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

This standard is issued under the fixed designation E 2639; 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 measures the magnitude of blast waves (that is, external overpressures) developed and determines the extent and location of fragmentation produced during the explosion.

1.1.2 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 *Government Standards:*

DOD 4145.26 M Department of Defense: DOD Contractors' Safety Manual for Ammunition and Explosives[2]

DOD 6055.9 STD Department of Defense: DOD Ammunition and Explosives Safety Standards[3]

Department of Commerce: Voluntary Product Standard PS 1, Structural Plywood[4]

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**

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**

[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.

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

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

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

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

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

3.2.10.1 *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).

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

3.2.11.1 *Discussion*—This device is normally fitted to the configuration of the interior of the trash receptacle and is manufactured using a molding process from non-rigid plastic materials.

3.2.12 *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 Upon detonation, the magnitude of the resultant pressure waves is measured. Subsequently, changes in the trash receptacle dimensions are recorded, and the extent and location of fragmentation produced is recorded.

5. Significance and Use

5.1 This test procedure is used to measure two 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 sources of damage are from:

5.1.1 Primary and secondary fragments due to the detonation, and

5.1.2 Overpressure from the detonation.

5.2 This test procedure is also used to document the physical damage to the trash receptacle due to explosion.

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

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

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 *Pressure Measuring Sensors and Recorder*, as described in 11.5.1 and 11.5.2, respectively; allowed pressure sensor variability is ±17 kPa (±2.5 lbf/in.^{2}).

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

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

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

6.12 *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 1—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.[5]

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 from the tube's top.

9. Trash Receptacles for Test

9.1 *Test Specimen*—Any trash receptacle, as defined in 3.2.10, 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 15.

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

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 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 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.

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[5] *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.

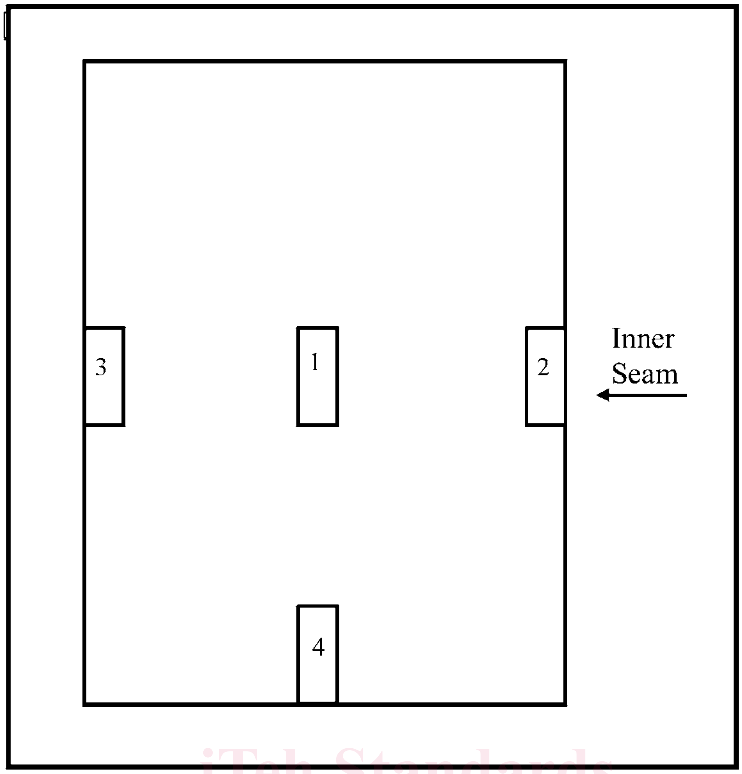


Figure 1A. Side view of the charge locations inside the trash receptacle specimen.

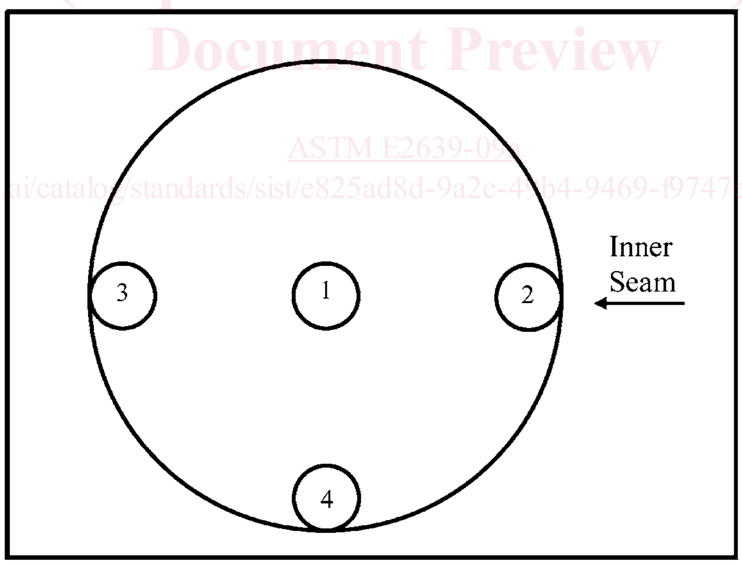


Figure 1B. Top view of the charge locations inside the trash receptacle specimen.

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

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. 2~~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).

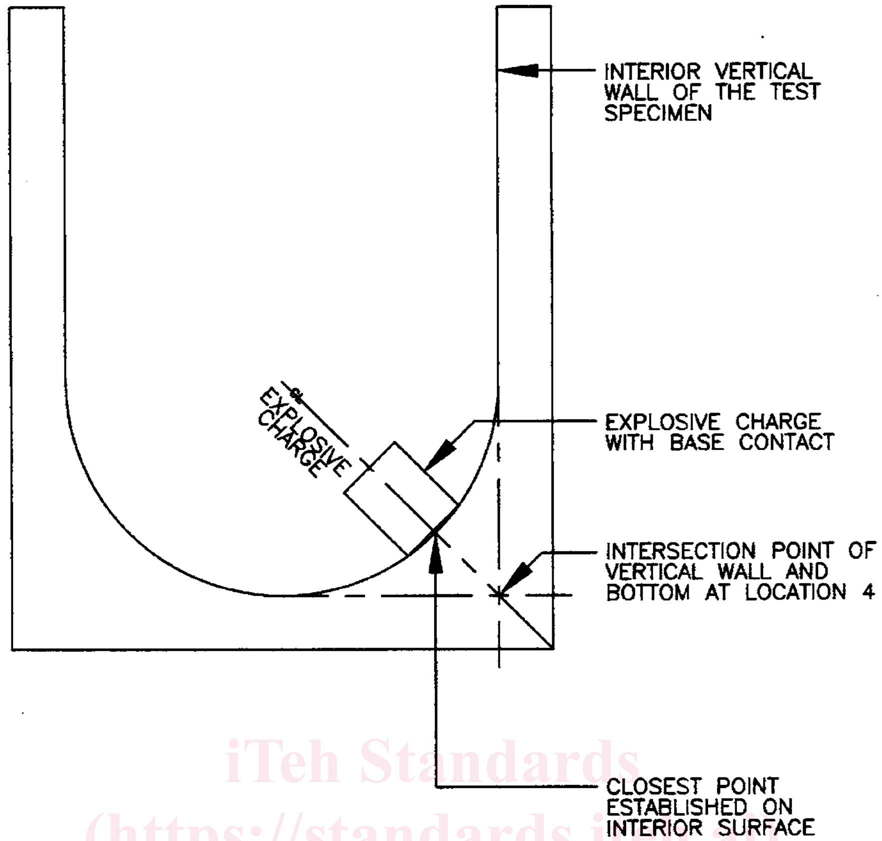


FIG. 2 Positioning of the Explosive Charge at the Intersection of the Wall and Base of the Trash Receptacle for those Specimens in which this Location has a Curved, Hemispherical, or Similar Configuration (see 10.5 and 10.6).

11.1.1.4 Pressure sensors and data acquisition system to measure the magnitude of shock waves generated during the explosion.

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

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. ~~2~~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. 2~~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 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. 2~~ 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.

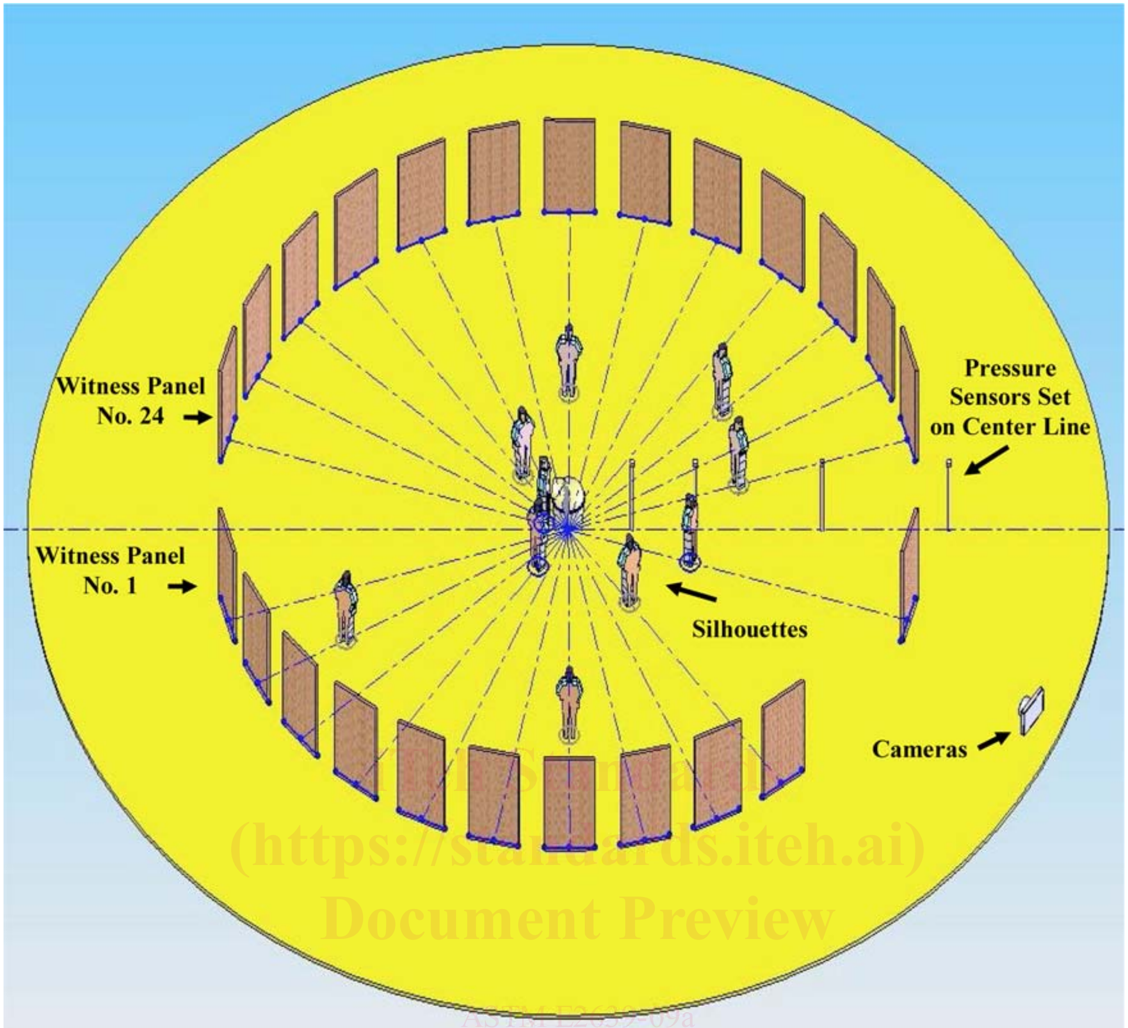
11.4.1.5 Silhouettes with sequential numbers are aligned with non-adjacent witness panels.

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 *Pressure Sensors and Data Acquisition System*:

11.5.1 *Pressure Sensors*:

11.5.1.1 Up to 16 pressure sensors are 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



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 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 11.5.1.1.
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. ~~2~~ 3 Diagram of the Test Arena

~~Fig. 2~~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 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.

(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).

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