UL 1242

STANDARD FOR SAFETY

Electrical Intermediate Metal Conduit – Steel

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UL Standard for Safety for Electrical Intermediate Metal Conduit – Steel, UL 1242

Fourth Edition, Dated February 16, 2006

Summary of Topics

This revision to ANSI/UL 1242 dated April 18, 2022 includes the following:

– Reference to Table of Minimum acceptable dimensions of elbows; 14.1.1 and 14.2.1

– Editorial updates; 18.2.1 and 21.7

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated March 4, 2022.

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UL 1242

Standard for Electrical Intermediate Metal Conduit – Steel

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Fourth Edition

February 16, 2006

This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through April 18, 2022.

The most recent designation of ANSI/UL 1242 as an American National Standard (ANSI) occurred on April 18, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 1242 on May 21, 1984. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover steel electrical intermediate metal conduit (IMC), nipples, elbows, and couplings. This conduit is provided in trade sizes 1/2 – 4 (16 – 103), for use as a metal raceway for the installation of wires and cables in accordance with the National Electrical Code (NEC), NFPA 70. The values in parentheses are metric designators of conduit.

1.2 Steel intermediate metal conduit is provided both internally and externally with an acceptable level of corrosion resistance in normally corrosive environments. Reference 6.1 for details regarding protective coatings.

2 Units of Measurement

2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

3 References

3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

4 Glossary

4.1 For purposes of this standard the following definitions apply.

4.2 COATING(S), ALTERNATE CORROSION-RESISTANT – A coating(s) (other than one consisting solely of zinc) that, upon evaluation, has demonstrated the ability to provide the level of corrosion resistance required on the exterior of conduit. Coatings may include zinc. See 15.2.

4.3 COATING(S), ORGANIC – A coating(s) (other than one consisting solely of zinc) that, upon evaluation, has demonstrated the ability to provide the level of corrosion resistance necessary where the coating is not subject to physical damage, such as on the interior of conduit. The coatings may include zinc. See 15.3.

4.4 COATING(S), ZINC – A coating consisting solely of zinc, that, upon evaluation, has demonstrated the ability to provide the level of corrosion resistance required for the exterior or interior of the conduit as applicable. See 15.1.

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CONSTRUCTION

5 General

5.1 Each tube shall be constructed of steel or stainless steel.

5.2 Each tube shall have a circular cross section, thereby facilitating the cutting of clean, true threads. All seams shall be thoroughly welded.

5.3 A welded seam shall be without any metal trimming, sharp edge, or sharp projection. A slight bead on the interior wall at the weld line is not prohibited when the bead is not sharp and when the bead does not decrease the interior diameter of the tube by more than:

a) 0.015 inch (0.38 mm) for trade sizes 1/2 – 2 (16 – 53) or

b) 0.020 inch (0.51 mm) for trade sizes 2-1/2 – 4 (63 – 103).

5.4 Before the protective coating is applied, the interior and exterior surfaces of each tube shall be free from scale, flash, or any other protrusion.

6 Protective Coatings

6.1 General

6.1.1 The exterior surface of the steel conduit shall be protected against corrosion by a zinc or an alternate corrosion-resistant coating.

6.1.2 The interior surface of the steel conduit shall be protected against corrosion by an organic or zinc coating.

6.1.3 Conduit and fittings constructed of stainless steel are not required to be provided with interior or exterior protective coatings.

6.2 Surface treatments

6.2.1 When one or more surface treatments not exceeding 0.00015 inch (0.38 mm) are used as a top coat or conversion coating, the coatings are not required to meet the requirements for an alternate corrosion-resistant or organic coating.

6.3 Supplementary coatings

6.3.1 The use of one or more supplementary coatings is not prohibited. The supplementary coating or coatings are not required to meet the requirements for primary corrosion-resistant coatings. Conduit, elbows, or nipples that are provided with supplementary coatings that have not been evaluated as furnishing corrosion-resistance for the tube shall be marked in accordance with 21.8.

6.3.2 Supplementary nonmetallic coatings shall be evaluated with respect to flame propagation, any detrimental effects on the corrosion resistance provided by the primary protective coating, the fit of couplings, and electrical continuity with couplings. The supplementary coating shall be provided in addition to the full primary corrosion-resistant coating.

6.4 Alternate corrosion-resistant coatings

6.4.1 Conduit provided with a nonmetallic alternate corrosion-resistant coating that is not marked with a temperature designation, or is marked "200 F", is for use in ambient temperatures not in excess of 200°F (90°C). Conduit provided with a nonmetallic alternate corrosion-resistant coating that is for use at temperatures in excess of 200°F may be marked with a higher rating that has been evaluated in accordance with Section 15.2. See 21.6.

6.4.2 Conduit provided with a nonmetallic alternate corrosion-resistant coating that is not marked with a temperature designation, or is marked "32 F", is for use in ambient temperatures not below 32°F (0°C). Conduit provided with a nonmetallic alternate corrosion-resistant coating that is for use at temperatures below 32°F may be marked with a lower rating that has been evaluated in accordance with 14.2.1 and the Cold Impact Test, Section 17. See 21.7.

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7 Threading and Chamfering

7.1 General

7.1.1 Each elbow, nipple, or straight length of conduit shall be threaded on both ends. Each end shall be chamfered on the interior surface to remove burrs and sharp edges formed by the cutting-off tool. All the effective length of threads (L_2) shall be full and clean cut.

7.1.2 Threads that are cut before the pickling operation of the cleaning process are susceptible to being eaten away by the acid so that very little metal remains, particularly at the crest of the threads. The tube manufacturer is to guard against this condition prior to pickling, after pickling, and before the coating is applied. When found, this condition is to be corrected by recutting the threads, or the tube is to be rejected for conduit purposes.

7.2 Protection of threads

7.2.1 Threads are to be given a protective coating to prevent corrosion from occurring before installation. The coating is not required to comply with Protective Coatings, Section 6.

7.3 Dimensions of threads

7.3.1 The finished threads provided on conduit, nipples, and elbows shall comply with the dimensions of the NPT (National Pipe Taper) thread outlined in Figure 7.1, when measured using the ring gauges described in 8.1. See Table 7.1.

Figure 7.1

Conduit thread dimensions

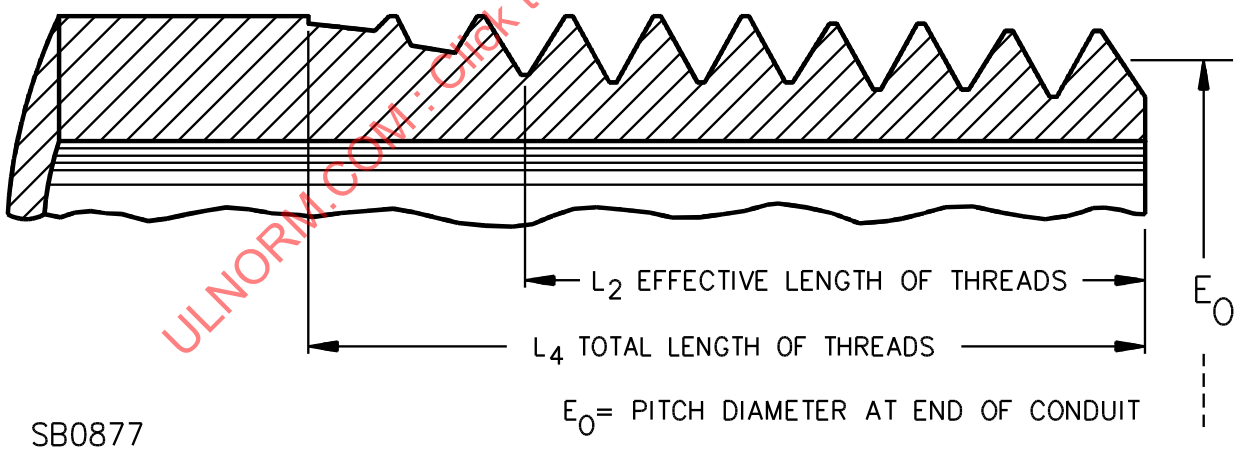

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Table 7.1
Dimensions of threads

Trade size	(Metric designator)	Number of threads per inch	L_4 Total length of threads,[a]		L_2 Effective length of threads,		Pitch diameter E_o at end of conduit,[b]	
			inches	(mm)	inches	(mm)	inches	(mm)
1/2	16	14	0.78	19.8	0.53	13.5	0.758	19.3
3/4	21	14	0.79	20.1	0.55	14.0	0.968	24.6
1	27	11-1/2	0.98	24.9	0.68	17.3	1.214	30.8
1-1/4	35	11-1/2	1.01	25.7	0.71	18.0	1.557	39.5
1-1/2	41	11-1/2	1.03	26.2	0.72	18.3	1.796	45.6
2	53	11-1/2	1.06	26.9	0.76	19.3	2.269	57.6
2-1/2	63	8	1.57	39.9	1.14	29.0	2.720	69.1
3	78	8	1.63	41.4	1.20	30.5	3.341	84.9
3-1/2	91	8	1.68	42.7	1.25	31.8	3.838	97.5
4	103	8	1.73	43.9	1.30	33.0	4.334	110.1

[a] A minus tolerance of one thread applies to the total length of threads L_4.

[b] Plus or minus tolerances of one turn apply to the pitch diameter E_o.

7.4 Taper of threads

7.4.1 The taper of threads shall be 3/4 inch per foot (1 in 16), and the perfect thread shall be tapered for its entire length.

8 Thread Gauging

8.1 The ring gauges to be used for the measurement of NPT threads as required in 7.3.1 shall have the dimensions indicated in Table 8.1. The gauging information and practice for pipe threads are in accordance with ASME B1.20.1, Pipe Threads, General Purpose (Inch) – Revision and Redesignation of ASME/ANSI B2.1-1968.

Table 8.1
Ring-gauge dimensions

Trade size	(Metric designator)	Gauge length L_1,			Pitch diameter E_1,	
		inch	(mm)	threads	inches	(mm)
1/2	16	0.320	8.13	4.48	0.7784	19.77
3/4	21	0.339	8.61	4.75	0.9889	25.12
1	27	0.400	10.16	4.60	1.2386	31.46
1-1/4	35	0.420	10.67	4.83	1.5834	40.22
1-1/2	41	0.420	10.67	4.83	1.8223	46.29
2	53	0.436	11.07	5.01	2.2963	58.33
2-1/2	63	0.682	17.32	5.46	2.7622	70.16
3	78	0.766	19.46	6.13	3.3885	86.07
3-1/2	91	0.821	20.85	6.57	3.8888	98.78
4	103	0.844	21.44	6.75	4.3871	111.43

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9 Straight Conduit

9.1 The exterior diameters, wall thicknesses, and length of straight conduit shall be within the limits indicated in Table 9.1. Each standard straight length of conduit shall be provided with one separate

threaded coupling threaded in place, or shall have an assembled-on integral coupling. Straight lengths shorter or longer than the standard length specified in the table are not prohibited.

Exception: The shorter or longer lengths may be provided without couplings.

Table 9.1
Exterior diameters, wall thicknesses, and standard length of straight conduit[a]

Trade size	(Metric desig.)	Exterior diameters				Wall thicknesses				Length of straight conduit[a] (±1/4 inch or ±6 mm)	
		Maximum,		Minimum,		Maximum,		Minimum,			
		inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	Feet and inches	(mm)
1/2	16	0.820	20.83	0.810	20.57	0.085	2.16	0.070	1.79	9	11-1/4	3030
3/4	21	1.034	26.26	1.024	26.01	0.090	2.29	0.075	1.90	9	11-1/4	3030
1	27	1.295	32.89	1.285	32.64	0.100	2.54	0.085	2.16	9	11	3025
1-1/4	35	1.645	41.78	1.630	41.40	0.105	2.67	0.085	2.16	9	11	3025
1-1/2	41	1.890	48.01	1.875	47.62	0.110	2.79	0.090	2.29	9	11	3025
2	53	2.367	60.12	2.352	59.74	0.115	2.92	0.095	2.41	9	11	3025
2-1/2	63	2.867	72.82	2.847	72.31	0.160	4.06	0.140	3.56	9	10-1/2	3010
3	78	3.486	88.54	3.466	88.04	0.160	4.06	0.140	3.56	9	10-1/2	3010
3-1/2	91	3.981	101.12	3.961	100.61	0.160	4.06	0.140	3.56	9	10-1/4	3005
4	103	4.476	113.69	4.456	113.18	0.160	4.06	0.140	3.56	9	10-1/4	3005

[a] The lengths indicated are designed to produce a 10-foot (3.05-m) length of conduit when a standard coupling is attached.

9.2 The measurements from which the exterior diameters of a length of finished conduit are to be determined for comparison with the limits specified in Table 9.1 are to be made by means of a machinist's micrometer caliper that has a ratchet, a flat-ended spindle, and a flat anvil. The caliper shall be calibrated to read directly to at least 0.001 inch or 0.01 mm.

9.3 The measurements from which the wall thicknesses of a straight length of finished conduit are to be determined for comparison with the limits specified in Table 9.1 are to be made by means of an instrument such as a machinist's micrometer caliper that has a ratchet, a flat-ended spindle, and a hemispherical anvil. The instrument is to be calibrated to read directly to at least 0.001 inch or 0.01 mm.

9.4 Each piece of finished conduit on which measurements are made is to be smooth and clean wherever it is to touch a spindle or an anvil. While measurements are being made, the conduit, measuring instrument, and the surrounding air are to be in thermal equilibrium with one another at any convenient temperature.

9.5 Each individual outside diameter is to be recorded. The measurement is to be taken at the center and at least one end of the conduit by means of the caliper described in 9.4 (flat anvil). At least four measurements are required at each place to ensure that the largest and smallest diameters are found. The maximum and minimum of all recorded diameters are to be compared with the maximum and minimum diameters in Table 9.1 for the size of conduit involved. The measurements shall be within the specified limits.

9.6 The wall thickness is to be measured away from the threads and recorded at one end of the conduit by means of the instrument specified in 9.3. At least four measurements are required at the conduit end to ensure that the thickest and thinnest parts of the wall are found. The maximum and minimum of all recorded thicknesses are to be compared with the maximum and minimum wall thicknesses in Table 9.1 for the size of conduit involved. The measurement shall be within the specified limits.

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10 Nipples

10.1 A nipple shall be made from straight tubing of the same grade as the conduit and shall be treated, coated, threaded, etc. according to the applicable requirements for conduit. A nipple shall not exceed 2 feet (610 mm) in length.

Exception: Nipples of the 1/2 and 3/4 (16 and 21) trade sizes shall not exceed 6 feet (1.83 m) in length.

11 Elbows

11.1 *Deleted*

11.2 *Deleted*

Table 11.1
Minimum dimensions of elbows
Table deleted

Figure 11.1

Conduit elbows
Figure deleted

12 Couplings

12.1 A threaded coupling shall comply with the appropriate requirements in 5.7 of the Standard for Electrical Rigid Metal Conduit – Steel UL 6, CSA C22.2 No. 45.1, or NMX-J-534-ANCE or the Standard for Electrical Rigid Metal Conduit – Aluminum, Red Brass, and Stainless Steel UL 6A, CSA C22.2 No. 45.2, or NMX-J-576-ANCE.

Table 12.1
Dimensions of straight-tapped couplings
Table deleted

12.2 *Deleted*

12.3 *Deleted*

12.4 *Deleted*

Figure 12.1

Illustration of the dimensions of a coupling
Figure deleted

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PERFORMANCE

13 Identification of Compounds

13.1 Both a nonmetallic material used as an alternate corrosion-resistant coating and an organic coating shall be subjected to the Infrared Spectroscopy (IR), Thermogravimetry (TGA), and Differential Scanning Calorimetry (DSC) test specified in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

14 Bending

14.1 Ambient temperature

14.1.1 The protective coating used on the interior or exterior of the conduit shall not crack or flake, as visible using normal or corrected to normal vision, when a finished specimen of the smallest available trade size produced by the manufacturer is tested, at any time up to one year after the time of manufacture. The specimen shall be bent into a semicircle, the center line of which has a radius as described in the Standard for Electrical Rigid Metal Conduit – Steel, UL 6, CSA C22.2 No. 45.1, or NMX-J-534-ANCE, Table 5.5.

14.1.2 Compliance with the requirements in 14.1.1 for trade size 1/2 (16) and 3/4 (21) conduit is to be determined by bending the tube with any suitable bending equipment.

Figure 14.1

Form for bending conduit

Figure deleted

14.2 Low temperature

14.2.1 One specimen of the smallest available trade size of finished conduit shall be capable of being bent into a quarter of a circle around a mandrel after being conditioned at a temperature of 0°C (32°F) for 60 minutes. The tube shall not develop a crack and a weld shall not open. The coating shall not be damaged to the extent that bare metal is exposed or the coating separates from the metal. The radius of the conduit shall be as specified in the Standard for Electrical Rigid Metal Conduit – Steel, UL 6, CSA C22.2 No. 45.1, or NMX-J-534-ANCE, Table 5.5. The test is to be conducted inside the cold chamber or started within 15 seconds after removal from the cold chamber.

Exception: Conduit that is provided with a nonmetallic alternate corrosion-resistant coating and is marked with a temperature rating below 32°F is to be conditioned at the rated temperature. The rated temperature is to be any temperature below 32°F in 10°F (5.6°C) increments.

15 Protective Coatings

15.1 Zinc coating

15.1.1 A protective zinc coating that provides the sole means of primary corrosion-resistance on the exterior of the conduit shall be such that a specimen of the finished conduit does not show a bright, adherent deposit of copper after four 60-second immersions in a copper sulfate solution.

15.1.2 A protective zinc coating that provides the sole means of primary corrosion-resistance on the interior of the conduit shall be such that a specimen of the finished conduit does not show a bright, adherent deposit of copper after one 60-second immersion in a copper sulfate solution.

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15.1.3 When it is desired to show the character of the bright metallic copper deposit on an exposed steel surface, prepare a reference standard for comparison as follows. Partially submerge a zinc-coated specimen in strong hydrochloric acid until violent action ceases. Immediately remove the specimen, wash, and wipe it dry. Then dip the specimen, with an area of bare surface thus exposed including a portion with zinc coating intact, for a few seconds in the copper sulfate solution at a temperature of 16 – 20°C (61 – 68° F), remove it, wash it, and wipe it dry. Prepare this copper-coated reference standard at the time of testing.

15.1.4 The solution of copper sulfate is to be made from distilled water and the American Chemical Society (ACS) reagent grade of copper sulfate ($CuSO_4$). In a copper container or in a glass, polyethylene, or other chemically nonreactive container in which a bright piece of copper is present, a quantity of the copper sulfate is to be dissolved in hot distilled water to obtain a solution that has a specific gravity within the range of 1.183 to 1.189 after the solution is cooled to a temperature of 18.3°C (65.0°F). As necessary, any free acid that is present is to be neutralized by the addition of 1 gram of copper oxide (CuO) or 1 gram of copper hydroxide [$Cu(OH)_2$] per liter of solution. The solution is then to be diluted with distilled water to obtain a specific gravity within the range of 1.183 to 1.189 at a temperature of 18.3°C. The solution is then to be filtered.

15.1.5 Several 6-inch (150-mm) specimens are to be cut from a length of the finished zinc-coated conduit. The specimens are to be cleaned with an organic solvent. Each specimen is then to be examined for evidence of damage to the zinc coating. Three specimens that are not damaged are to be selected for use in the test.

15.1.6 The selected specimens are to be rinsed in water and all of their surfaces are to be dried with clean cheesecloth. As much of the water as possible is to be removed in the drying operation because water slows the reaction between the zinc and the solution, thereby adversely affecting the test results. The surface of the zinc is to be dry and clean before a specimen is immersed in the solution of copper sulfate. The specimens are not to be touched by hands or anything else that can contaminate or damage the surfaces.

15.1.7 A glass, polyethylene, or other chemically nonreactive beaker, having a diameter equal to twice the diameter measured over the specimen, is to be filled with the solution of copper sulfate to a depth of not less than 3 inches (76 mm). The temperature of the solution is to be maintained at 18.3 ±1.1°C (65 ±2.0°F). The specimen is to be immersed in the solution and supported on end in the center of the beaker so that not less than 2-1/2 inches (64 mm) of its length is immersed. The specimen is to remain in the solution for 60 seconds, during which time it is not to be moved nor is the solution to be stirred.

15.1.8 At the end of the 60-second period the specimen is to be:

a) Removed from the beaker,

b) Rinsed immediately in running water,

c) Rubbed with clean cheesecloth until any loosely adhering deposits of copper are removed, and

d) Dried with clean cheesecloth.

Again, hands and other damaging and contaminating objects and substances are not to touch the surfaces that were immersed. The part of the specimen that was immersed is to be examined, disregarding any threaded area and the portions of the specimen within 1/2 inch (13 mm) of any cut edge.

15.1.9 Deposits of bright, firmly adhering copper are to be noted.

Exception: Copper adhering to threaded areas or the 1/2-inch (13-mm) cut edge portion is to be disregarded.

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15.1.10 When bright adhering copper is not found the process of immersion, washing, rubbing, drying, examining, and recording is to be repeated up to the required number of immersions, or until the presence of copper is noted, whichever comes first. The same specimen and beaker of solution is to be used. After the dips are completed on any single specimen, the used solution of copper sulfate is to be discarded. A fresh portion of the solution is to be used for each succeeding specimen.

15.1.11 There shall not be any evidence of bright, adherent deposits of copper (disregarding the threaded area and cut portions noted in the Exception to 15.1.9) on any of the three specimens following any immersion into the copper sulfate solution.

15.2 Alternate corrosion-resistant coatings

15.2.1 General

15.2.1.1 A coating, other than one consisting solely of zinc, that is to be evaluated for its ability to provide the primary corrosion resistance on the exterior of conduit shall, in addition to the requirements in 15.2.1.2 – 15.2.6.3, be evaluated with respect to flame propagation. See the Flammability Test, Section 18. Additionally, the conduit, elbow, or nipple shall be subjected to the assembly, bending, resistance, pull and fault current tests in accordance with the Standard for Conduit, Tubing, and Cable Fittings, UL 514B, with both set-screw and compression type fittings.

Exception: Conduit, elbows, and nipples provided with an alternate corrosion-resistant coating and marked in accordance with 21.2 are not suitable for use with these couplings and therefore do not require evaluation for use with set-screw and compression type couplings.

15.2.1.2 The coating shall comply with the salt-spray (fog), moist carbon dioxide-sulfur dioxide-air, and ultraviolet light and water tests after being conditioned in accordance with 15.2.3.1. Corrosion within 1/2 inch (13 mm) of cut edges is to be disregarded.

15.2.2 Preparation of specimens

15.2.2.1 Thirty 6 – 8 inch (152 – 203 mm) long specimens, provided with the corrosion-resistant coating, of trade size 2 (53), or the closest trade size manufactured, are to be tested.

15.2.2.2 Half of the specimens to be exposed are to be scribed using a Dremel, or equivalent rotary tool, operating at a speed of 15,000 – 30,000 rpm. The specimens are to be scribed in accordance with Figure 15.1 using a 0.045-inch (1.14-mm) thick fiberglass reinforced cut-off wheel (Dremel Cat. No. 426 or equivalent) until bright base metal is exposed. The specimens are to be free of grease and dirt. The coating thickness of each specimen is to be measured before exposing them to the test environments.

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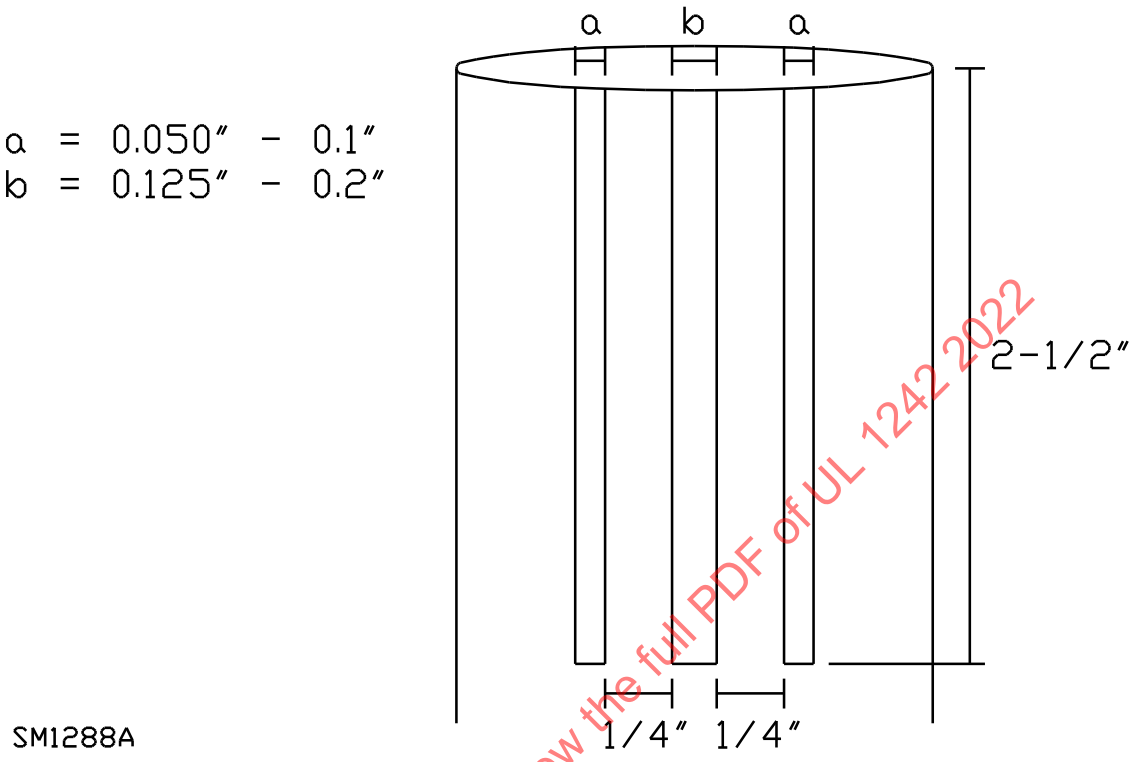
Figure 15.1

Scribe pattern



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15.2.3 Air oven conditioning exposure

15.2.3.1 Six scribed and six unscribed specimens of each coating are to be conditioned for 240 hours at a temperature of 100 ±1°C (212 ±2°F) in an air-circulating oven. These specimens are to be used for the resistance to salt spray (fog), 15.2.5, and the resistance to moist carbon dioxide-sulfur dioxide-air, 15.2.6, tests.

Exception: Conduit that is marked with a temperature rating above "200 F" is to be conditioned at the rated temperature plus 18°F (10°C). The rated temperature shall be any temperature in excess of 200°F in 50°F (28°C) increments.

15.2.4 Resistance to ultraviolet light and water

15.2.4.1 Three scribed and three unscribed specimens are to be exposed to ultraviolet light and water by either of the methods specified in 15.2.4.3 or 15.2.4.4.

15.2.4.2 As a result of the exposure, the unscribed specimens shall not show any base metal corrosion or any blisters. For the scribed specimens, the average creeping distance of red rust from the scribe is not to be greater than Rating No. 6 [1/16 – 1/8 inch (1.6 – 3.2 mm)] as designated in Procedure A, Method 2 of the Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments, ASTM D 1654, with maximum isolated spot not exceeding 3/8 inch (9.5 mm). There shall not be any visual evidence of substrate pitting and only the beginning of red rust buildup beneath the coating uplifted from the scribe.

15.2.4.3 For twin enclosed carbon-arc, the specimens are to be exposed for 360 hours to light and water in accordance with Cycle 1 in the Standard Practice for Operating Open Flame Carbon Arc Light

Apparatus for Exposure of Nonmetallic Materials, ASTM G 152. This method consists of continuous exposure to light and intermittent exposure to water spray with a programmed cycle of 120 minutes: a 102-minute light exposure and an 18-minute exposure to water spray with light. The apparatus is to operate with a black-panel temperature of 63 ±3°C (145 ±5°F).

15.2.4.4 For xenon-arc, the specimens are to be exposed for 500 hours to light and water in accordance with Cycle 1 in the Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials, ASTM G 155. This method consists of continuous exposure to light and intermittent exposure to water spray, with a programmed cycle of 120 minutes: a 102-minute light exposure and an 18-minute exposure to water spray with light. The apparatus is to operate with a 6500 W, water-cooled xenon-arc lamp, orosillicate glass inner and outer optical filters, a spectral irradiance of 0.35 W/m^2/nm at 340 nm, and a black-panel temperature of 63 ±3°C (145 ±5°F).

15.2.5 Resistance to salt spray (fog)

15.2.5.1 Six as-received and six air-oven conditioned specimens are to be exposed to salt spray (fog) in accordance with the Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B 117, for 600 hours. Three of the as-received and three of the air-oven conditioned specimens are to be scribed as described in 15.2.2.2.

15.2.5.2 As a result of the conditioning, the unscribed specimens shall not show more than light corrosion beneath the coating system. There shall be no visual pitting of the substrate and only the beginning of a buildup or weeping of red rust. For the scribed specimens, the average creeping distance of red rust from the scribe shall not be greater than Rating No. 5 [1/8 – 3/16 inch (3.2 – 4.8 mm)] as designated in Procedure A, Method 2 of the Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments, ASTM D 1654, with maximum isolated spot not exceeding 3/8 inch (9.5 mm). There shall not be any separation of the coating from the substrate as a result of the exposure.

15.2.6 Resistance to moist carbon dioxide-sulfur dioxide-air

15.2.6.1 Six as-received and six air-oven conditioned specimens are to be exposed to moist carbon dioxide-sulfur dioxide-air for 1200 hours. The apparatus used for this exposure is to consist of a chamber having a volume of at least 3 cubic feet with a water jacket and thermostatically controlled heater to maintain a temperature of 35 ±2°C (95 ±3°F). Three of the as-received and three of the air-oven conditioned specimens are to be scribed as described in 15.2.2.2.

15.2.6.2 As a result of the conditioning the unscribed specimens shall not show more than a light corrosion beneath the coating system, with no visual pitting of the substrate and only the beginning of a buildup or weeping of red rust. For the scribed specimens, the average creeping distance of red rust from the scribe shall not be greater than Rating No. 6 [1/16 – 1/8 inch (1.6 – 3.2 mm)] as designated in Procedure A, Method 2 of The Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments, ASTM D 1654, with maximum isolated spot not exceeding 3/8 inch (9.5 mm). There shall not be any separation of the coating from the substrate as a result of the exposure.

15.2.6.3 The carbon dioxide and sulfur dioxide are to be supplied to the test chamber from commercial cylinders containing the gases under pressure. An amount of carbon dioxide equivalent to 1 percent of the volume of the test chamber and an equal volume of sulfur dioxide are to be introduced into the chamber each working day. Before introducing the new charge of gas each day, the remaining gas-air mixture from the previous day is to be purged from the chamber. A small amount of water is to be maintained at the bottom of the chamber for humidity. This water is not to be changed during the exposure. The specimens are to be supported in plastic racks at an angle of 15 degrees from the vertical.

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15.3 Organic coatings

15.3.1 General

15.3.1.1 An organic coating shall evenly cover the surface to which it is applied, shall be of uniform quality throughout, shall have a smooth and even appearance, and shall not soften at a temperature of 50°C (122°F).

15.3.1.2 The organic coating used to protect the interior of the conduit, when applied to a sheet-steel test piece and baked in an oven for 5 hours, shall withstand without damage 10 successive bends of the test piece back and forth through an angle of 180 degrees against an edge having a radius of 1/16 inch (1.6 mm).

15.3.1.3 The apparatus is to consist of flat test pieces of sheet-steel 3 inches (75 mm) wide, 5 inches (125 mm) long, and 0.010 inch (0.25 mm) thick; an oven for baking the test pieces; and a vise with jaws at least 3 inches wide for holding the test pieces during the bending test. The 3-inch edge of each jaw is to be rounded to a radius of 1/16 inch (1.6 mm).

15.3.1.4 Two test pieces are to be cleaned with an organic solvent to remove any grease and foreign material and are then to be dipped in the organic coating used for the conduit. After air drying for 30 minutes, the test pieces are to be suspended by means of short wires in the oven. The specimens are to be baked for 5 hours at the normal baking temperature for the coating in question; however, if the normal baking temperature is lower than 135°C (275°F) or the coating is regularly air dried, the oven temperature is to be maintained at 135 – 150°C (275 – 302°F).

15.3.1.5 At the end of the 5 hours, the test pieces are to be removed from the oven and cooled in still air to room temperature. Each flat test piece is to be secured in the vise, gripped at its free end, and then bent for 90 degrees against one of the 3-inch (75-mm) edges of the vise jaws. Each test piece is then to be bent back past its original position through 180 degrees to end bent 90 degrees against the other 3-inch edge of the vise jaw. It is then to be bent for 90 degrees in the opposite direction, ending with the test piece in its original position. This cycle is to be repeated 5 times. The organic coating shall not crack, flake off, or be otherwise damaged.

15.3.2 Warm humid air

15.3.2.1 The test apparatus is to be an insulated specimen chamber with inside dimensions approximately 47 by 28 by 28 inches (119 by 71 by 71 cm). It shall contain a temperature-controlled water reservoir, pump, spray chamber for humidifying the air, an air-circulating fan, provision for heating the air, specimen supports, and the necessary means of control.

15.3.2.2 The dry bulb temperature of the test chamber is to be maintained at 60 ±1°C (140 ±2°F) and the relative humidity is to be maintained at 98 ±2 percent throughout the test. The specimens are to be supported in racks at an angle of 15 degrees from the vertical.

15.3.2.3 The test is to be conducted for 60 days, at the end of which there shall not be any underlying corrosion of the metal.

16 Tensile Strength and Adhesion

16.1 A PVC alternate corrosion-resistant coating shall have a minimum tensile strength of 2000 psi when tested in accordance with the Standard Test Method for Tensile Properties of Plastics, ASTM D 638. Other materials shall be subject to a special investigation.

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16.2 The adhesion of an alternate corrosion-resistant coating that is 0.020 – 0.050 inch (0.51 – 1.27 mm) thick shall be greater than the strength of the alternate corrosion-resistant coating itself. This is to be determined by making two circumferential cuts 1/2 inch (13 mm) apart through the alternate corrosion-resistant coating to the substrate. A third cut is to be made perpendicular to, and crossing the circumferential cuts. The edge of the alternate corrosion-resistant coating is to be carefully lifted with a knife to form a tab. This tab is to be pulled perpendicular to the conduit with a pair of pliers. The tab shall tear rather than have any additional alternate corrosion-resistant coating separate from the substrate.

16.3 The adhesion of an alternate corrosion-resistant coating that is 0.005 inch (0.127 mm) thick or less is to be determined in accordance with the Standard Test Method for Measuring Adhesion by Tape Test, ASTM D 3359.

16.4 The adhesion of an alternate corrosion-resistant coating other than as defined in 16.2 or 16.3 is to be determined by a special investigation.

17 Cold Impact Test

17.1 Ten 6 – 8 inch (152 – 203 mm) specimens of finished conduit provided with a nonmetallic alternate corrosion-resistant coating are to be conditioned at a temperature of 0°C (32°F) for a period of 60 minutes. They are then to be subjected to an impact of 9 ft-lbs (12.2 J). The coating shall not separate from the metal nor be damaged to the extent that bare metal is exposed.

Exception: Conduit that is marked with a temperature rating below 32°F is to be conditioned at the rated temperature. The rated temperature shall be any temperature below 32°F in 10°F (5.6°C) increments.

17.2 The impact test in 17.1 is to be performed using the Tup B falling mass using the apparatus and method specified in the Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight), ASTM D 2444. The test is to be conducted inside the cold chamber or within 15 seconds of removal from the cold chamber.

17.3 Alternatively, a combination of any height and weight which results in the same impact force specified in 17.1 may be used when the impact face remains unchanged.

18 Flammability Test

18.1 General

18.1.1 Vertical specimens of finished conduit provided with a nonmetallic alternate corrosion-resistant coating shall not flame for longer than 5 seconds following any of three 60-second applications of flame, the period between applications being 30 seconds. A specimens shall not:

a) Emit flaming or glowing particles or flaming drops at any time that ignite the cotton on the burner, wedge, or floor of the enclosure (flameless charring of the cotton is to be ignored);

b) Continue to flame longer than 5 seconds after any application of the gas flame; or

c) Have the coating completely consumed during or after any application of the gas flame.

18.2 Preparations

18.2.1 This test is to be performed on three unaged specimens tested separately with each positioned in a 3-sided metal enclosure in an exhaust hood or cabinet. The metal enclosure is to be 12 inches (305 mm) wide, 14 inches (355 mm) deep, 24 inches (610 mm) high, and the top and front are to be open. An 18-inch (457-mm) specimen of finished conduit is to be secured with its longitudinal axis vertical in the center

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of the enclosure. A flat, horizontal layer of untreated surgical cotton 1/4 – 1 inch (6 – 25 mm) thick is to cover the floor of the enclosure. The upper surface of the cotton is to be 9 – 9-1/2 inches (229 – 241 mm) below point B, which is the point at which the tip of the blue cone of the test flame touches the specimen (this is shown in Figure 18.1).

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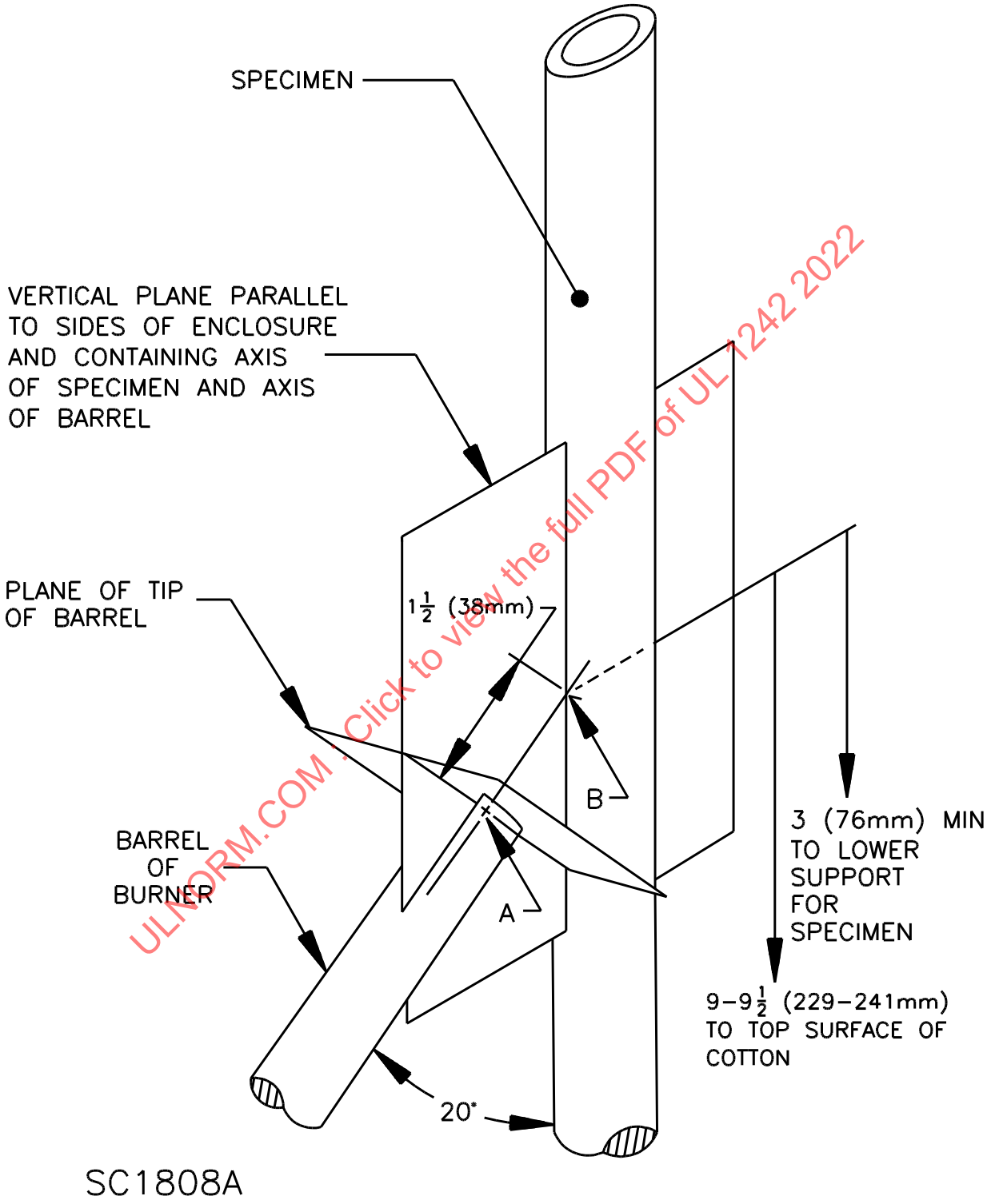
Figure 18.1

Essential dimensions, in inches and mm, for flame test



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