Standard Test Method for Blast Resistance of Trash Receptacles[1]

This standard is issued under the fixed designation E2639; 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 test method provides a procedure for characterizing the performance of a trash receptacle when an explosive is detonated within the receptacle.

1.1.1 The procedure determines the extent and location of fragments produced during the explosion, and whether breaches are created in the exterior surfaces of the trash receptacle.

1.1.2 Appendix X1 provides guidance for determining the magnitude of blast waves (that is, external overpressures) developed.

1.1.3 Effects due to a fireball resulting from the detonation of an explosive within a trash receptacle are beyond the scope of the test method.

1.2 This test method is intended to be performed in open-air test arenas.

1.3 The values stated in SI units are to be regarded as the standard. The values stated in parentheses are for information only.

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]

D638 Test Method for Tensile Properties of Plastics

D747 Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D882 Test Method for Tensile Properties of Thin Plastic Sheeting

D883 Terminology Relating to Plastics

E2740 Specification for Trash Receptacles Subjected to Blast Resistance Testing

2.2 *Government Standards:*

DOD 4145.26 M Department of Defense: DOD Contractors' Safety Manual for Ammunition and Explosives[3]

DOD 6055.9 STD Department of Defense: DOD Ammunition and Explosives Safety Standards[4]

Voluntary Product Standard PS 1 Structural Plywood[5]

3. Terminology

3.1 For terminology generally associated with explosives, refer to the glossaries given in DOD 4145.26 M and DOD 6055.9 STD.

3.1.1 Some of the definitions in this standard (3.2) are either adopted as exact copies, or are adapted, from DOD 4145.26 M. Where adapted, changes to the DOD definitions were made only to clarify the meaning or to incorporate related terms that also are defined in this terminology section.

3.1.2 The DOD source is identified parenthetically at the right margin following the definition.

3.2 *Definitions:*

3.2.1 *alias, n*—a false low-frequency component that appears when reconstructing analog data that are sampled at an insufficient rate.

3.2.2 *detonation, n—(1)* a violent chemical reaction within a chemical compound or mechanical mixture resulting in heat and pressure; *(2)* a reaction that proceeds through the reacted material toward the unreacted material at a supersonic velocity.

3.2.2.1 *Discussion*—The result of the chemical reaction is exertion of extremely high pressure on the surrounding medium forming a propagating shock wave that is originally of supersonic velocity. **DOD 4145.26 M**

[1] This test method is under the jurisdiction of ASTM Committee E54 on Homeland Security Applications and is the direct responsibility of Subcommittee E54.08 on Operational Equipment.

Current edition approved Feb. 15, 2012. Published March 2012. Originally approved in 2009. Last previous edition approved in 2009 as E2639 – 09a. DOI: 10.1520/E2639-12.

[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 the Defense Technical Information Center, 8725 John J. Kingman Road, Suite 0944, Ft. Belvoir, VA 22060 6128.

[4] Available from the worldwide web at: http://www.ddesb.pentagon.mil/DoD6055.9-STD%205%20Oct%202004.pdf.

[5] Available from the worldwide web at http://ts.nist.gov/Standards/Conformity/upload/PS%201%20final%20complete%20w%20cover.pdf.

3.2.3 *explosion, n*—a chemical reaction of any chemical compound (or mechanical mixture) that, when initiated, undergoes a very rapid combustion or decomposition releasing large volumes of highly heated gases that exert pressure on the surrounding medium. **DOD 4145.26 M**

3.2.4 *explosive, n*—any chemical compound (or mechanical mixture) that, when subjected to heat, impact, friction, detonation, or other suitable initiation, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases that exert pressures in the surrounding medium. **DOD 4145.26 M**

3.2.5 *fireball, n*—a highly luminous, intensely hot cloud of dust, gas, and or vapor generated by an explosion.

3.2.6 *fragment, n*—solid material propelled from an explosion as a result of fragmentation.

3.2.6.1 *primary fragment, n*—a fragment produced from the explosive device itself.

3.2.6.2 *secondary fragment, n*—a fragment produced from the container or environment where the container is placed; a piece of receptacle broken off as a result of the charge being detonated inside of it.

3.2.7 *fragmentation, n*—breaking up of the confining material of a chemical compound (or mechanical mixture) when an explosion takes place. **DOD 4145.26 M**

3.2.8 *overpressure, n*—the pressure, exceeding the ambient pressure, manifested in the shock wave of an explosion. **DOD 4145.26 M**

3.2.9 *rigid plastic, n*—for purposes of general classification, a plastic that has a modulus of elasticity, either in flexure or in tension, greater than 700 MPa (100 000 lbf/in^2) at 23°C (73°F) and 50 % relative humidity when tested in accordance with Test Method D747, Test Methods D790, Test Method D638, or Test Method D882. **D883**

3.2.10 *silhouette, n*—a witness panel that is constructed in the approximate shape of a human.

3.2.11 *trash receptacle, n*—a public- or commercial-use refuse bin that holds discarded items until collected.

3.2.11.1 *Discussion*—The capacity of a trash receptacle specimen subjected to the test procedure described in this standard is typically less than 200 L (50 gal).

3.2.12 *trash receptacle lid, n*—a removable or hinged cover that fits over the open hollow of the receptacle.

3.2.12.1 *Discussion*—A lid component is normally fitted to the configuration of the top opening of the trash receptacle and is manufactured by means of a molding process using a rigid plastic having a relatively low tensile or flexural modulus, 1000 MPa (150 000 lbf/in.^{2}) maximum. The thickness of a section (for example, top) of a typical lid generally does not exceed 5 mm (3⁄16 in.).

3.2.13 *trash receptacle liner, n*—a removable lining that is provided within a trash receptacle to retain liquids and fluid-like materials that seep from trash.

3.2.13.1 *Discussion*—This component is normally fitted to the configuration of the interior of the trash receptacle and is manufactured by means of a molding process using a rigid plastic having a relatively low tensile or flexural modulus, 1000 MPa (150 000 lbf/in.^{2}) maximum. The wall thickness of a typical liner generally does not exceed 5 mm (3⁄16 in.).

3.2.14 *trash receptacle rubbish bag, n*—a removable, replaceable container that is provided within a trash receptacle to allow collected trash (that is, rubbish) to be removed from the receptacle and moved to a disposal location.

3.2.14.1 *Discussion*—This bag is normally of a volume capacity to fit the configuration of the interior of the trash receptacle. It is manufactured from a plastic film generally having a thickness of less than 0.16 mm (0.006 in.).

3.2.15 *witness panel, n*—a flat, rectangular sheet-construction mounted upright within the explosion test arena for purposes of determining whether fragments are produced during the detonation of the specimen.

4. Summary of Test Method

4.1 A trash receptacle is placed on a steel plate in the center of an explosive test arena (as described in Section 11).

4.2 An explosive charge is placed at one of four predetermined locations within the receptacle and detonated.

4.3 After detonation, the trash receptacle is examined for the presence of breaches (such as cracks, fissures, and holes) in its exterior surface, and the extent and location of fragments produced are recorded.

NOTE 1—Users of this standard testing the blast resistance of trash receptacles can, at their own option, measure the magnitude of overpressures created during the explosion. Guidance for performing such measurements is provided in Appendix X1.

5. Significance and Use

5.1 This test procedure is used to measure two of the main effects of an explosive detonated in a trash receptacle as related to the type and amount of explosive charge and the location where the charge is placed in the trash receptacle. The two effects are:

5.1.1 Release of primary and secondary fragments, and

5.1.2 Physical damage to the trash receptacle.

5.2 This test procedure is applicable to all trash receptacles, including lidded or non-lidded as supplied by the manufacturer.

5.3 This test procedure is used to generate data for use in developing performance specifications for trash receptacles.

5.4 For users having interest in determining overpressures created by the detonation, Appendix X1 provides guidance for making such determinations.

6. Test Apparatus and Equipment

6.1 *Barometric Pressure Gauge*—To determine atmospheric pressure at the time of the test, allowed variability is ±0.1 kPa (±1 mbar). The gauge shall be capable of reading pressure at the altitude of the explosion test site.

6.2 *Calipers, Steel Rule, and Measuring Tape,* calibrated in millimetres, to determine the internal and external dimensions of the trash receptacle specimen before and after the explosive event.

6.3 *Cameras*—Digital for still photos; digital video and high speed digital video, capable of recording a minimum 2400 frames per second, to record the explosive event, including slow-motion effects of fragmentation and deformation of the trash receptacle.

6.4 *Cardboard Tubes,* to hold bare C4 explosive (see 7.1.3).

6.5 *Detonator*—Standard electric detonator placed in the center of mass of the charge.

6.6 *Explosive,* as described in Section 7.

6.7 *Humidity Sensor*—Allowed variability is ±2 % RH.

6.8 *Temperature Measuring Device*—Allowed variability is ±1°C (±2°F).

6.9 *Weighing Balance or Scales,* for weighing the amount of explosive charge; allowed variability is ±0.1 g.

6.10 *Weighing Scales,* for determining the mass of the trash receptacle test specimen; allowed variability is ±1.0 %.

6.11 *Wind Measuring Device*—allowed variability is ±2 m/s (4.5 mph).

7. Explosive Charge

7.1 *Type of Explosive Charge*—Unless otherwise determined by agreement between the party commissioning the test and the testing laboratory, use a bare C4 explosive charge as the test explosive at a relative effectiveness factor of 1.34 in relation to 0.45 kg (1.0 lb) of trinitrotoluene (TNT).

NOTE 2—A Relative Effectiveness Factor (R.E. factor) is a measurement of an explosive's power and is used to compare an explosive's effectiveness relative to TNT by mass (weight) only. Engineers can substitute one explosive for another when using blasting equations that are designed for TNT. For example, if a timber cutting charge requires 1 kg of TNT to work, it would take 0.75 kg of C4 to have the same effect. For further discussions on the potential and relative strength of explosives, see *Fundamentals of Naval Weapons Systems*, Chapter 12.[6]

7.1.1 *Mass of Explosive Charge*—Determine the mass of the explosive charge by agreement between the party commissioning the test and the testing laboratory.

7.1.2 Fabricate the charge by packing C4 charge (or the agreed upon explosive) into a cylindrical cardboard tube. The height of the explosive packed in the cardboard tube shall be within 1.0 to 1.5 times the diameter of the tube. For ease of handling, use masking or duct tape to close the top and bottom openings of the packed cardboard tube.

7.1.3 The density of the packed explosive charge shall be uniform throughout the cardboard tube. For purposes of this standard test method, the charge is considered to be uniformly packed in the cardboard tube if the explosive charge density is at least 1.4 g/cm^3 (0.051 lb/in.^{3}).

7.2 *Fragmentation Charge*—Secure rings of 9 ± 0.03 mm (0.35 ± 0.001 in.) American Iron and Steel Institute (AISI) Type 440, Grade 25 stainless steel balls (10 balls per 0.45 kg (1 lb) of explosive charge) horizontally to the outside of the cardboard tube at the center of the tube's length. Check that the stainless steel balls are placed uniformly around the tube.

8. Detonator

8.1 Use an electric detonator (for example, a M-6 or Mk-11 electric blasting cap) to detonate the explosive.

8.2 Place the detonator in the charge at the center of the cardboard tube's axis and at a distance of 20 to 25 mm (0.8 to 1 in.) from the tube's top.

9. Trash Receptacles for Test

9.1 *Test Specimen*—Any trash receptacle, as defined in 3.2.11, is acceptable as a test specimen.

9.1.1 Weigh the test specimen at the testing laboratory prior to transporting it to the test arena.

9.1.2 Record the test specimen mass in accordance with Section 14.

9.2 Test trash receptacles including accessory components as supplied by the manufacturer for in-use service, unless otherwise agreed upon by the party commissioning the test and the testing laboratory.

9.2.1 Typical trash receptacle accessory components supplied by manufacturers for in-use service include lids, trash receptacle liners, and trash receptacle rubbish bags.

10. Location of the Explosive Charge in the Test

10.1 During testing, place the charge at one of the following four locations, as agreed upon by the party commissioning the test and the testing laboratory (see Fig. 1):

10.1.1 Center of the receptacle, halfway up the interior without contact with the wall,

10.1.2 In contact with the wall on the inner seam, halfway up the interior,

10.1.3 In contact with the wall 180° opposite the inner seam, halfway up the interior, and

10.1.4 In contact with the wall and bottom of the receptacle 90° from the inner seam.

10.2 In cases where there is no agreement for placing the explosive charge, place the charge in contact with the wall on the inner seam, halfway up the interior, as described in 10.1.2.

10.3 In case where the inner seam of the trash receptacle test specimen is not visible, the testing laboratory shall ask the receptacle manufacturer to indicate the inner seam location.

10.4 For the locations described in 10.1.1, 10.1.2, and 10.1.3, support the charge with a consumable, non-blast absorbing support such as a cardboard cylinder.

10.5 For trash receptacle specimens supplied with liners, in some cases, the intersection of the interior wall and bottom of the trash receptacle specimen can have a curved, hemispherical, or similar configuration that impedes placing the explosive charge in location 4 (see Fig. 1) as described in 10.1.4. In such cases, as shown by visual examination when setting the charge in the place, use the following procedure for charge placement at location 4:

10.5.1 Locate the charge on the liner at a position corresponding to the intersection of the vertical wall and bottom of

[6] *Fundamentals of Naval Weapons Systems* , Chapter 12, Weapons and Systems Engineering Department, United States Naval Academy, http://www.fas.org/man/dod-101/navy/docs/fun/part12.htm.

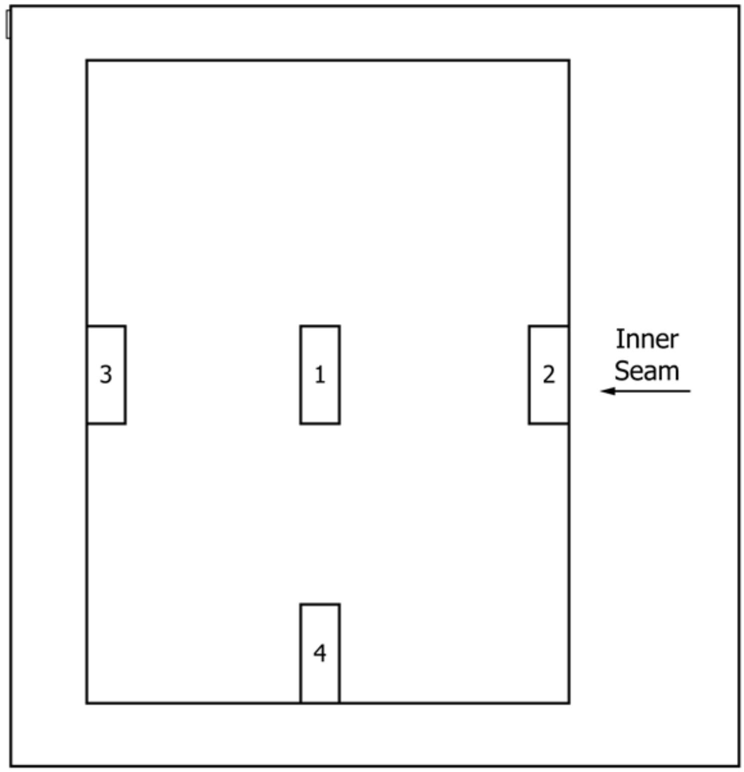


Figure 1A. Side view of the charge locations inside the trash receptacle specimen.

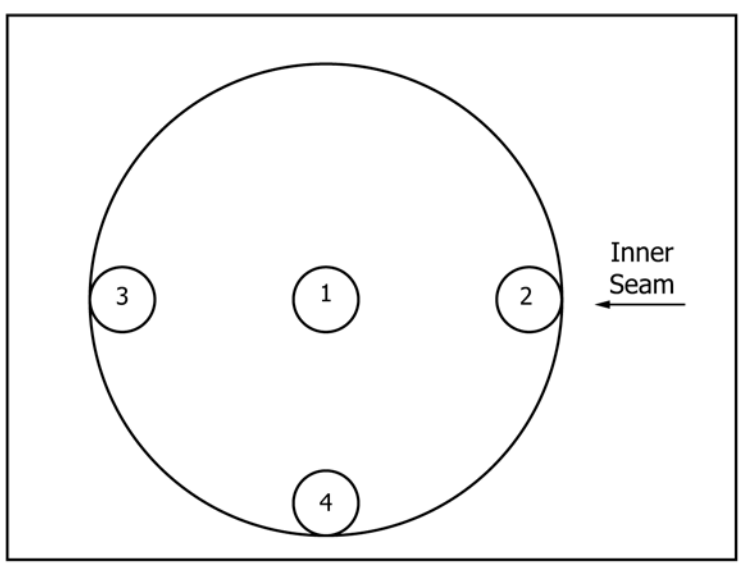


Figure 1B. Top view of the charge locations inside the trash receptacle specimen.

FIG. 1 Side View (top) and Top View (bottom) of the Charge Locations

the trash receptacle, as illustrated in Fig. 2. Place the circular base of the cardboard tube holding the explosive in contact with the liner. Angle the centerline of the cardboard tube, as shown in Fig. 2. Use cardboard supports and tape, as necessary, to hold the charge in this position.

10.6 Even for some trash receptacle specimens supplied without liners, the intersection of the interior wall and bottom of the trash receptacle specimen can have a curved, hemispherical, or similar configuration that impedes placing the explosive charge in location 4 (see Fig. 1) as described in 10.1.4. In such cases, as shown by visual examination when setting the charge in the place, use the following procedure for charge placement at location 4:

10.6.1 Locate the charge on the specimen interior at a position corresponding to the intersection of the vertical wall and bottom of the trash receptacle, as illustrated in Fig. 2. Place

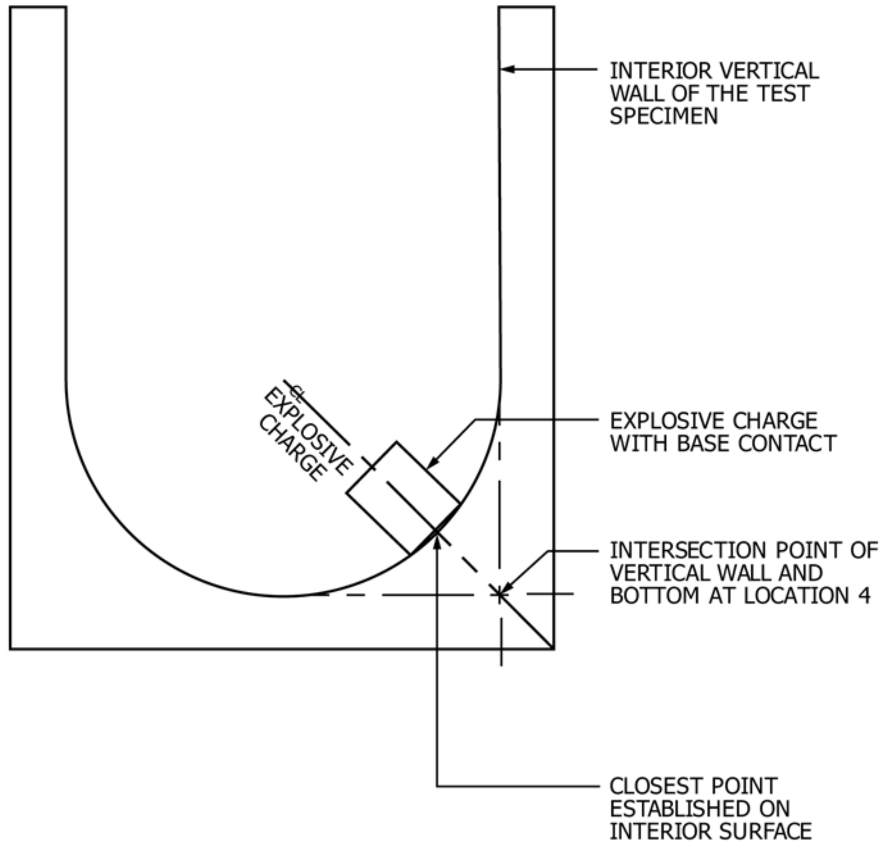


FIG. 2 Positioning of the Explosive Charge at the Intersection of the Wall and Base of the Trash Receptacle for those Specimens in which this Location has a Curved, Hemispherical, or Similar Configuration (see 10.5 and 10.6).

the circular base of the cardboard tube holding the explosive in contact with the trash receptacle wall. Angle the centerline of the cardboard tube, as shown in Fig. 2. Use cardboard supports and tape, as necessary, to hold the charge in this position.

11. Test Arena

11.1 The test arena shall consist of a flat, open-air terrain that is approximately circular and without obstructions. The diameter of this terrain shall be a minimum of 76 m (250 ft).

11.1.1 Fig. 3 shows a schematic of the test arena. The key components of the test arena are:

11.1.1.1 The test platform, on which the trash receptacle is placed during testing,

11.1.1.2 Witness panels arranged around the trash receptacle specimen to register any fragment damage from the explosion.

11.1.1.3 Silhouettes placed across the test arena for qualitative and visual purposes of assessing fragmentation damage Silhouettes are only used for tests incorporating fragmentation charges (see 7.2).

11.1.1.4 A camera station on which is mounted normal-speed and high-speed video cameras.

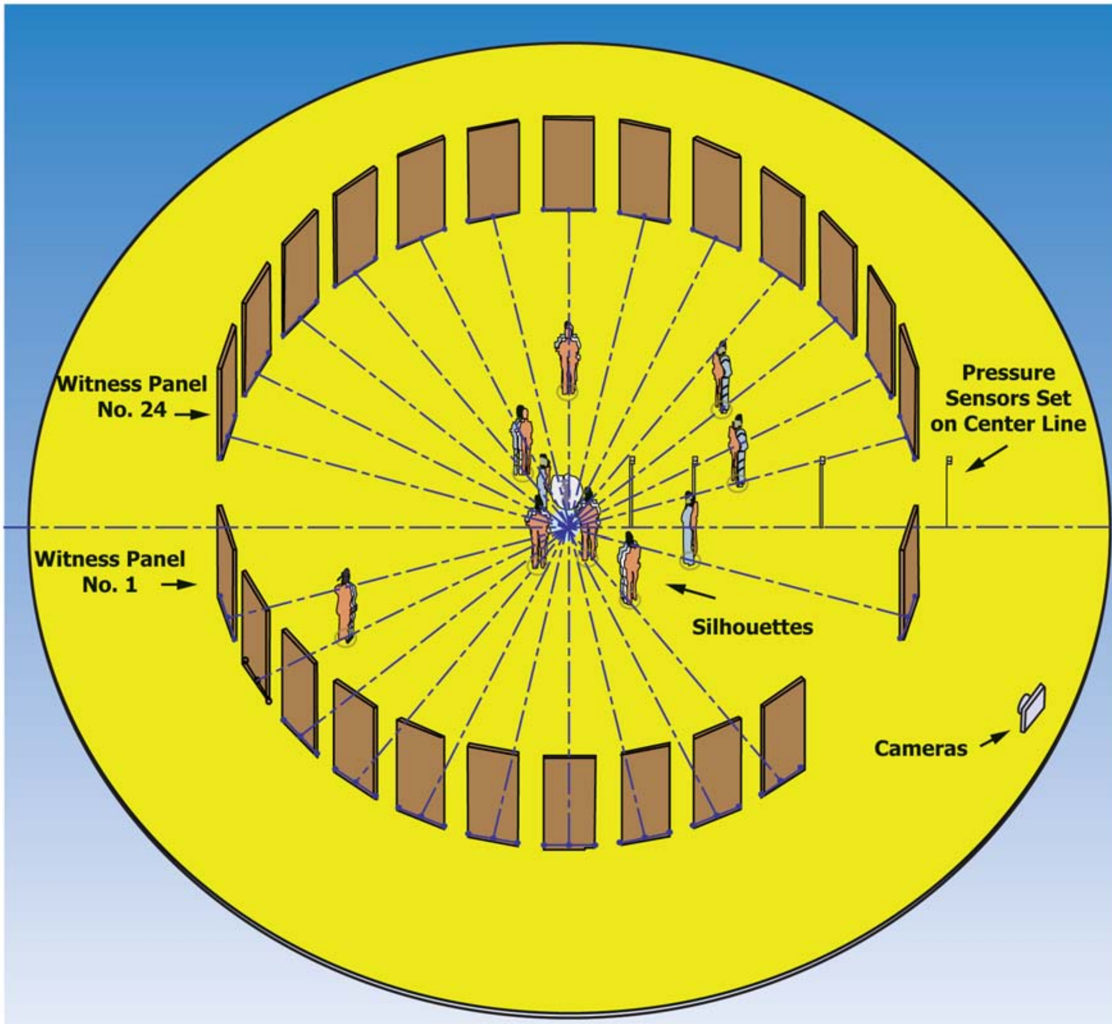
11.1.1.5 Optional pressure sensors and an optional data acquisition system used at the discretion of users of the standard if the magnitude of overpressures generated during the explosion are recorded (see Appendix X1).

11.2 *Test Platform*—The test platform on which the trash receptacle specimen is placed during testing shall be a steel plate having a minimum thickness of 150 mm (6 in.) and a minimum length and a minimum width of 1.2 by 1.2 m (4.0 by 4.0 ft), respectively. Place this steel plate in the center of the test arena.

11.3 *Witness Panels*—Construct witness panels using 9.5 mm (⅜ in.) exterior, A grade veneer plywood sheets conforming to the requirements of Voluntary Product Standard PS 1. Attach the sheets measuring 1.2 m (4 ft) wide by 2.4 m (8 ft) high with nails or screws to nominal 2 by 4 wooden frames. Place 24 witness panels 9 m (30 ft) from the center of the test platform as shown in Fig. 3. For those panels that are in close proximity to each other, separate adjacent panels by approximately 0.6 m (2 ft). With the A-face of the plywood sheets oriented toward the trash receptacle test specimen, secure the witness panels in a vertical position to the terrain using an adequate quantity of anchors or sand bags or both.

11.3.1 Number the witness panels consecutively for documentation purposes (see Fig. 3).

11.4 *Silhouettes*—Construct silhouettes, used for tests incorporating fragmentation charges, from cardboard sheets reinforced with wooden or steel supports attached to a wooden or steel base plate. With the cardboard sheets in a vertical



Ten silhouettes numbered as given below; distances are measured from the center of the test platform. Silhouettes are only used for tests incorporating fragmentation charges.

- No. 1 is 0.6 m (2 ft) in line with panel no. 24.
- No. 2 is 1.2 m (4 ft) in line with panel no. 4.
- No. 3 is 1.8 m (6 ft) in line with panel no. 21.
- No. 4 is 2.4 m (8 ft) in line with panel no. 10.
- No. 5 is 3.0 m (10 ft) in line with panel no. 11.
- No. 6 is 3.6 m (12 ft) in line with panel no. 18.
- No. 7 is 4.2 m (14 ft) in line with panel no. 12.
- No. 8 is 4.8 m (16 ft) in line with panel no. 14.
- No. 9 is 5.4 m (18 ft) in line with panel no. 7.
- No. 10 is 6.0 m (20 ft) in line with panel no. 2.

Twenty-four (24) witness panels numbered consecutively counterclockwise from panel no. 1, which is shown in the illustration:

- Panels are set 9 m (30 ft) from the test arena, and where adjacent, about 0.6 m (2 ft) apart.
- Panels 1, 11, 12, and 24 are set back 2.4 m (8 ft) from the center line.

A minimum of four optional pressure sensors are set 1.5 , 3 , 6 , and 9 m (5, 10, 20, and 30 ft) from the center of the test platform at a height of 1.8 m (6 ft). Up to 16 pressure sensors may be used and are placed as described in X1.3.
Normal speed and high speed video cameras are mounted 35 m (115 ft) from the test platform.
(Note: the camera in the illustration is not set to scale.)

FIG. 3 Diagram of the Test Arena

position, secure the base plates to the terrain using a sufficient quantity of anchors or sand bags, or both.

11.4.1 *Placement of Silhouettes*—Place 10 silhouettes throughout the test arena as shown in Fig. 3 such that for each silhouette:

11.4.1.1 The plane of the forward face is facing the center of the test arena.

11.4.1.2 The distance to the trash receptacle specimen is as specified in Fig. 1.

11.4.1.3 The location is in line with a randomly selected witness panel.

11.4.1.4 Only one silhouette is aligned with the same witness panel.

11.4.1.5 Silhouettes with sequential numbers are aligned with non-adjacent witness panels.

11.4.2 The cardboard sheet shall be plain (that is, without a printed image), double wall conforming to type ECT 51, and life-sized with die-cut dimensions of 165 by 74 cm (65 by 29 in.).

11.5 *Cameras*—Mount normal speed and high speed video cameras 35 m (115 ft) from the test platform as shown in Fig. 3. Check operation of the cameras prior to conducting the explosive test.

12. Procedure

12.1 Place the trash receptacle specimen on the flat steel plate of the test platform such that:

12.1.1 Any edge of the specimen is a minimum of 150 mm (6 in.) from any edge of the steel plate, and

NOTE 3—Placing the specimen at a minimum distance from the edge of the steel plate allows the steel plate to be used for multiple tests so long as the trash receptacle specimen can be set on a flat portion of the plate.

12.1.2 For a trash receptacle specified by its supplier to be attached to its substrate, secure the trash receptacle specimen to the steel plate in accordance with the supplier's attachment instructions.

12.2 Using calipers, a steel rule, or measuring tape as appropriate, measure the inside and outside dimensions and inside and outside height of the trash receptacle specimen to the nearest ±6 mm (±¼ in.).

12.2.1 Record the dimensions of the trash receptacle specimen in accordance with Section 14.

12.3 Immediately prior to the test, measure the temperature, humidity, wind speed, and atmospheric pressure.

12.3.1 Do not conduct tests during rain.

12.3.2 Record the temperature, humidity, wind speed and atmospheric pressure measurements in accordance with Section 14.

12.4 Take sufficient pictures of the trash receptacle specimen and test arena to document the pretest conditions accurately including the location (see 10.1) at which the charge is placed in the trash receptacle specimen.

12.5 Secure the explosive charge in one of the four designated locations as described in 10.1. Orient the long dimension of the charge vertically (that is, parallel to the walls of the receptacle). For locations described in 10.1.1, 10.1.2, and 10.1.3, tape the charge to the top of the non-blast absorbing cardboard support if needed.

12.6 Ensure that the test arena is cleared for testing in conformance to applicable explosive safety regulations.

12.7 Conduct the test such that the high speed photography equipment is active and recording relevant images throughout the entire explosive event.

12.8 Detonate the charge.

12.9 Take sufficient pictures of the trash receptacle specimen and test arena to document the post-explosion conditions accurately.

12.10 Examine the exterior surfaces of the trash receptacle test specimen for breaches (such as cracks, fissures, and holes).

12.10.1 Using calipers, a steel rule, or measuring tape as appropriate, measure the inside and outside dimensions (for example, length, width, diameter, and height) of the post-explosion trash receptacle specimen to the nearest ±6 mm (±¼ in.) to document damage and deformations such as bulges.

12.10.2 Record the dimensions of the exploded trash receptacle specimen in accordance with Section 14.

12.11 Examine the witness panels (and silhouettes when used) for damage. Record the number, and measure the dimensions, of penetrations (for example, holes, cuts, tears, and punctures) that pierced through the total thickness of each plywood witness panel and each cardboard silhouette. Take photos of any damage observed.

12.11.1 In the case of a test conducted using a fragmentation charge (see 7.2), when examining witness panels and silhouettes for damage, distinguish to the extent possible penetrations due to primary and secondary fragments.

12.11.2 Record the data obtained from the examination of each witness panel and each silhouette in accordance with Section 14. Note those panels for which penetrations were not observed.

12.12 Review and record the pressure data obtained during the test, if pressure data were measured as an option during the explosion.

13. Evaluation of the Exploded Trash Receptacle

13.1 Evaluate the performance of the trash receptacle specimen under the selected explosive charge according to the following four categories, specifically the ability of the trash receptacle specimen:

13.1.1 To direct blast effects (for example, the fireball) and pressure and fragments upward,

13.1.2 To not produce secondary fragments,

13.1.3 To contain primary fragments (whenever fragment charges are employed), and

13.1.4 To withstand structurally the detonation of a bare charge.

13.2 *Remaining Upright*—Visually examine the trash receptacle test specimen to determine whether it remained on the test platform in the vertical position in which it was mounted or attached prior to detonation.

13.3 *Direction of Blast Effects*—Analyze qualitatively real-time and high speed video recorded during the explosion to determine how well the trash receptacle specimen directed the blast products upward.

13.3.1 Evaluate whether the blast effects were directed upward without exiting through a breach in the wall.

13.3.2 Determine whether horizontal fragments were produced.

13.4 *Production of Secondary Fragments*—Use physical inspection of the exploded trash receptacle specimen, witness panels, and surrounding test arena to determine if secondary fragments were produced. Note in particular the presence of any metallic fragments.

13.4.1 When a trash receptacle liner or rubbish bag is included as part of the test specimen, record whether explosive debris from these accessory components was observed in the test arena.

13.4.2 Evaluate visually the trash receptacle specimen and the witness panels for damage. Document the observations with photographs.

13.4.3 Analyze qualitatively real-time and high speed video recorded during the explosion; use the results as documentation.

13.5 *Containment of Primary Fragments*—Use physical inspection of the exploded trash receptacle specimen, silhouettes and witness panels to determine if the specimen contained primary fragments during the explosion.

13.5.1 Evaluate visually the trash receptacle specimen for signs that it was breached (for example, cracks, fissures, and holes) such that fragments were created. Also inspect the witness panels for damage. Document the observations with photographs.

13.5.2 Analyze qualitatively real-time and high speed video recorded during the explosion; use the results as documentation.

13.6 *Breaching of the Outer Wall*—Use physical inspection of the exploded trash receptacle specimen to determine if the outer walls were breached during the explosion.

13.6.1 Evaluate visually the trash receptacle specimen for signs that it was breached (for example, cracks, fissures, or holes). Document the observations with photographs.

13.6.1.1 Record the presence of such breaches and the dimensions of each.

13.6.1.2 Evaluate whether direct openings from the exterior to the interior of the test specimen were produced, as evidenced by probing all visible breaches in the exterior wall with a round, straight 4 mm (3⁄16 in.) steel rod. A direct opening is present if the steel rod penetrates all the way through from the exterior to the interior of the specimen.

13.6.2 Analyze qualitatively real-time and high speed video recorded during the explosion; use the results as documentation.

14. Records

14.1 At a minimum, record and manage data collected by the testing laboratory in field notebooks, photographs, and electronic files as follows:

14.1.1 *Field Notebooks:*

14.1.1.1 Document data collected by handwriting in a field notebook, which shall be bound and have pre-numbered pages. Record all entries in the field notebook using ink accompanied by the signature of the individual making the entry and the date of the entry.

14.1.1.2 *Errors*—Correct any errors using only a single line drawn through the incorrect entry (that is, no scratch outs) accompanied by the initials of the person making the correction and the date of the correction.

14.1.2 *Photographs*—Create a record of photographs. Ensure that these records are traceable to all photographs and photographic media and to the trash receptacle specimen tested (for example, name, address, and other appropriate information regarding the trash receptacle specimen, the name of the person taking the photograph, and the date taken).

14.1.3 *Electronic Records:*

14.1.3.1 Properly protect data and other information stored electronically (for example, with passwords) to ensure their integrity, and properly maintain them (that is, back them up) to prevent accidental loss.

14.1.3.2 *Errors*—When mistakes occur, at a minimum, make an electronic entry to describe changes that were made in the record in a corresponding file or place within the original data file. Include an electronic signature and date(s) that changes were made.

NOTE 4—Computer software is available to assist with the insertion of electronic signatures.

15. Report

15.1 At a minimum, report the following information for each test conducted:

15.1.1 *Test Laboratory:*

15.1.1.1 The name, address, and contact phone numbers of the test laboratory.

15.1.1.2 The name of the project manager responsible for conducting the test.

15.1.1.3 The name of all other individuals involved in conducting the test, or observing the test, or both.

15.1.1.4 The name of the laboratory manager having oversight responsibility for the test.

15.1.2 *Party Commissioning the Test:*

15.1.2.1 The name, address, and contact phone number of the party commissioning the test.

15.1.2.2 The name of the responsible individual acting on behalf of the party commissioning the test.

15.1.3 *Trash Receptacle Test Specimen:*

15.1.3.1 The brand name and model number of the trash receptacle specimen(s).

15.1.3.2 The name, address, and contact phone numbers of the producer of the specimen(s).

15.1.3.3 A description of the trash receptacle specimen including accessory components; for example, whether or not it contained a liner or lid.

15.1.3.4 The mass of the specimen.

15.1.3.5 The inside and outside dimensions of the trash receptacle specimen.

15.1.4 *Test Arena:*

15.1.4.1 A general description of the test arena.

15.1.4.2 Name and models numbers of all measuring equipment and devices used during the test including pressure sensors, recorders, and temperature, humidity, wind speed, and barometric devices. Information regarding the most recent calibration of the equipment and devices.

15.1.4.3 Name and model numbers of all cameras used during the test.

15.1.4.4 A description of the witness panels and silhouettes.

15.1.5 *Explosive Charge:*

15.1.5.1 Identification of the explosive and amount of charge.

15.1.5.2 Description of the detonation system.

15.1.5.3 The location where the explosive charge was set in the trash receptacle specimen.

15.1.6 *Results of the Explosion:*

15.1.6.1 The direction of the blast effects, for example, upwards or horizontal.

15.1.6.2 For each witness panel and silhouette, the number and dimensions of observed penetrations, if any, and photos typical of the damage observations. Indicate panels having no penetrations.

15.1.6.3 Whenever the explosive was a fragmentation charge, for each witness panel and silhouette, the number and dimensions of observed penetrations, if any, and photos typical of the damage observations. Distinguish to the extent possible penetrations resulting from primary and secondary fragments. Indicate panels having no penetrations.

15.1.6.4 Overpressures, if measured as an option during the explosion; attach Fig. 4.

15.1.6.5 Deformation of the trash receptacle specimen as determined from the dimension measurements taken before and after the explosion.

16. Precision and Bias

16.1 No information is presented about either the precision or bias of Test Method E2639 for measuring the blast resistance of trash receptacles since the test result is non-quantitative.

17. Keywords

17.1 blast resistance; explosive charge; fragmentation; overpressure; pressure waves; security; trash receptacle

Probe Distance		0.9 m (3 ft) Sensor Height						1.8 m (6 ft) Sensor Height					
		Receptacle Overpressure		Open Air Overpressure[A]		Change in Overpressure		Receptacle Overpressure		Open Air Overpressure[A]		Change in Overpressure	
m	ft	kPa	lbf/in.^{2}	kPa	lbf/in.^{2}	kPa	lbf/in.^{2}	kPa	lbf/in.^{2}	kPa	lbf/in.^{2}	kPa	lbf/in.^{2}
1.5	5												
3.0	10												
6.0	20												
9.0	30												
12.0	40												
15.0	50												
23.0	75												
38.0	125												
Barometric pressure at time of test:____ kPa (____mbar); altitude of the test site:____m (____ft)													
Overpressures adjusted to sea level:____Yes ____No													

[A] Open air overpressures are commonly available in standard tables, or from data available at the test laboratory.

FIG. 4 Form for Comparison of Overpressures Measured During the Test Specimen Explosion with Those Measured for Detonation of the Same Charge in Open Air

APPENDIX

(Nonmandatory Information)

X1. RECORDING OVERPRESSURES DURING DETONATION

X1.1 Introduction

X1.1.1 ASTM Standard Specification E2740 provides performance requirements for trash receptacles when they are subjected to the explosive tests. However, in Specification E2740 there is no performance requirement based on measurements of overpressures generated during the detonation, as explained in an appendix in that standard. Consequently consistent with the standard specification, this companion standard, Test Method E2639, also does not contain a mandatory requirement for measurement of overpressures. Rather such measurement is an option provided in this appendix to those users of this standard who wish to conduct overpressure measurements. The purpose of this appendix is to provide direction to users wishing to conduct overpressure tests such that such tests are performed in a standardized fashion.

X1.2 Test Apparatus and Equipment

X1.2.1 *Pressure Measuring Sensors:*

X1.2.1.1 The allowed pressure sensor variability shall be ±17 kPa (±2.5 lbf/in.^{2}).

X1.2.1.2 Each pressure sensor shall be factory or field calibrated according to the sensor manufacturer's recommendations.

X1.2.1.3 The pressure sensor selected for each pressure measurement location shall have the expected peak pressure in the upper 25 % of the full scale measurement range. This maximizes the resolution and minimizes the nonlinearity error of the measurement.

X1.2.2 *Data Acquisition System*—The data acquisition system shall be capable of continuously recording the magnitude of the pressure waves created during testing without significant data aliasing. Aliasing is minimized by choosing a sampling rate that acquires more than two points per cycle of the highest frequency component in the signal or by using an anti-aliasing filter.

X1.3 Placement of Pressure Sensors in the Test Arena and Their Orientation to the Trash Receptacle Test Specimen

X1.3.1 Place the pressure sensors and data acquisition system in the test arena to measure the magnitude of shock waves generated during the explosion as shown Fig. 3.

X1.3.1.1 Use a minimum of four pressure sensors set at 1.5, 3, 6, and 9 m (5, 10, 20, and 30 ft) from the center of the test platform, all at a height of 1.8 m (6 ft).

X1.3.1.2 Up to 16 pressure sensors are allowed to be used to measure the magnitude of the pressure waves generated during testing, as agreed upon by the party commissioning the test and the testing laboratory. Attach the sensors to stands placed along the center line (see Fig. 3) of the test arena at distances ranging from 1.5 to 38 m (5 to 125 ft) from the center of the test platform. Table X1.1 includes the distance of each stand to the center of the test platform. Construct each stand from steel supports secured to the terrain using a sufficient quantity of anchors or sand bags or both. Each stand shall hold up to two sensors—one placed 0.9 m (3 ft) and the other 1.8 m (6 ft) above the ground. Protect the pressure sensors from fragments by using solid steel poles placed 10 pole diameters upstream of the pressure sensors to strip fragments from the airstream flowing toward the sensors.

X1.3.2 The inner seam of the specimen is oriented in the direction of the pressure sensors (see 10.3).

X1.4 Pre-Test Calibration Check

X1.4.1 Prior to conducting the first test of a series, conduct a systems check of the pressure sensors and data acquisition system.

X1.5 Procedure

X1.5.1 Conduct the test such that the pressure sensors are active and recording relevant data throughout the entire explosive event.

X1.5.2 Review, collate, and record the pressure data obtained.

X1.5.2.1 Complete Fig. 4 as appropriate for the number of pressure sensors used during the test. Include in Fig. 4 the barometric pressure at time of the test, the altitude of the test site, and a notation indicating whether the overpressures are adjusted to sea level.

TABLE X1.1 Sensors: Positions, Height Off Ground, Distances From the Trash Receptacle Specimen, and Pressure Ranges

Sensor Number	Position Number	Height Off Ground		Sensors Distance from Trash Receptacle Specimen[A]		Sensor Pressure Range	
		m	ft	m	ft	kPa	lbf/in.^{2}
1	1	1.0	3	1.5	5	0.7 to 3450	0.1 to 500
2	1	1.8	6	1.5	5	0.7 to 3450	0.1 to 500
3	2	1.0	3	3.0	10	0.7 to 3450	0.1 to 500
4	2	1.8	6	3.0	10	0.7 to 3450	0.1 to 500
5	3	1.0	3	6.0	20	0.7 to 3450	0.1 to 500
6	3	1.8	6	6.0	20	0.7 to 3450	0.1 to 500
7	4	1.0	3	9.0	30	0.7 to 3450	0.1 to 500
8	4	1.8	6	9.0	30	0.7 to 3450	0.1 to 500
9	5	1.0	3	12.0	40	0.7 to 3450	0.1 to 500
10	5	1.8	6	12.0	40	0.7 to 3450	0.1 to 500
11	6	1.0	3	15.0	50	0.35 to 350	0.05 to 50
12	6	1.8	6	15.0	50	0.35 to 350	0.05 to 50
13	7	1.0	3	23.0	75	0.35 to 350	0.05 to 50
14	7	1.8	6	23.0	75	0.35 to 350	0.05 to 50
15	8	1.0	3	38.0	125	0.35 to 350	0.05 to 50
16	8	1.8	6	38.0	125	0.35 to 350	0.05 to 50

[A] Sensor numbers 2, 4, 6, and 8 are the minimum required when using this appendix, whereas all others are discretionary, as agreed upon by the party commissioning the test and the testing laboratory.