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Standard Specification for Trash Receptacles Subjected to Blast Resistance Testing[1]

This standard is issued under the fixed designation E2740; 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.

ε[1] NOTE—Added Note 3 editorially in November 2012.

1. Scope

1.1 This specification provides performance requirements for trash receptacles when subjected to the explosive tests described in Test Method E2639.

1.1.1 These trash receptacles are intended for use in public spaces.

1.2 *Units*—The values stated in SI units are to be regarded as the standard. The values stated in parentheses are for information only.

1.3 *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

D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens

E2639 Test Method for Blast Resistance of Trash Receptacles

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]

UFC 3-340-02 Department of Defense: Structures to Resist the Effects of Accidental Explosions (supersedes TM 5-1300)[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 *bare charge, n*—explosive charge that is either not encased or is encased by a material, such as a cardboard tube, that will not produce primary fragments.

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*—chemical reaction of any chemical compound (or mechanical mixture) that, when initiated, undergoes a very rapid combustion or decomposition releasing large

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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 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://www.wbdg.org/ccb/DOD/UFC/ufc_3_340_02_pdf.pdf.

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

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

3.2.5.2 *secondary fragment, n*—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.

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

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

3.2.8 *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**

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

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

3.2.10.1 *Discussion*—The capacity of a trash receptacle specified according to this standard is typically less than 200 L (50 gal).

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

3.2.11.1 *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.).

3.2.12 *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.

3.2.12.1 *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.).

3.2.13 *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.

3.2.13.1 *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.).

3.2.14 *witness panel, n*—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.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *blast resistance, n*—for purposes of this standard specification, the non-numerical attribute of a trash receptacle that is established when the results of explosive testing of the submitted specimens meet all performance requirements given in this specification.

3.3.2 *force protection, n*—numerical level of blast resistance of a trash receptacle expressed in the mass of trinitrotoluene (TNT) explosive.

4. Ordering Information

4.1 Purchase orders for each trash receptacle specimen meeting the requirements of this specification shall list the model and desired force protection required in kilograms (pounds) of TNT.

4.2 Purchase orders shall also list the physical trash content size of the receptacle in liters (gallons) along with desired finishes and other requirements associated with the physical attributes of the trash receptacle.

5. Materials and Manufacture

5.1 The materials and method of manufacture shall be at the discretion of the manufacturer sufficient to meet the performance requirements of this specification.

6. Workmanship

6.1 The trash receptacles shall have no defects that will adversely affect their service qualities.

7. Number of Tests and Retests

7.1 *Test Specimens*—Each explosive test shall be performed on a new, undamaged trash receptacle.

7.2 *Number of Test Specimens*—The minimum number of test specimens submitted for each force protection level test shall be three. The manufacturer shall provide all three test specimens at one time.

7.3 *Retests*—Only one retest is allowed per group of submitted test specimens.

7.3.1 If upon testing, one of the trash receptacle specimens in the group submitted does not meet the requirements of this specification, the manufacturer shall provide a new specimen for retesting.

7.3.1.1 If this retest specimen does not meet the requirements of this specification, the entire force protection level group of specimens including test specimens that may or may not have been tested shall be rejected. The group shall be

considered not to meet the requirements of this specification. The manufacturer shall provide three new specimens for retesting.

7.3.2 If upon testing, two or more trash receptacle specimens in the group submitted do not meet the requirements of this specification, the manufacturer shall provide three new specimens, all of which shall be subject to retesting.

8. Specimen Mounting

8.1 The trash receptacle test specimen shall be placed on the test platform in accordance with the manufacturer's written instructions subject to the requirements of Test Method E2639, paragraph 13.1.

9. Test Method

9.1 *Testing*—The trash receptacle test specimens shall be tested according to the requirements of Test Method E2639. Each test specimen shall be tested separately from the others in the group submitted with the charge at one of three different locations. The testing laboratory shall randomly select the individual test specimen for each test from the group submitted.

9.1.1 Trash receptacles including accessory components shall be tested as supplied by the manufacturer for in-use service. For example, if the trash receptacle is intended to have a lid in service, it shall be tested with the lid in place. The lid shall be secured to the receptacle as recommended by the manufacturer.

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

9.2 *The Explosive Charge*—The mass of the explosive charge shall be agreed upon between the manufacturer and the buyer.

NOTE 1—In practice, the buyer is expected to have knowledge of the force protection level required of the trash receptacles being considered for purchase. Based on this knowledge, the manufacturer and buyer are expected to discuss the availability of products meeting the required force protection level, which in turn would lead to agreement on the mass of charge to be used in the testing.

9.2.1 The mass of the explosive charge shall be the same for all test specimens in the group submitted.

9.2.1.1 The force protection level of the trash receptacle specimen group submitted shall be the numerical mass of the explosive charge expressed in kilograms (pounds) of TNT.

9.3 *Explosive Charge Locations (for purposes of this specification):*

9.3.1 *Fragmentation Charge Test*—This test shall be conducted by placing the explosive charge at location 1, as described in Test Method E2639, paragraph 10.1.1 and Figures 1A and 1B.

9.3.2 *Bare Charge Test 1*—This test shall be conducted by placing the explosive charge at location 2, as described in Test Method E2639, paragraph 10.1.2 and Figures 1A and 1B.

9.3.3 *Bare Charge Test 2*—This test shall be conducted by placing the explosive charge at location 4, as described in Test Method E2639, paragraphs 10.1.4 and 10.1.5 or 10.1.6, and Figures 1A, 1B, and 2.

9.4 *Testing Laboratory*—Testing shall be performed at an independent commercial or government explosive testing laboratory following conformance with applicable safety standards and laws. The testing laboratory shall have all required licenses and permits for explosive testing.

10. Performance Requirements

10.1 Trash receptacle specimens conforming to this specification shall meet the following performance requirements:

10.1.1 *Requirement Specific to the Fragmentation Charge Test:*

10.1.1.1 There shall be no perforation of the vertical exterior wall of the trash receptacle test specimen from a primary fragment. In addition, there shall be no perforation of silhouettes that are located 3 m (10 ft) and further from the center of the test platform.

NOTE 2—The requirement regarding no perforation of silhouettes located 3 m (10 ft) and further from the center of the test platform is based on considerations associated with existing technology and costs of producing trash receptacles that provide blast resistance. These products mitigate the effects of an explosion; in general they are not vessels that provide total containment of an explosion.

10.1.2 *Requirements for Either Fragmentation or Bare Charge Tests:*

10.1.2.1 The test specimen shall remain on the test platform and in the vertical position in which it was mounted or attached prior to detonation.

10.1.2.2 There shall be no release of metallic secondary fragments from either the interior surfaces of the test specimen or from the exterior surfaces including the top of the test specimen, as evidenced by examination of:

(1) the witness panels, which shall show no impingement or perforation by metallic fragments,

(2) the grounds within the 76 m (250 ft) diameter of the test arena, which shall show no metallic fragments due to the explosion, and

(3) the high speed photography, which shall show no release of metallic fragments.

10.1.2.3 There shall be no visible fissure in the outer surface of the trash receptacle specimen exterior wall that is either greater than 15 mm (0.6 in.) in width, or greater than 100 mm (4 in.) in length.

10.1.2.4 There shall be no more than three separate visible fissures of any size in the outer surface of the exterior wall.

10.1.2.5 There shall be no direct opening from the exterior to the interior of the test specimen, as evidenced by probing all visible fissures 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.

10.2 *Bulging*—Bulging of the exterior wall of a test specimen that conforms to the requirements in 10.1.1 and 10.1.2 does not constitute failure.

10.3 *Pressure Data:*

10.3.1 At the option of the user of this specification, pressure data can be collected using the guidance provided in the Appendix of Test Method E2639 and recorded in the testing laboratory report. Pressure data are not used as the basis of a

performance requirement of this standard specification. Pressure data may be useful when considering alternative locations for placement of trash receptacles in service.

10.3.2 See Appendix X1 for a discussion of pressure data.

10.4 *Performance Requirements Specific to Trash Receptacle Liners and Lids:*

10.4.1 Plastic trash receptacle liners and lids, when supplied by the receptacle manufacturer as an accessory component for in-service use, shall have properties in accordance with the following requirements:

10.4.1.1 *Thickness*—The thickness of any area of the trash receptacle liner or lid shall not exceed 5 mm (3⁄16 in.), when determined in accordance with Test Methods D5947.

10.4.1.2 *Flexural Modulus*—The flexural modulus of any area of the trash receptacle liner or lid shall not exceed 1000 MPa (150 000 lbf/in.^{2}), when determined in accordance with Test Methods D790.

NOTE 3—Performance requirements specific to trash receptacle liners and lids are included in this specification to help to ensure that these accessory components are acceptable for in-service use. Accessory components not meeting these requirements might perform unsatisfactorily in explosive tests.

11. Product Marking

11.1 Each trash receptacle shall be marked with the manufacturer's name and contact information, and with a unique serial number, unless otherwise agreed upon by the manufacturer and buyer. The serial number shall be marked in a durable manner, such as with a metallic plate riveted to the trash receptacle.

NOTE 4—For security purposes force protection levels of trash receptacles meeting this standard specification are not provided in publicly disseminated marketing materials or marked on units sold commercially.

12. Keywords

12.1 bare charge; blast resistance; explosives; force protection; fragmentation charge; performance requirements; primary fragments; secondary fragments; testing; trash receptacle

APPENDIX

(Nonmandatory Information)

X1. COLLECTION OF PRESSURE DATA

X1.1 Introduction

X1.1.1 The referenced ASTM Test Method E2639 provides an option for the collection of pressure data. However, this specification does not contain performance requirements associated with the pressure data. The primary use for the pressure data is to assist in determining proper in service placement. There are two reasons that performance requirements are not placed on the pressure field recorded during the test. Both are based on data for the lethality of blast pressures and impulses. In the first, the distances for 90 and 99 % survivability of blasts in free air are calculated. In the second, data collected from tests of commercially available trash receptacles which are advertised as blast resistant are examined. Finally, an overall discussion is offered.

X1.2 Test Data

X1.2.1 In 2005, the Naval Explosive Ordnance Disposal Technology Division tested eleven commercially available trash receptacles that are sold as blast resistant. All tests were conducted in an open arena. It is likely that the test results would have differed widely if the tests were conducted in an enclosed structure. The results are detailed in *S.A.V.E.R. Report - Test Results of Blast Resistant Trash Receptacles*.[6] Differing models were tested with a range of advertised capacities of 0.9 to 5.4 kg (2 to 12 lb) of TNT. The test method used corresponded closely with the Test Method E2639 referenced in this document. Pressure data were collected during the tests.

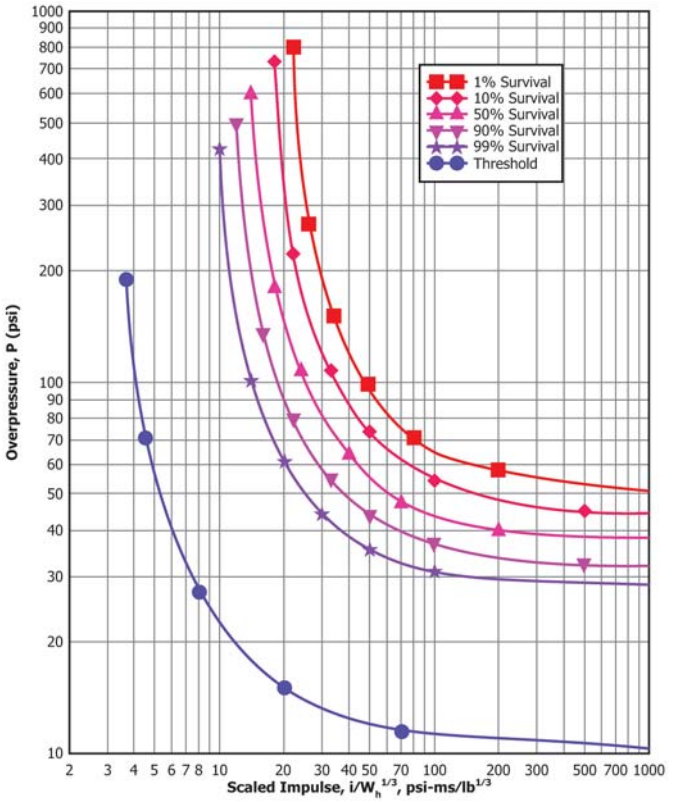


FIG. X1.1 Survivability Curves for Lung Damage From UFC 3-340-02

[6] This report has restricted distribution. Refer requests for this document to the United States Department of Homeland Security, Office of State and Local Government Coordination and Preparedness, Systems Support Division, 800 K Street, NW, Washington, DC 20001.

These data were examined with attention paid to the sensors at the two positions closest to the trash receptacle specimen, 1.5 and 3 m (5 and 10 ft). Two sensors were at each position, one at a height of 0.9 m (3 ft) and one at a height of 1.8 m (6 ft). Not surprisingly, the sensor located 1.5 m (5 ft) from the receptacle at a height of 1.8 m (6 ft) consistently recorded the highest pressures. In no case did the pressure rise above 240 kPa (35 lbf/in.^{2}). As will be shown below, this is well below the 99 % survivability threshold for a 5 kg (11 lb) infant, approximately the absolute survivability threshold for a 25 kg (55 lb) child, and well below the absolute survivability for an adult. In the report, the data were extrapolated to estimate that the absolute threshold of lethality for an adult would be approximately 3 m (1 ft). It must also be remembered that this pressure was recorded at a height of 1.8 m (6 ft). It is unlikely that either a child or an infant would be at such a height. A more typical height for an infant in a parent's arms would be approximately 1.2 m (4 ft) and an average level for a child would be approximately 0.9 m (3 ft). The greatest pressure recorded at 0.9 m (3 ft) was 124 kPa (18.1 lbf/in.^{2}), well below the threshold of survival for even an infant. Furthermore, the test results showed little variation in performance between units of similar rated capacity. Therefore, pressure data do not offer a potential purchaser useful information on which to base a decision. That is, if all units of the desired rated explosive resistance attenuate the blast pressure to approximately the same value, blast pressure is not a discriminator.

X1.3 Effects of Blast Loads on People

X1.3.1 UFC 3-340-02 states that "Tests have indicated that the air-containing tissues of the lungs can be considered as the critical target organ in blast pressure injuries." It gives survival curves for lung damage as a function of the overpressure, P_r and $i_r{}^h$, the impulse scaled on $(W_h)^{1/3}$, where W_h is weight of the person, reproduced here as Fig. X1.1. It also gives standard weights for adult males, adult women, small children, and babies as 70 kg, 55 kg, 25 kg, and 5 kg (154 lb, 121, lb, 55 lb, and 11 lb), respectively. UFC 3-340-02 was originally published as TM 5-1300 and these numbers may need to be updated. However, because they are conservative, they will be used in this discussion.

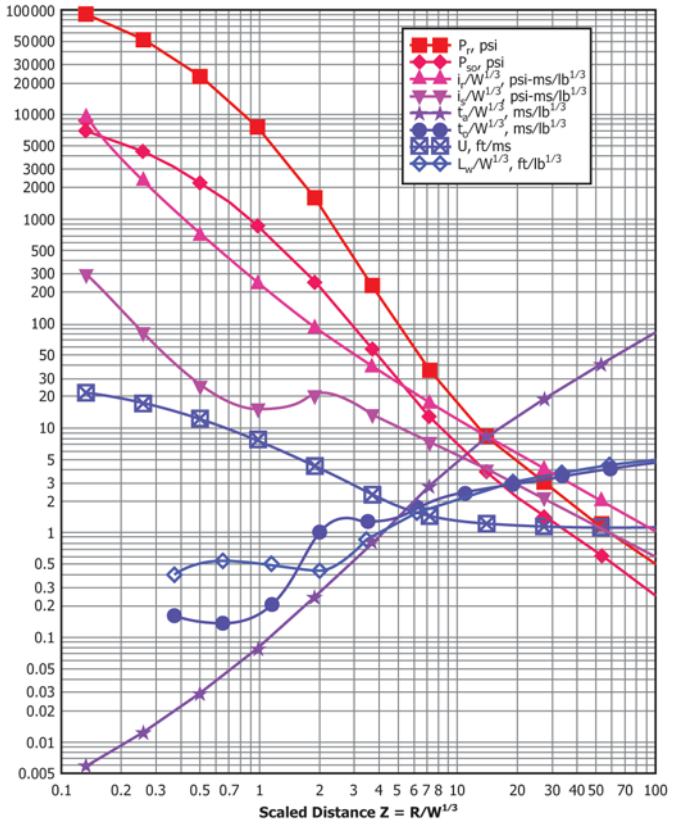
X1.3.2 Using these curves and assuming a charge of 2.3 kg (5 lb) of TNT, the pressure thresholds for different levels of survivability can be calculated as follows:

X1.3.2.1 TM 5-1300 gives data for blast pressures and impulse versus scaled distance. These data are reproduced in Fig. X1.2. Two curves are used: i_r versus Z, and P_r versus Z, where P_r is the peak pressure, i_r is the impulse scaled on $(W)^{1/3}$, Z is the distance scaled on $(W)^{1/3}$, and W is the charge weight. The data are used to create a curve of P_r versus i_r for a bare charge in air.

X1.3.2.2 The impulse data in Fig. X1.1 are scaled $(W_h)^{1/3}$ while the impulse data in Fig. X1.2 are scaled on $(W)^{1/3}$. Therefore, for each class of person, the x-axis Fig. X1.1 is multiplied by

$$\left(\frac{W_h}{W_c}\right)^{1/3}$$

to change it from $i_r{}^h$ to i_r. It must be noted that the new



NOTE 1—The units of the y-axis vary depending on the curve; see legend for units.

FIG. X1.2 Blast Data Versus Scaled Distance From TM 5-1300

curves are valid only for the particular value of W_h and W_c. These curves are plotted on the same axes as the P_r versus i_r curves derived from Fig. X1.2. An example for a 68 kg (151 lb) male is shown in Fig. X1.3.

X1.3.2.3 The intersection of P_r versus i_r with the survivability curves gives the threshold impulse and pressure of lung damage.

X1.3.3 Table X1.1 gives the pressures for the threshold of survival and 99 % survival for a 2.3 kg (5 lb) charge in free air for all four categories of person. As can be seen, the threshold of survival ranges from 149 kPa (21.6 lbf/in.^{2}) for an infant to 280 kPa (40.8 lbf/in.^{2}) for an adult.

X1.4 Discussion

X1.4.1 The calculated distances for the survivability of bare charges indicates that blast pressures are generally not the major threat of improvised explosive devices. Furthermore, the test data indicate that all trash receptacles designed to be blast resistant will significantly mitigate the blast pressures. Therefore, there is little to be gained from including a performance requirement based on pressure. If a reasonable requirement were set, then it is almost certain that all trash receptacles meeting the other performance requirements (given in Section 10 of this specification) would also meet the pressure requirement. The pressure requirement would not offer a prospective purchaser an additional criterion on which to make an informed decision. On the other hand, as stated in

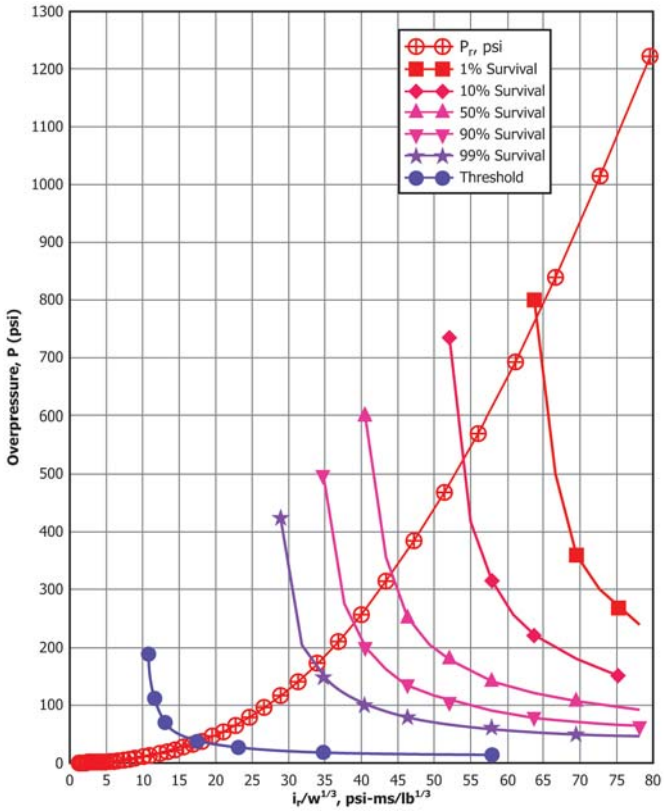


FIG. X1.3 Lung Damage Curves for a 151-lb male and a 5-lb Charge Plotted with P_r Versus i_r for a Blast in Free Air

TABLE X1.1 Peak Pressures (psi) for Different Levels of Survival and Types of Person for a Bare 5 lb TNT Charge

% Survivability	154 lb man	121 lb woman	55 lb child	11 lb infant
99 %	191.07	170.49	119.16	69.81
Threshold	40.79	37.75	30.38	21.60

10.3.1, pressure data may be useful when considering alternative locations for placement of trash receptacles in service.