesticide spray drift reduction adjuvants under simulated field use conditions for drift management decisions in the context of the entire spraying process. The measured reduction in driftable fines and shift in spray droplet size distribution can be used to reduce the buffer zones mandated by regulatory agencies.

### 6. Apparatus

6.1 *Spray chamber or wind tunnel* of known air flow characteristics. Droplet size measurements may be made in a spray chamber or wind tunnel. Where a spray chamber is used for simulating ground application of pesticides, make provisions to have an air flow with a minimum 7 mph velocity in the direction of the sprayed fluid. The Spray Drift Task Force (<http://www.spraydrift.com>) has found that this minimum air flow will keep the small drops moving forward and prevent them from swirling back and getting measured multiple times. A diagram of an example test arrangement can be seen in Fig. 1 of Test Method E1260, but locate the exhaust vent at the bottom of the spray chamber so the ambient air is moving in the same direction as the sprayed fluid. Where a wind tunnel is used for simulating ground applications of pesticides, size the wind tunnel working section width to allow the spray to fully form without constriction. The minimum width for normal use with a wide range of nozzle and atomizer types will be 1 m. The height shall be sufficient to allow a full traverse (using either continuous or chordal measurement sampling) through the entire spray cross-section. Usually this will require a minimum height of 1 m.

6.2 *Droplet size analyzer* with calibration verification for tests. The droplet size analyzer selected for the tests shall be appropriate for the type of measurement being conducted and have a dynamic size range configuration capable of measuring the entire droplet size range produced by the sprays under investigation. Appropriate techniques include, but are not limited to, laser diffraction, Phase-Doppler particle size analyzers and imaging systems. Sympatec<sup>6</sup> and Malvern<sup>7</sup> make instruments capable of measuring spray droplet size using laser diffraction analysis. Test Method E1260 outlines the procedure for determining liquid drop size using these instruments.

6.3 *Liquid preparation and delivery system*, including agitation mechanism for tank mixes.

6.4 *Nozzle and spray application system* for ground application platforms.

### 7. Hazards

7.1 *Safety Precautions*—Before testing, read the precautionary statements on the product label, and the Material Safety Data Sheet, or both. Take proper precautions to prevent skin contact and inhalation of the fines, or the vapors, or both. Take care to prevent contamination of the surrounding area. Always wear the appropriate safety equipment and, where indicated, wear respiratory devices approved by NIOSH for the product being tested.

7.1.1 **Warning**—A spray of flammable liquid dispersed in air presents the risk of explosion and fire. Refer to NFPA 30 or NFPA 33 for information about safe practices for storage and handling of flammable liquids and for spray processes involving sprays of flammable liquids.

7.1.2 **Warning**—Exposure to drops of various liquids by inhalation, ingestion, and skin contact may constitute health hazards.

7.1.3 **Warning**—Emission of some sprayed liquids into the atmosphere may be harmful to the environment or may pose a health risk.

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<sup>6</sup>The sole source of supply of the apparatus known to the committee at this time is Sympatec GmbH, System-Partikel-Technik, Am Pulverhaus 1 D-38678 Clausthal-Zellerfeld, Germany. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,<sup>1</sup> which you may attend.

<sup>7</sup>The sole source of supply of the apparatus known to the committee at this time is Malvern Instruments Ltd, Enigma Business Park, Grovewood Road, Malvern, Worcestershire WR14 1XZ, United Kingdom. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,<sup>1</sup> which you may attend.

7.1.4 **Warning**—Laser-based instruments contain lasers or other strong light sources which may pose a hazard to persons in their vicinity.

7.2 Contain all sprayed material and be sure to dispose of this material and remaining test substances properly.

## 8. Selection of Test Substances

8.1 Select test substances that reflect the intended end-use of the drift reduction adjuvant. While water can provide a useful baseline for range-finding tests, it must not be the sole system tested. Use the active ingredient pesticide formulation spray tank mixture as one of the test substances with the adjuvant. For example, commercial herbicides may be selected for adjuvants intended for use in herbicide applications. The use rate for the tests shall reflect commercial label use rates. It may be desirable to select several test substances for the evaluations, to compare performance between products. It may be appropriate to include other adjuvants such as surfactants, crop oils, or fertilizers, as the label allows. For example, ammonium sulfate (AMS) is recommended on many pesticide levels. Compatibility agents will be included if necessary to create a physically stable system.

8.2 Where possible, measure the physical properties of the test substance, particularly the dynamic surface tension at a surface lifetime age of 20 ms, shear and extensional viscosities. Test Method [D3825](#) provides a technique for measuring dynamic surface tension. Test Method [E2408](#) provides a technique for measuring extensional viscosity.

8.3 Use WHO 342 ppm hardness water in all sample preparations.

## 9. Preparation of Test Substances

9.1 *Mixing Order*—Mix the test substance components in the manner described in their respective mixing instructions. In some cases, this may involve the preparation of a pre-mix of adjuvant(s) and active ingredient formulation. The samples must be mixed until homogeneous. Compatibility agents must be added to mixtures that do not form physically stable samples.

## 10. Nozzles, Atomizers, and Spraying System

10.1 *Nozzle Types and Use Conditions*—The nozzle selection will depend on the intended end-use for the adjuvant under evaluation. Section [10.2](#) lists resources for nozzles which should be used at a minimum for the tests, depending on application types. Additional nozzle types and use patterns may also be included if appropriate for the pesticide and use type. The performance of many adjuvants depends on the nozzle type and use conditions, as well as the initial droplet size range. For example, some adjuvants may cause an increase in the coarseness of the spray for sprays which are initially relatively fine, or for certain types of nozzle, while providing different behavior with sprays of different initial (that is, no adjuvant) conditions. Ground nozzles are usually operated at pressures around 40 psig. The exact pressure for a given test will depend on manufacturer recommended operating conditions and test requirements. Measure and record the effect of the adjuvant on spray pressure and liquid flow rate. Ground applications usually involve an airstream velocity up to 18 mph to facilitate sampling with number density sampling techniques.

10.2 *Ground Spraying Systems*—For ground-based applications, [ASAE S572.1+ANSI/ASAE S572.2](#) provides flat fan reference nozzles of different designations between extremely fine (XF) and ultra coarse (UC). These are often used in standard droplet size tests in Europe, North America, and other regions. Include the reference sprays for the boundaries between fine/medium and medium/coarse sprays (which cover most commercial arable spray applications) to assess whether the adjuvants cause the sprays to shift toward finer or coarser sprays. If the desired test nozzle produces a coarser spray quality, then also include the reference nozzles for the coarse/very coarse and very coarse/ultra coarse boundaries. The extremely fine category is not commonly used in agricultural sprays. The actual test nozzle will be specified by the adjuvant manufacturer, but may include one or more of the following nozzle types for ground-based application tests at typical recommended use conditions: flat fan, air induction, and cone. If possible, include nozzles of at least two initial droplet size classes. [Table 1](#) provides examples of test and reference nozzle/pressure combinations that are used in ground applications. All use a 50 mesh screen to prevent plugging and all yield about 0.2 gpm flow at the same given pressure listed in [Table 1](#).

## 11. Procedure

11.1 *Droplet Size Measurement*—Data criteria and processing examples are given in Practice [E799](#). The droplet size analyzer shall be used in accordance with appropriate ASTM/ISO standard test methods. Methods for using laser diffraction instruments are given in Test Methods [E1260](#).

11.1.1 *Precision*—Refer to Practice [E177](#).

11.1.2 *Droplet Size*—Droplets shall be measured and characterized using an instrument having demonstrated accuracy in the range of droplet size produced by the nozzle being tested. The instrument shall have a calibration verification performed with a known source of droplets or other method. An alternative method would be to measure reference particles in a liquid suspension, as supplied by the instrument manufacturer.

11.1.3 *Volume Density Weighted (Spatial) Sampling Type Droplet Measuring Device*—Measurements can be made with a forward-light scattering (also called diffraction) instrument, imaging system, or other number density-weighted sampling technique. Spray measurements shall be collected across a plane perpendicular to the nozzle axis. Instrument calibration