



# Standard Specification for Heat-Shrink Cable Entry Seals (Metric)<sup>1</sup>

This standard is issued under the fixed designation F 1837M; 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 approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers the general requirements for heat-shrink cable entry seals. Cable entry seals are intended for making electrical cable penetrations into connection boxes, bulkheads, or other enclosures. These devices are suitable for both thin wall enclosures up to 5 mm ( $\frac{3}{16}$  in.) thick and thick-wall enclosures of 5 mm to 19 mm ( $\frac{3}{16}$  in. to  $\frac{3}{4}$  in.) thick.

1.2 Cable entry seals shall have factory-applied adhesive that provides the seal to wire and cable jackets.

1.3 The values stated in SI units are to be regarded as the standard. The values given 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 its use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

- D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies<sup>2</sup>
- D 257 Test Methods for DC Resistance to Conductance of Insulating Materials<sup>2</sup>
- D 412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers<sup>3</sup>
- D 570 Test Method for Water Absorption of Plastics<sup>4</sup>
- D 635 Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position<sup>4</sup>
- D 747 Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam<sup>4</sup>
- D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement<sup>4</sup>
- D 2240 Test Methods for Rubber Property—Durometer Hardness<sup>3</sup>

D 2671 Test Methods for Heat-Shrinkable Tubing for Electrical Use<sup>5</sup>

D 2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)<sup>6</sup>

D 3149 Specification for Crosslinked Polyolefin Heat-Shrinkable Tubing for Electrical Insulation<sup>5</sup>

D 4572 Test Method for Rubber Chemicals, Wet Sieve Analysis of Sulfur<sup>3</sup>

D 4732 Specification for Cool-Application Filling Compounds for Telecommunication Wire and Cable

### 2.2 ASME Standard

ASME B1.1 Unified Inch Screw Threads (UN and UNR Thread Form)<sup>7</sup>

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

NEMA 250 Enclosures for Electrical Equipment (1000 Volts Max)<sup>8</sup>

### 2.4 IEC Standard:

IEC 68-2-6 Environmental Testing—Part 2: Tests—Test FC: Vibration (Sinusoidal) Sixth Edition<sup>9</sup>

## 3. Terminology

### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *heat-shrink cable entry seal, n*—heat-shrinkable tube making a watertight, fume-tight seal where cable connections boxes, bulkheads, or other enclosures.

3.1.2 *polyolefin, n*—a polymer made by the polymerization of hydrocarbon olefins or copolymerization olefins.

## 4. Classification

4.1 Heat-shrink cable entry seals shall be of the following types:

4.1.1 *Type I*, standard cable entry seals for thin-wall enclosures shall consist of the three part assembly; a rigid plastic nut, O-ring, and heat-shrinkable molded area.

4.1.1.1 *Type I-1*, molded area configured with one opening for a single wire or cable entry.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.10 on Electrical.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 10.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 09.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 08.01.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 10.02.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 08.02.

<sup>7</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

<sup>8</sup> Available from National Electrical Manufacturers Association (NEMA), 1300 N. 17th St., Suite 1847, Rosslyn, VA 22209.

<sup>9</sup> Available from International Electrotechnical Commission (IEC), 3, rue de Varembe, Case Postale 131, CH-1211, Geneva 20, Switzerland.

4.1.1.2 *Type I-2*, molded area configured with two equal size openings to seal two wires or cables.

4.1.1.3 *Type I-3*, molded area configured with three equal size openings to seal three wires or cables.

4.1.1.4 *Type I-4*, molded area configured with four equal size openings to seal four wires or cables.

4.1.1.5 *Type I-5*, molded area configured with six equal size openings to seal six wires or cables.

4.1.1.6 *Type I-6*, molded area configured with eight equal size openings to seal eight wires or cables.

4.1.2 *Type II*, cable entry seal for threaded hole applications shall consist of a one-part assembly that combines a tapered national pipe thread (NPT) in rigid plastic with heat-shrinkable molded area.

4.1.2.1 *Type II-1*, molded area configured with one opening for a single wire or cable entry.

4.1.2.2 *Type II-2*, molded area configured with two equal size openings to seal two wires or cables.

4.1.2.3 *Type II-3*, molded area configured with three equal size openings to seal three wires or cables.

4.1.2.4 *Type II-4*, molded area configured with four equal size openings to seal four wires or cables.

4.1.3 *Type III*, right angle cable entry seal for thin-wall enclosure shall consist of a three part assembly; a rigid plastic nut, O-ring, and heat-shrinkable molded area.

4.1.4 *Type IV*, right angle cable entry seal for threaded hole application shall consist of a one-part assembly that combines a tapered national pipe thread (NPT) in rigid plastic with a heat-shrinkable molded area.

**5. Ordering Information**

5.1 Orders for cable entry seals under this specification shall include the following:

- 5.1.1 Part Number (see Figs. 1-6).
- 5.1.2 Quantity (per each part).

**6. Materials and Manufacture**

6.1 The rigid plastic parts shall be made from polyamide (nylon), (or polyester material, or both.) The material shall be Group 1, Class 8, Grade 1 as specified in Specification D 4066.

6.1.1 Threads shall be unified form UN 2A or 2B or taper pipe thread (NPT) as specified in ASME B1. 1.

6.2 The heat-shrinkable tubing shall be of a crosslinked polyolefin in accordance with Type III of Specification D 3149.

6.3 The adhesive shall be general purpose high-bond-strength adhesive sealant that provides stain relief and environmental sealing of heat-shrink tubing to cable jackets.

6.4 O-rings shall be made of a material conforming to Type II of Specification D 4732.

6.5 The polyolefin heat-shrinkable tubing shall met requirements of Test Methods D 2671.

**7. Other Requirements**

7.1 *Dimensional Requirements*—Cable-entry seals shall conform to the dimensional requirements of Tables 1-6. Type I cable-entry seals are presented in Fig. 1 and Fig. 2. Type II cable-entry seals are presented in Fig. 3 and Fig. 4. Right-angle cable-entry seals (Types III and IV) are presented in Fig. 5 and Fig. 6.

7.2 *Performance Requirements:*

7.2.1 *Vibration Resistance*—When cable-entry seals are tested as specified in 9.1, there shall be no evidence of cracking or loosening of parts.

7.2.2 *Ruggedness*—When cable-entry seals are subjected to a mechanical abuse test as specified in 9.2, there shall be no cracking, breaking, distortion, or damage to the sample.

7.2.3 *Effectiveness of seal*—When cable-entry seals are tested as specified in 9.3, there shall be no evidence of leakage through or around the cable entry seals.

**8. Workmanship, Finish, and Appearance**

8.1 Cable-entry seals shall be free from warp, cracks, chipped edges, or surfaces, blisters, uneven surfaces, scratches, dents, and flow lines. They shall be free from fins, burrs, and from unsightly finish caused by chipping, filling, or grinding without subsequent buffing or polishing. All molded parts shall cleaned thoroughly of annealing mediums.

**9. Test Methods**

9.1 Conformance testing of a random sample may be requested by the purchaser in order to verify that selected performance characteristics specified herein have been incorporated in the cable-entry seal design and maintained in production.

9.1.1 *Vibration*—The cable-entry seals shall be subjected to vibration testing as specified in IEC Standard 68-2-6. The following details shall apply:

9.1.1.1 The cable-entry seals shall be complete with O-rings and 1 to 2-m (3 to 6 ft) lengths of cable of appropriate size.

9.1.1.2 The free end of the cables shall be secured to prevent excessive cable whipping action during test.

9.1.1.3 Tests are to be carried out in three perpendicular planes.

9.1.1.4 Duration of the test for no resonance condition shall be 90 min at 30 Hz. Duration at each resonance frequency at which  $Q > 2$  is recorded. It is recommended as guidance that  $Q$  does not exceed 5.

9.1.1.5 Test range shall be  $2 \pm 0.3$  Hz to 13.2 Hz—amplitude  $\pm 1$  mm: 13.2 Hz to 100 Hz—acceleration  $\pm 7$  g.

9.1.1.6 Nonconformance to the requirements of 7.2.1 shall be cause for rejection.

9.2 *Mechanical Abuse Test:*

9.2.1 A mechanical abuse test shall be conducted on the sample cable-entry seal assembled on the end of a 2-m (6-ft) length of electrical cable of appropriate size.

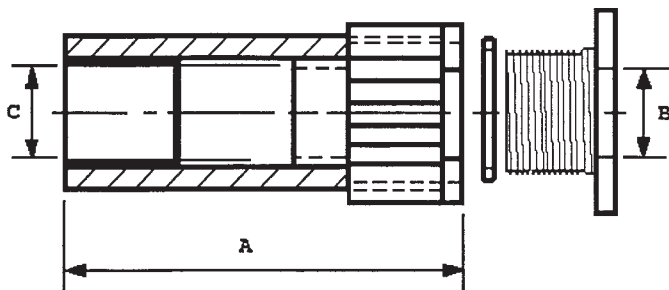


FIG. 1 Type I—Single-Legged Standard Cable Entry Seals

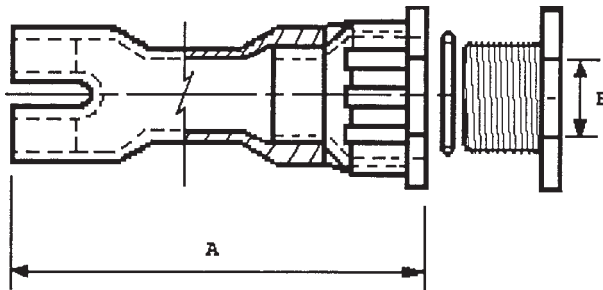


FIG. 2 Type I-Multi-Legged Standard Cable Entry Seals

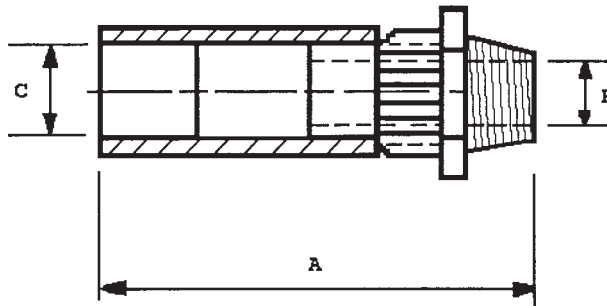


FIG. 3 Type II-Single-Legged Threaded Cable Entry Seals

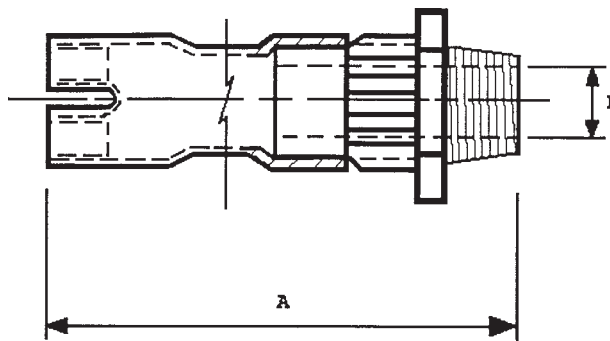


FIG. 4 Type II-Multi-Legged Threaded Cable Entry Seals

9.2.2 The cable-entry seal shall be allowed to swing on a radius, while suspended by the electrical cable, from a vertical surface and strike against a vertical flat steel plate on that surface. The vertical distance through which the cable entry seal is allowed to fall shall be 1.5 m (5 ft), and the number of impacts shall be ten.

9.2.3 The cable-entry seal shall be disassembled and examined. Nonconformance to the requirements of 7.2.2 shall be cause for rejection.

9.3 *Level of Effectiveness*—A complete cable-entry seal with O-ring installed and assembled properly and shrunk to a cable or with a plug installed shall conform to the performance requirements of NEMA 250. The NEMA enclosure type designation (4, 4X, 6, 6P) shall establish the appropriate environmental capability required of the installed cable-entry seal.

9.3.1 Nonconformance to the requirements of 7.2.3 shall be cause for rejection.

## 10. Inspection

10.1 *Visual and Dimensional Examination*—Samples shall be examined visually to verify that the materials, design, construction, physical dimensions, marking, and workmanship are as specified in the applicable requirements.

## 11. Certification

11.1 *Material Certification*—Material certification shall be required from the manufacturers of the plastic material and shirk-tubing to ensure the materials were manufactured, sampled, tested, and inspected in accordance with Specifications D 4066 and D 3149. Material identity traceable to this certification shall be maintained throughout the manufacturing process.

11.2 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. When

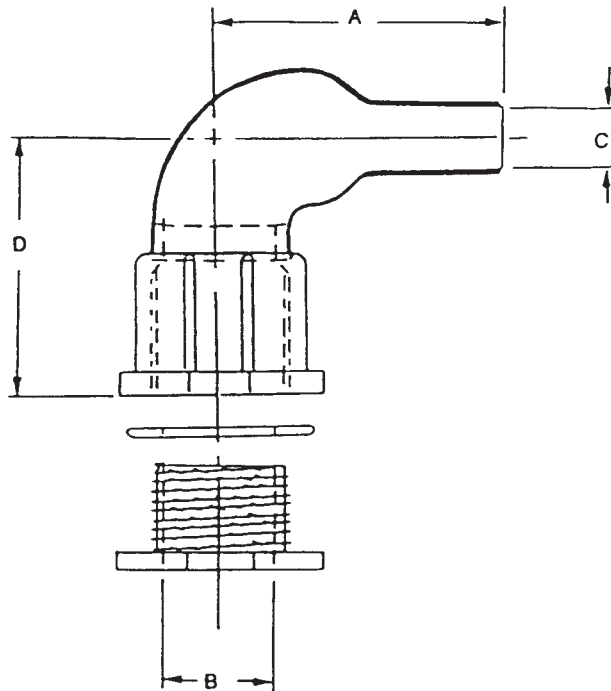


FIG. 5 Type III-Right-Angle Cable Entry Seals

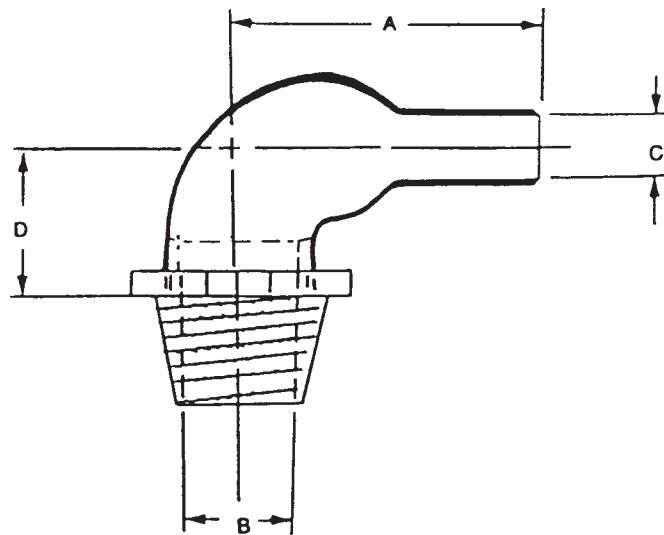


FIG. 6 Type IV-Right-Angle Cable Entry Seals

specified in the purchase order or contract, a report of the test results shall be furnished.

## 12. Product Marking

12.1 Each cable-entry seal shall be identified distinctly. The name of the manufacturer, part number, identification of this ASTM standard, and other appropriate information shall be shown thereon.

## 13. Packaging Requirements

13.1 The seals shall be supplied by type as specified in Figs. 1-6.

13.2 The seals shall be packaged in conformance with good commercial practice unless otherwise specified. Individual

types and sizes shall be neatly bundled or boxed. The exterior shipping container shall be acceptable by parcel post or common carrier.

13.3 Each bundle or container of seals shall be identified distinctly by a tag or label. The name of the manufacturer, the part number of the seals, the quantity, and other appropriate information shall be shown thereon.

## 14. Quality Assurance

14.1 *Responsibility for Inspection*—Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the manufacturer may use his own

**TABLE 1 Type 1—Single Legged Standard Cable Entry Seals<sup>A</sup>**

C		B	A		
Tubing					
Expanded I.D. (min)	Recovered I.D. (max)	I.D. (min)	Overall Nominal Recovered Length	Recommended Hole Diameter	Part No. <sup>B</sup>
13.0 (0.50)	3.0 (0.12)	19.0 (0.75)	89.0 (3.50)	25.5 (1.00)	CES S 1-1
19.0 (0.75)	6.5 (0.25)	19.0 (0.75)	89.0 (3.50)	25.5 (1.00)	CES S 1-2
19.0 (0.75)	6.5 (0.25)	19.0 (0.75)	32.0 (1.25)	25.5 (1.00)	CES S 1-3
28.5 (1.20)	13.0 (0.50)	28.0 (1.10)	95.0 (3.75)	35.0 (1.38)	CES S 1-4
35.0 (1.38)	13.0 (0.50)	28.0 (1.10)	95.0 (3.75)	44.5 (1.75)	CES S 1-5
40.0 (1.70)	19.0 (0.75)	40.0 (1.60)	120.0 (4.75)	51.0 (2.00)	CES S 1-6
70.0 (2.75)	19.0 (0.75)	53.0 (2.10)	102.0 (4.00)	60.0 (2.36)	CES S 1-7
70.0 (2.75)	36.0 (1.43)	74.0 (2.90)	178.0 (7.00)	89.0 (3.50)	CES S 1-8

<sup>A</sup> Dimensions shown are nominal and in millimeters (in).

<sup>B</sup> Part numbers were established in the following way:

CES—cable entry seal,

S or T—standard or threaded, and

1-1—number preceding hyphen represents number legs; number following hyphen represents size type.

**TABLE 2 Type 1—Multi-Legged Standard Cable Entry Seals<sup>A</sup>**

No. of Legs	Multi-Leg Boot		B	A		
	Expanded I.D. Min. (Each Leg)	Recovered I.D. Max. (Each Leg)	I.D. (min)	Overall Nominal Recovered Length	Recommended Hole Diameter	Part No. <sup>B</sup>
	2	10.0 (0.40)	3.0 (0.11)	19.0 (0.75)	89.0 (3.50)	25.5 (1.00)
2	15.0 (0.60)	4.5 (0.17)	28.0 (1.10)	95.0 (3.75)	35.0 (1.38)	CES S 2-2
2	23.0 (0.90)	7.5 (0.30)	40.0 (1.60)	120.0 (4.75)	51.0 (2.00)	CES S 2-3
3	10.0 (0.40)	3.0 (0.11)	19.0 (0.75)	89.0 (3.50)	25.5 (1.00)	CES S 3-1
3	15.0 (0.60)	4.5 (0.17)	28.0 (1.10)	95.0 (3.75)	35.0 (1.38)	CES S 3-2
3	23.0 (0.90)	7.5 (0.30)	40.0 (1.60)	120.0 (4.75)	51.0 (2.00)	CES S 3-3
3	32.0 (1.25)	13.0 (0.50)	74.0 (2.90)	178.0 (7.00)	89.0 (3.50)	CES S 3-4
4	10.0 (0.40)	3.0 (0.11)	19.0 (0.75)	89.0 (3.50)	25.5 (1.00)	CES S 4-1
4	15.0 (0.60)	4.5 (0.17)	28.0 (1.10)	95.0 (3.75)	35.0 (1.38)	CES S 4-2
4	23.0 (0.90)	7.5 (0.30)	40.0 (1.60)	120.0 (4.75)	51.0 (2.00)	CES S 4-3
4	32.0 (1.25)	13.0 (0.50)	74.0 (2.90)	178.0 (7.00)	89.0 (3.50)	CES S 4-4
6	23.0 (0.90)	7.5 (0.30)	74.0 (2.90)	178.0 (7.00)	89.0 (3.50)	CES S 6-1
8	23.0 (0.90)	7.5 (0.30)	74.0 (2.90)	178.0 (7.00)	89.0 (3.50)	CES S 8-1

<sup>A</sup> Dimensions shown are nominal and in millimeters (inches).

<sup>B</sup> Part numbers were established in the following way:

CES—cable entry seal,

S or T—standard or threaded, and

1-1—number preceding hyphen represents number of legs; number following hyphen represents size type.

or may other facilities suitable for the performance of the inspection requirements specified.

**14.2 Responsibility for Compliance**—All items must meet all requirements of section 7. The inspection set forth in this specification shall become a part of the manufacturer's overall inspection system or quality program. The absence of any inspection requirements in this specification shall not relieve the manufacturer of the responsibility of assuring that all products or supplied submitted to the customer for acceptance

comply with all the requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material either indicated or actual, nor does it commit the customer to acceptance of defective material.

## 15. Keywords

15.1 cable-entry seal; cable penetrator; cable termination; cross-linked polyolefin heat-shrinkable tubing; electrical insulation; heat-shrinkable tubing

**TABLE 3 Type II—Single-Legged Threaded Cable Entry Seals<sup>A</sup>**

C		B	A		Part No. <sup>B</sup>
Tubing		I.D. (min.)	Overall Nominal Recovered Length	NPT Pipe Size	
Expanded I.D. (Min.)	Recovered I.D. (Max.)				
9.5 (0.37)	3.0 (0.12)	6.5 (0.25)	87.0 (3.40)	6.5 (0.25)	CST T 1-1
14.5 (0.57)	5.0 (0.19)	14.0 (0.55)	87.0 (3.40)	13.0 (0.50)	CES T 1-2
19.0 (0.75)	6.5 (0.25)	14.0 (0.55)	87.0 (3.40)	13.0 (0.50)	CES T 1-3
19.0 (0.75)	6.5 (0.25)	19.0 (0.75)	87.0 (3.40)	19.0 (0.75)	CES T 1-4
19.0 (0.75)	6.5 (0.25)	19.0 (0.75)	89.0 (3.50)	25.5 (1.00)	CES T 1-5
32.0 (1.25)	13.0 (0.50)	25.5 (1.00)	112.0 (4.40)	25.5 (1.00)	CES T 1-6
32.0 (1.25)	13.0 (0.50)	28.0 (1.10)	119.0 (4.70)	38.0 (1.50)	CES T 1-7
51.0 (2.00)	19.0 (0.75)	36.0 (1.40)	127.0 (5.00)	38.0 (1.50)	CES T 1-8
70.0 (2.75)	25.5 (1.00)	61.0 (2.40)	152.0 (6.00)	63.5 (2.50)	CES T 1-9

<sup>A</sup> Dimensions shown are nominal and in the millimeters (inches).

<sup>B</sup> Part numbers were established in the following way:

CES—cable entry seal,

S or T—standard or threaded, and

1-1—number preceding hyphen represents number of legs; number following hyphen represents size type.

**TABLE 4 Type II—Multi-Legged Threaded Cable Entry Seals<sup>A</sup>**

No. of Legs	Multi-Leg Boot		B	A		Part No. <sup>B</sup>
	Expanded I.D. Min. (Each Leg)	Recovered I.D. Max. (Each Leg)	I.D. (Min.)	Overall Nominal Recovered Length	NPT Pipe Size	
2	10.0 (0.40)	3.0 (0.11)	14.0 (0.55)	87.0 (3.40)	13.0 (0.50)	CES T 2-1
2	10.0 (0.40)	3.0 (0.11)	19.0 (0.75)	87.0 (3.40)	19.0 (0.75)	CES T 2-2
2	15.0 (0.60)	4.5 (0.18)	28.0 (1.10)	112.0 (4.40)	25.5 (1.00)	CES T 2-3
2	15.0 (0.60)	4.5 (0.18)	28.0 (1.10)	119.0 (4.70)	38.0 (1.50)	CES T 2-4
2	23.0 (0.90)	7.5 (0.30)	37.0 (1.47)	119.0 (4.70)	38.0 (1.50)	CES T 2-5
3	10.0 (0.40)	3.0 (0.11)	14.0 (0.55)	95.0 (3.75)	13.0 (0.50)	CES T 3-1
3	10.0 (0.40)	3.0 (0.11)	19.0 (0.75)	94.0 (3.70)	19.0 (0.75)	CES T 3-2
3	10.0 (0.40)	3.0 (0.11)	19.0 (0.75)	95.0 (3.75)	25.5 (1.00)	CES T 3-3
3	15.0 (0.60)	4.5 (0.18)	28.0 (1.10)	112.0 (4.40)	25.5 (1.00)	CES T 3-4
3	15.0 (0.60)	4.5 (0.18)	28.0 (1.10)	119.0 (4.70)	38.0 (1.50)	CES T 3-5
3	23.0 (0.90)	7.5 (0.30)	37.0 (1.47)	127.0 (5.00)	38.0 (1.50)	CES T 3-6
3	32.0 (1.25)	13.0 (0.50)	61.0 (2.40)	152.0 (6.00)	63.5 (2.50)	CES T 3-7
4	10.0 (0.40)	3.0 (0.11)	14.0 (0.55)	87.0 (3.40)	13.0 (0.50)	CES T 4-1
4	10.0 (0.40)	3.0 (0.11)	19.0 (0.75)	87.0 (3.40)	19.0 (0.75)	CES T 4-2
4	15.0 (0.60)	4.5 (0.18)	28.0 (1.10)	112.0 (4.40)	25.5 (1.00)	CES T 4-3
4	15.0 (0.60)	4.5 (0.18)	28.0 (1.10)	119.0 (4.70)	38.0 (1.50)	CES T 4-4
4	23.0 (0.90)	7.5 (0.30)	37.0 (1.47)	127.0 (5.00)	38.0 (1.50)	CES T 4-5
4	32.0 (1.25)	13.0 (0.50)	61.0 (2.40)	152.0 (6.00)	63.5 (2.50)	CES T 4-6

<sup>A</sup> Dimensions shown are nominal and in millimeters (inches).

<sup>B</sup> Part numbers were established in the following way:

CES—cable entry seal and

S or T—standard or threaded.

**TABLE 5 Type III—Right Angle Cable Entry Seals<sup>A</sup>**

C		B	A	D		
Tubing						
Expanded I.D. (min.)	Recovered I.D. (max.)	I.D. (min.)	Overall Nominal Recovered Length		Recommended Hole Diameter	Part No. <sup>B</sup>
14.0 (0.55)	7.0 (0.28)	14.0 (0.55)	36.0 (1.40)	43.0 (1.68)	25.5 (1.00)	CES SR-1
19.0 (0.75)	8.5 (0.33)	19.0 (0.75)	43.0 (1.70)	45.0 (1.77)	25.5 (1.00)	CES SR-2
28.0 (1.10)	16.0 (0.62)	28.0 (1.10)	79.0 (3.10)	58.0 (2.30)	35.0 (1.37)	CES SR-3
40.0 (1.60)	16.0 (0.62)	40.0 (1.60)	79.0 (3.10)	71.0 (2.80)	51.0 (2.00)	CES SR-4

<sup>A</sup> Dimensions shown are nominal and in millimeters (inches).

<sup>B</sup> Part numbers were established in the following way:

CES—cable entry seal,  
S or T—standard or threaded, and  
R-1—Right angle; number following hyphen represents size type.

**TABLE 6 Type IV—Right Angle Cable Entry Seals<sup>A</sup>**

C		B	A	D		
Tubing						
Expanded I.D. (min.)	Recovered I.D. (max.)	I.D. (min.)	Overall Nominal Recovered Length		NPT Pipe Size	Part No. <sup>B</sup>
14.0 (0.55)	7.0 (0.28)	14.0 (0.55)	36.0 (1.40)	25.5 (1.00)	13.0 (0.50)	CES TR-1
19.0 (0.75)	8.5 (0.33)	19.0 (0.75)	43.0 (1.70)	28.0 (1.10)	19.0 (0.75)	CES TR-2
25.5 (1.00)	10.0 (0.38)	25.5 (1.00)	79.0 (3.10)	34.0 (1.33)	25.5 (1.00)	CES TR-3
28.0 (1.10)	16.0 (0.62)	28.0 (1.10)	79.0 (3.10)	40.0 (1.56)	38.0 (1.50)	CES TR-4

<sup>A</sup> Dimensions shown are nominal and in millimeters (inches).

<sup>B</sup> Part numbers were established in the following way:

CES—cable entry seal,  
S or T—standard or threaded, and  
R-1—Right angle; number following hyphen represents size type.

## SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements are applicable to DoD procurements and shall apply only when specified by the purchaser in the contract or purchase order.

### S1. Referenced Documents

#### S.1.1 Military Specification:

MIL-S-901 Shock Tests, H.I. (High-Impact), Shipboard Machinery, Equipment, and Systems<sup>10</sup>

### S2. Shock Tests

S2.1 Cable-entry seals shall be subjected to the high-impact shock test for Grade A, Type A, Class I equipment as specified in MIL-S-901. The details specified in 9.1.1 and 9.1.2 shall apply. Nonconformance to the requirements of S2.2 shall be cause for rejection.

S2.2 *Examination After Shock Tests—When cable-entry seals are tested as specified in S.2.1, there shall be no evidence of cracking, breaking, distortion, or loosening of parts.*

### S3. Performance Requirements

S3.1 Table S3.1 establishes the physical, thermal, and chemical properties for heat-shrink tubing used in the cable-entry seal.

### S4. Level of Effectiveness (See 9.3)

S4.1 *Submersible and Open Submersible*—Equipment shall be submergence tested to a depth of 4.5 m (15 ft) at 44.8 KPa

**TABLE S3.1 Performance Requirements For Heat Shrink Tubing**

Property Units	Test Methods	Value
<b>Physical</b>		
Ultimate tensile, psi, min	D 412	1700
Ultimate elongation, %, min	D 412	350
Hardness-shore "D"	D 2240	52
Water absorption, %, max	D 570	0.1
Specific gravity	D 792, Method 6.1	1.36
Stiffness in flexure, psi	D 747	18 500
<b>Electrical</b>		
Dielectric strength, 75 mils (v/mil)	D 149	400 min
Volume resistivity, ohm-cm, min	D 257	10 <sup>15</sup>
<b>Thermal Properties</b>		
Heat aging	MIL-I-81765	5 days 168 h at 175°C
Tensile strength, psi, min	D 412	1200
Elongation, %, min	D 412	200
Heat shock	MIL-I-81765	4 hr at 225°C
Low temperature	MIL-I-23053D	-55°C
<b>Flammability</b>		
Non-burning	D 635	yes
Oxygen-index	D 2863	28

(6.5 psi) for 24 h. Nonconformance to the requirements of 7.1.3 shall be cause for rejection.

S4.2 *Examination After Immersion*—Failure for cable-entry seals to operate satisfactorily shall be cause for rejection. For enclosures including terminal boxes, as revealed by subsequent

<sup>10</sup> Available from the Standardization Document Order Desk, 700 Robbins Ave., Bldg. 4D, Philadelphia, PA 19111-5098.

disassembly and examination leakage of water into any part of the enclosure, shall be cause for rejection.

clude cure date, shelf life, and expiration dates of rubber products.

**S5. Packaging**

S5.1 *Preservation, Packing, and Marking*—Preservation and packing may be commercial. Marking information shall in-

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