



UL 651

STANDARD FOR SAFETY

Schedule 40, 80, Type EB and A Rigid
PVC Conduit and Fittings

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UL Standard for Safety for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings, UL 651

Eighth Edition, Dated October 25, 2011

Summary of Topics

This revision for ANSI/UL 651 dated May 10, 2022 includes changes to the following:

- [Table 5.1](#)
- **PVC Offset Fittings; [5.2.3](#) and [5.2.4](#)**
- **Editorial update to correct reference from Table 6.1 to Table 6.3; [6.9.2](#)**

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 new and revised requirements are substantially in accordance with Proposal(s) on this subject dated December 10, 2021 and April 1, 2022.

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ANSI/UL 651-2022

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UL 651

Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

Prior to the fourth edition, the requirements for the Schedule 40 products covered by this standard were included in the Standard for Rigid Nonmetallic Conduit, UL 651. Prior to the eighth edition, the requirements for Type EB and A products covered by this standard were included in the Standard for Type EB and A Rigid PVC Conduit, UL 651A.

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Eighth Edition

October 25, 2011

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The most recent designation of ANSI/UL 651 as an American National Standard (ANSI) occurred on May 10, 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 651 on August 5, 1983. 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 General

1.1.1 These requirements cover Schedule 40, Schedule 80, Type EB and Type A extruded rigid PVC (polyvinyl chloride) electrical conduit and fittings. These requirements also cover elbows, couplings, adapters, expansion, expansion-deflection, or deflection joints, and similar fittings that are constructed at least in part of rigid PVC. The designations "Schedule 40", "Schedule 80", "Type EB", "Type A" refer to USA trade sizes of conduit having iron pipe-size outside diameters and specific wall thicknesses. Couplings, adapters, expansion, expansion-deflection, or deflection joints, and similar fittings are intended to be used with Schedule 40, Schedule 80, Type EB and Type A rigid PVC conduit, and elbows in accordance with the National Electrical Code (NEC), NFPA 70.

1.1.2 Rigid PVC conduit and fittings covered in these requirements are intended for use as rigid nonmetallic raceway for wires and cables in accordance with the National Electrical Code (NEC), NFPA 70.

1.1.3 Conduit bodies (pull boxes) and covers, flush-device boxes and covers, and outlet boxes and covers that are constructed of rigid PVC or another nonmetallic material and are for use with the rigid PVC conduit and fittings covered in these requirements are covered separately in the Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C.

1.1.4 Rigid PVC conduit and fittings covered in these requirements are intended to be joined to each other and to rigid PVC boxes, conduit bodies, and fittings in the field by such means as a push-fit or a cement that is or contains a solvent for polyvinyl chloride.

1.1.5 Unless the wording of a requirement that applies to rigid PVC conduit and fittings specifically limits the requirement to Schedule 40, Schedule 80, Type EB or to Type A, each such requirement in this standard applies to all types.

1.1.6 Reinforced thermosetting resin conduit and associated fittings are covered separately in the Standard for Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings, UL 2515 and the Standard for Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings, UL 2420.

1.2 Schedule 40 and 80 conduit and fittings

1.2.1 Schedule 40 rigid PVC conduit and fittings are for aboveground use indoors or outdoors exposed to sunlight and weather, and for underground use by direct burial or encasement in concrete. Schedule 40 rigid PVC conduit, elbows, that are specifically marked for underground use are suitable for use underground only by direct burial or encasement in concrete.

1.2.2 Schedule 80 rigid PVC conduit and fittings are for use wherever Schedule 40 rigid PVC conduit may be used and are for installation on poles in accordance with the National Electrical Code (NEC), NFPA 70.

1.2.3 The following restrictions apply to use of the Schedule 40 and Schedule 80 rigid PVC conduit and fittings mentioned in [1.1.1](#):

- a) Use at 50°C (122°F) and lower ambient temperatures and

b) Use with 75°C (167°F) wiring, but the conduit and fittings may be used with 90°C (194°F) wiring if they comply with the construction (see Conduit for Use with 90°C Wire, [6.15](#)) and marking (see [8.2.1](#), [8.2.4](#) and [8.2.5](#)) requirements covering use with 90°C (194°F) wiring.

1.2.4 In addition to the applicable requirements specified in this standard, Schedule 40 and Schedule 80 rigid PVC conduit intended for directional boring shall be subjected to the performance requirements in [6.12](#).

1.2.5 *Deleted.*

1.3 Type EB and A conduit and fittings

1.3.1 The Type EB and Type A rigid PVC conduit and fittings mentioned in [1.1.1](#) are intended for use at 50°C (122°F) and lower ambient temperatures. Type A rigid PVC conduit and fittings are intended for use with 75°C (167°F) wiring. Type A and Type EB rigid PVC conduit and fittings, where encased in concrete in trenches outside of buildings, may be used with 90°C (194°F) wiring.

1.3.2 Type EB (encased burial) rigid PVC conduit is intended for encasement in concrete in trenches outside of buildings. Type A rigid PVC conduit is intended for encasement in concrete in any location.

1.4 Applications

1.4.1 Couplings covered by these requirements are fittings intended for joining:

- a) Two lengths of rigid PVC conduit,
- b) A length of rigid PVC conduit to a rigid PVC elbow and
- c) In conjunction with a junction-box adapter, a length of rigid PVC conduit or a rigid PVC elbow to a box.

1.5 Fittings

1.5.1 Junction-box adapters covered by these requirements are fittings intended to connect a length of rigid PVC conduit, a PVC elbow to a rigid PVC box (not limited to junction boxes) with a coupling.

1.5.2 Internally-threaded adapters covered by these requirements are fittings intended for joining a length of rigid PVC conduit, a PVC elbow to threaded rigid metal conduit or other externally-threaded devices.

1.5.3 Externally-threaded adapters (also referred to as terminal adapters) covered by these requirements are fittings intended for joining a length of rigid PVC conduit or elbow to:

- a) The knockout area of a metal box with a metal locknut,
- b) A threaded metal hub or fitting on a metal box,
- c) A threaded hub on a phenolic box, or
- d) A knockout in a phenolic box.

1.5.4 Reducers covered by these requirements are fittings intended for joining lengths of two different sizes of rigid PVC conduit.

1.5.5 Caps covered by these requirements are fittings intended for closing the ends of unused lengths of rigid PVC conduit.

1.5.6 End bells covered by these requirements are fittings intended to provide a bushed opening at the open end of a length of rigid PVC conduit. (See [5.8.1](#).)

1.5.7 Construction requirements for fittings covered by this standard are specified in Section [5](#). Performance requirements are specified in Section [7](#).

2 Units of Measurement

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

2.2 Unless otherwise indicated, all voltage and current values mentioned in this standard are root-mean-square (rms).

3 Undated 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.

CONSTRUCTION

4 Rigid PVC Conduit

4.1 General

4.1.1 The compound of which rigid PVC conduit and fittings are made shall equal or exceed the cell classification 12123 as described in Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC Compounds), ASTM D 1784.

4.1.2 Clean rework compound, generated from the manufacturer's own production and reused by the manufacturer, meets the intent of these requirements when the finished product complies with all of the requirements of this standard.

4.1.3 Clean industrial scrap material (single or blended) originating entirely from operations in the same plant as that in which the conduit is manufactured) that is not commingled with other plastic materials and originates from a single manufacturing process shall be permitted to be used if:

- a) Each source has been qualified in accordance with the requirements of the Standard for Polymeric Materials – Fabricated Parts, UL 746D and
- b) The conduit and fittings produced meet all the requirements of this standard.

4.1.4 Rigid PVC conduit and fittings are inherently resistant to the corrosive influences of common industrial atmospheres including the vapors and mists of bases, hydrofluoric and chromic acids, and pickling and plating baths. Resistance to wetting by and immersion in specific reagents is covered in Resistance to Specific Reagents, [6.13](#) and [7.2.10](#) and related markings in [8.2.2](#), [8.2.3](#), [9.2.1](#) and [9.2.2](#).

4.1.5 Rigid PVC conduit shall provide a smooth raceway for the pulling in of wires and cables. They shall not have any features that can abrade or otherwise damage wires and cables. The outside surfaces of conduit and fittings shall be smooth and without any chips, blisters, cracks, or other defects. There shall not be any tendency for conduit or fittings to peel, scale, flake, chalk, or crumble.

4.1.6 Both ends of each length of rigid PVC conduit shall be perpendicular to the longitudinal axis of the conduit.

Exception: An interior chamfer on the spigot end of conduit is not prohibited. The chamfer shall be constructed as shown in Figure 1 of Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation, ASTM F 512. A chamfered end is not considered to be a taper.

4.1.7 Rigid PVC conduit and elbows shall not be threaded. There shall not be any taper to the conduit unless one end is formed as an integral coupling. In that case, only the interior surface of the integral coupling may be tapered.

4.1.8 For specific applications or uses, lengths may be shipped from the factory with or without couplings or with an adapter instead of a coupling. A coupling with a center stop need not be cemented to the conduit when the conduit is shipped but may be separately packaged.

4.1.9 For general use, a PVC coupling or similar fitting shall be cemented, heat-fused, or molded (see [4.1.10](#)) to one end of each length of conduit before the conduit is shipped from the factory. The coupling or similar fitting shall comply with the requirements concerning reagent resistance in Resistance to Specific Reagents, [7.2.10](#), and [9.2.1](#), and [9.2.2](#) if the conduit to which it is attached complies with the requirements for wetting by or immersion in reagents. If a stopless coupling is used, the end of the conduit shall be within 1/8 inch (3 mm) of the center of the coupling.

4.1.10 A PVC coupling shall be capable of being secured to rigid PVC conduit by means of the type of cement mentioned in [1.1.4](#). When assembled to conduit to which solvent cement is freshly applied, both of the following shall be complied with:

- a) The coupling shall be hand-tight on the conduit when the end of the conduit is against the stop or, in the case of a stopless coupling, within 1/8 inch (3 mm) of the center of the coupling. The coupling shall not be loose nor shall anything other than a person's hands be needed to assemble the coupling to the conduit; and
- b) Around the junction of the coupling socket and the conduit circumference to which the coupling is attached, there shall not be any void that is not essentially filled by cement.

4.2 Measurements

4.2.1 Each length of rigid PVC conduit on which measurements are made is to be finished, smooth and clean wherever it is to touch any part of a measuring device or tool. While measurements are being made, the conduit and the air around it are to be in thermal equilibrium with one another at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$). All of the average and individual outside diameter measurements are to be performed at the center and at least one end of the conduit.

4.2.2 The measurements from which the average outside diameters of a length of each type of finished conduit are to be determined for comparison with the limits specified in inches or in millimeters in the appropriate tables in [4.3](#) for Schedule 40 and 80 conduit and [4.5](#) for Type EB and A conduit. Measurements are to be made by one of the following means:

- a) A machinist's micrometer caliper that has a flat-ended spindle, a flat anvil and is calibrated to read directly to at least 0.001 inch or 0.01 mm;
- b) A vernier caliper calibrated to read directly to at least 0.001 inch or 0.01 mm;
- c) A vernier wrap tape, calibrated to read directly to at least 0.001 inch or 0.01 mm;

d) A tapered sleeve gauge accurate to ± 1 percent of its taper and ± 0.001 inch or ± 0.01 mm of its diameter; or

e) A sleeve window gauge accurate to within ± 1 percent of its tape and ± 0.001 inch of its diameter.

4.2.3 Wall thicknesses of a length of finished rigid PVC conduit shall be measured and compared with the limits specified in inches or millimeters in the appropriate tables in [4.3](#) for Schedule 40 and 80 conduit and [4.5](#) for Type EB and A conduit. Measurements are to be made by a machinist's micrometer caliper that has a ratchet, a flat-ended spindle, and a hemispherical anvil and is calibrated having a minimum resolution of 0.001 inches or 0.01 mm

4.2.4 When employing a tapered sleeve gauge, the entrance and exit diameters of the gauge shall correspond to the maximum and minimum outside diameters for the trade size of rigid PVC conduit being measured.

4.2.5 When employing a sleeve window gauge, the window shall extend beyond the two scribed marks which shall represent the minimum and maximum required diameters.

4.2.6 The measurements from which the minimum and maximum outside diameters (ovality or out-of-roundness) of a length of each type of finished conduit are to be determined for comparison with the limits specified in inches or in millimeters in the appropriate tables in [4.3](#) for Schedule 40 and 80 conduit and [4.5](#) for Type EB and A conduit. Measurements are to be made by one of the following means:

a) A machinist's micrometer caliper that has a flat-ended spindle, a flat anvil and is calibrated to read directly to at least 0.001 inch or 0.01 mm;

b) A vernier caliper calibrated to read directly to at least 0.001 inch or 0.01 mm; or

c) An out-of-roundness gauge accurate to ± 0.01 mm.

4.2.7 In disputes that may arise between measuring techniques, the vernier caliper is to act as the referee in determining compliance with the requirements for minimum and maximum outside diameters.

4.2.8 To determine the average outside diameter when using a micrometer caliper or vernier caliper, at least four measurements (every 45 degrees) are necessary at each place to ensure that the largest and smallest diameters are found. The average of all the recorded diameters is to be determined and compared with the average diameter for the trade size of rigid PVC involved that is found in the following tables:

a) For Schedule 40 and 80 conduit, [Table 4.1](#) (inches) or [Table 4.2](#) (millimeters);

b) For Type EB and A conduit, [Table 4.6](#) (inches) or [Table 4.7](#) (millimeters).

The average of the recorded diameters shall not differ from the average diameter in the applicable table by more than the specified tolerances.

4.2.9 To determine the average outside diameter when using vernier wrap tape, place the vernier wrap tape around the rigid PVC conduit making sure that it is at right angles to the conduit axis and is flat against the conduit surface. The observed reading is to be compared with the average diameter for the trade size of conduit involved as specified in [4.2.8](#) (a) or (b). The observed reading shall not differ from the average diameter in the applicable table by more than the specified tolerances.

4.2.10 To determine the average outside diameter when using a tapered sleeve gauge or sleeve window gauge, cut the end of the rigid PVC conduit square and remove burrs. Insert the conduit into the sleeve

gauge and observe the position of the end with respect to the ends of the tapered sleeve gauge or the position of the end with respect to the minimum and maximum scribed marks of the sleeve window gauge.

4.2.11 When using a tapered sleeve gauge, the rigid PVC conduit shall enter the larger end of the gauge and shall not pass through the smaller end of the gauge.

4.2.12 When using a sleeve window gauge, the end of the rigid PVC conduit shall be visible between the two scribed marks when the conduit is inserted into the gauge.

4.2.13 The average of the recorded diameters mentioned in [4.2.8](#) – [4.2.13](#) is to be determined and compared with the average diameter in inches or millimeters for the size of rigid PVC conduit involved as specified in [4.2.8](#) (a) or (b). The average of the recorded diameters shall not differ from the average diameter in the applicable table by more than the specified tolerances.

4.2.14 Additionally, the wall thickness is to be measured at one or both ends of the rigid PVC conduit by means of the caliper with the hemispherical anvil. At least four measurements are necessary at each end, measured to make certain that the thickest and thinnest parts of the wall are found. The maximum and minimum of all the recorded thicknesses are to be compared with the maximum and minimum wall thicknesses found in the following tables for the size of conduit involved:

- a) For Schedule 40 and 80 conduit, [Table 4.1](#) (inches) or [Table 4.2](#) (millimeters);
- b) For Type EB and A conduit, [Table 4.6](#) (inches) or [Table 4.7](#) (millimeters).

Neither limit shall be exceeded.

4.2.15 If desired, methods, tools, and measurement techniques may be employed to determine compliance with the above dimensional requirements provided they are accurate to within ± 0.001 inch or ± 0.01 mm and as such have been determined to be acceptable.

4.3 Schedule 40 and 80 conduit

4.3.1 Limits on the wall thickness and outside diameter of Schedule 40 and 80 rigid PVC conduit shall be as specified in inches in [Table 4.1](#) and in millimeters in [Table 4.2](#). Limits on inside diameters shall be as specified in [Table 4.3](#).

Table 4.1
Limits in inches on outside diameters and wall thicknesses of Schedule 40 and 80 conduit

Trade size of conduit	Outside diameters,			Minimum wall thicknesses,	
	Average	Maximum	Minimum	Schedule 40	Schedule 80
1/2	0.840 ± 0.004	0.848	0.832	0.109	0.147
3/4	1.050 ± 0.004	1.060	1.040	0.113	0.154
1	1.315 ± 0.005	1.325	1.305	0.133	0.179
1-1/4	1.660 ± 0.005	1.672	1.648	0.140	0.191
1-1/2	1.900 ± 0.006	1.912	1.888	0.145	0.200
2	2.375 ± 0.006	2.387	2.363	0.154	0.218
2-1/2	2.875 ± 0.007	2.890	2.860	0.203	0.276
3	3.500 ± 0.008	3.515	3.485	0.216	0.300
3-1/2	4.000 ± 0.008	4.050	3.950	0.226	0.318
4	4.500 ± 0.009	4.550	4.450	0.237	0.337
5	5.563 ± 0.010	5.613	5.513	0.258	0.375
6	6.625 ± 0.011	6.675	6.575	0.280	0.432

Table 4.2
Limits in millimeters on outside diameters and wall thicknesses of Schedule 40 and 80 conduit

Metric designator	Outside diameters,			Minimum wall thicknesses,	
	Average	Maximum	Minimum	Schedule 40	Schedule 80
16	21.34 ±0.10	21.54	21.13	2.77	3.73
21	26.67 ±0.10	26.92	26.42	2.87	3.91
27	33.40 ±0.13	33.66	33.15	3.38	4.55
35	42.16 ±0.13	42.47	41.86	3.56	4.85
41	48.26 ±0.15	48.56	47.96	3.68	5.08
53	60.32 ±0.15	60.63	60.02	3.91	5.54
63	73.02 ±0.18	73.41	72.64	5.16	7.01
78	88.90 ±0.20	89.28	88.52	5.49	7.62
91	101.60 ±0.20	102.87	100.33	5.74	8.08
103	114.30 ±0.23	115.57	113.03	6.02	8.56
129	141.30 ±0.25	142.57	140.03	6.55	9.52
155	168.28 ±0.28	169.54	167.00	7.11	10.97

Table 4.3
Minimum average inside diameter of Schedule 40 and 80 rigid PVC conduit

Trade size (metric design)		Minimum average inside diameter			
		Schedule 40		Schedule 80	
		inches	(mm)	inches	(mm)
1/2	(16)	0.578	(14.68)	0.502	(12.75)
3/4	(21)	0.780	(19.81)	0.698	(17.72)
1	(27)	1.004	(25.50)	0.910	(23.11)
1-1/4	(35)	1.335	(33.90)	1.227	(31.16)
1-1/2	(41)	1.564	(39.72)	1.446	(36.72)
2	(53)	2.021	(51.33)	1.881	(47.77)
2-1/2	(63)	2.414	(61.31)	2.250	(57.15)
3	(78)	3.008	(76.40)	2.820	(71.62)
3-1/2	(91)	3.486	(88.54)	3.280	(83.31)
4	(103)	3.961	(100.60)	3.737	(94.91)
5	(129)	4.975	(126.36)	4.713	(119.71)
6	(155)	5.986	(152.04)	5.646	(143.41)

4.4 Couplings for Schedule 40 and 80 conduit

4.4.1 The dimensions of an integral coupling shall comply with [Table 4.4](#) (inches) or [Table 4.5](#) (millimeters) when measured with a machinist's inside micrometer caliper (socket diameter) having a ratchet, a machinist's inside-depth gauge (socket depth), and the machinist's micrometer caliper (socket wall thickness) mentioned in [4.2.2](#). Each instrument is to be calibrated to read directly to at least 0.001 inch or 0.01 mm.

Table 4.4
Dimensions in inches of integral couplings for Schedule 40 and 80 conduit

Trade size of conduit	Socket diameters						Minimum socket depth ^a	Minimum thickness at any point of socket	
	At entrance			At bottom				Schedule 40	Schedule 80
	Maximum	Minimum	Average	Maximum	Minimum	Average			
1/2	0.860	0.844	0.852 ±0.004	0.844	0.828	0.836 ±0.004	0.652	0.095	0.129
3/4	1.074	1.054	1.064 ±0.004	1.056	1.036	1.046 ±0.004	0.719	0.095	0.136
1	1.340	1.320	1.330 ±0.005	1.320	1.300	1.310 ±0.005	0.875	0.100	0.158
1-1/4	1.689	1.665	1.677 ±0.005	1.667	1.643	1.655 ±0.005	0.938	0.120	0.168
1-1/2	1.930	1.906	1.918 ±0.006	1.906	1.882	1.894 ±0.006	1.062	0.120	0.166
2	2.405	2.381	2.393 ±0.006	2.381	2.357	2.369 ±0.006	1.125	0.130	0.181
2-1/2	2.905	2.875	2.890 ±0.007	2.883	2.853	2.868 ±0.007	1.469	0.165	0.229
3	3.530	3.500	3.515 ±0.008	3.507	3.477	3.492 ±0.008	1.594	0.179	0.249
3-1/2	4.065	3.965	4.015 ±0.008	4.007	3.977	3.992 ±0.008	1.687	0.188	0.264
4	4.565	4.465	4.515 ±0.009	4.506	4.476	4.491 ±0.009	1.750	0.197	0.280
5	5.643	5.543	5.593 ±0.010	5.583	5.523	5.553 ±0.010	1.937	0.214	0.311
6	6.708	6.608	6.658 ±0.011	6.644	6.584	6.614 ±0.011	2.125	0.232	0.359

^a Tests are not needed on sockets complying with these minimums.

Table 4.5
Dimensions in millimeters of integral couplings for Schedule 40 and 80 conduit

Metric desig	Socket diameters						Minimum socket depth ^a	Minimum thickness at any point of socket	
	At entrance			At bottom				Schedule 40	Schedule 80
	Maximum	Minimum	Average	Maximum	Minimum	Average			
16	21.84	21.44	21.64 ±0.10	21.44	21.03	21.23 ±0.10	16.56	2.41	3.28
21	27.28	26.77	27.03 ±0.10	26.82	26.31	26.57 ±0.10	18.26	2.41	3.45
27	34.04	33.53	33.78 ±0.13	33.53	33.02	33.27 ±0.13	22.22	2.54	4.01
35	42.90	42.30	42.60 ±0.13	42.34	41.73	42.04 ±0.13	23.83	3.05	4.28
41	49.02	48.41	48.72 ±0.15	48.41	47.80	48.11 ±0.15	26.97	3.05	4.22
53	61.09	60.48	60.78 ±0.15	60.48	59.87	60.17 ±0.15	28.58	3.30	4.60
63	73.79	73.02	73.41 ±0.18	73.23	72.47	72.85 ±0.18	37.31	4.19	5.82

Table 4.5 Continued on Next Page

Table 4.5 Continued

Metric design	Socket diameters						Minimum socket depth ^a	Minimum thickness at any point of socket	
	At entrance			At bottom				Schedule 40	Schedule 80
	Maximum	Minimum	Average	Maximum	Minimum	Average			
78	89.66	88.90	89.28 ±0.20	89.08	88.32	88.70 ±0.20	40.49	4.55	6.32
91	103.25	100.71	101.98 ±0.20	101.78	101.02	101.40±0.2 0	42.85	4.78	6.71
103	115.95	113.41	114.68 ±0.23	114.45	113.70	114.07±0.2 3	44.45	5.00	7.11
129	143.33	140.80	142.06 ±0.25	141.80	140.28	141.05±0.2 5	49.20	5.44	7.90
155	170.38	167.84	169.11±0.2 8	168.76	167.23	168.00 ±0.28	53.98	5.89	9.12

^a Tests are not needed on sockets complying with these minimums.

4.5 Type EB and A conduit

4.5.1 Limits on the wall thickness and outside diameter of Type A and Type EB rigid PVC conduit shall be as specified in [Table 4.6](#) (inches) and [Table 4.7](#) (millimeters).

Table 4.6
Outside diameter and wall thickness of Type A and EB rigid PVC conduit in inches

Trade size of conduit	Avg.	Outside diameters				Wall thicknesses			
		Type A PVC conduit		Type EB PVC conduit		Type A PVC conduit		Type EB ^b PVC conduit	
		Max	Min	Max	Min	Max	Min	Max	Min
1/2	0.840 ±0.004	0.848	0.832	a	a	0.080	0.060	a	a
3/4	1.050 ±0.004	1.060	1.040	a	a	0.080	0.060	a	a
1	1.315 ±0.005	1.325	1.305	a	a	0.080	0.060	a	a
1-1/4	1.660 ±0.005	1.672	1.648	a	a	0.090	0.070	a	a
1-1/2	1.900 ±0.006	1.912	1.888	a	a	0.100	0.080	a	a
2	2.375 ±0.006	2.387	2.363	2.405	2.345	0.120	0.100	0.094	0.060
2-1/2	2.875 ±0.007	2.890	2.860	a	a	0.130	0.110	a	a
3	3.500 ±0.008	3.515	3.485	3.530	3.470	0.145	0.125	0.109	0.061
3-1/2	4.000 ±0.008	4.050	3.950	4.050	3.950	0.165	0.145	0.124	0.072
4	4.500 ±0.009	4.550	4.450	4.550	4.450	0.170	0.150	0.129	0.082
5	5.563 ±0.010	5.613	5.513	5.613	5.513	a	a	0.144	0.103
6	6.625 ±0.011	6.675	6.575	6.675	6.575	a	a	0.164	0.125

^a Additional requirements will be added as these sizes are determined to be acceptable.

^b Length – Standard lengths are 10 feet and 20 feet. Other lengths may be shipped for specific applications.

Table 4.7
Limits on outside diameters and wall thicknesses of Type A and EB PVC conduit in millimeters

Metric designator	Avg.	Outside diameters				Wall thicknesses			
		Type A PVC conduit		Type EB PVC conduit		Type A PVC conduit		Type EB ^b PVC conduit	
		Max	Min	Max	Min	Max	Min	Max	Min
16	21.34 ±0.10	21.54	21.13	a	a	2.03	1.52	a	a
21	26.67 ±0.10	26.92	26.42	a	a	2.03	1.52	a	a
27	33.40 ±0.13	33.66	33.15	a	a	2.03	1.52	a	a
35	42.16 ±0.13	42.47	41.86	a	a	2.29	1.78	a	a
41	48.26 ±0.15	48.56	47.96	a	a	2.54	2.03	a	a
53	60.32 ±0.15	60.63	60.02	61.09	59.56	3.05	2.54	2.39	1.52
63	73.02 ±0.18	73.41	72.64	a	a	3.30	2.80	a	a
78	88.90 ±0.20	89.28	88.52	89.60	88.14	3.68	3.18	2.77	1.55
91	101.60 ±0.20	102.87	100.33	102.87	100.33	4.20	3.68	3.15	1.83
103	114.30 ±0.23	115.57	113.03	115.57	113.03	4.32	3.80	3.28	2.08
129	141.30 ±0.25	142.57	140.03	142.57	140.03	a	a	3.66	2.62
155	168.28 ±0.28	169.54	167.00	169.54	167.00	a	a	4.17	3.18
^a Additional requirements will be added as these sizes are determined to be acceptable.									
^b Length – Standard lengths are 10 feet and 20 feet. Other lengths may be shipped for specific applications.									

4.6 Couplings for Type EB and A conduit

4.6.1 The dimensions of an integral coupling on Type EB rigid PVC conduit shall comply with [Table 4.8](#) (inches) or [Table 4.9](#) (millimeters) when measured with a machinist's inside micrometer caliper (socket diameter) having a ratchet, a machinist's inside depth gauge (socket depth), and the machinist's micrometer caliper (socket wall thickness) mentioned in [4.2.2](#). Each instrument is to be calibrated to read directly to at least 0.001 inch or 0.01 mm.

Table 4.8
Dimensions in inches of integral coupling for Type EB rigid PVC conduit

Trade size of conduit	Inside diameter at inner end of socket			Inside diameter at entrance to socket			Minimum socket depth ^a	Minimum thickness at any point of socket
	Average	Maximum	Minimum	Average	Maximum	Minimum		
2	2.378 ±.008	2.408	2.348	2.396 ±.009	2.426	2.366	1.750	0.060
3	3.503 ±.010	3.533	3.473	3.529 ±.014	3.559	3.499	2.875	0.061

Table 4.8 Continued on Next Page

Table 4.8 Continued

Trade size of conduit	Inside diameter at inner end of socket			Inside diameter at entrance to socket			Minimum socket depth ^a	Minimum thickness at any point of socket
	Average	Maximum	Minimum	Average	Maximum	Minimum		
3-1/2	4.003 ±.011	4.053	3.953	4.031 ±.015	4.081	3.981	3.125	0.72
4	4.502 ±.012	4.552	4.452	4.533 ±.016	4.583	4.483	3.375	0.082
5	5.565 ±.013	5.615	5.515	5.601 ±.018	5.651	5.551	4.000	0.103
6	6.627 ±.014	6.677	6.577	6.669 ±.023	6.719	6.619	5.000	0.125

^a Socket depth shall be measured from the entrance edge to the shoulder stop. Tests are not needed on sockets complying with these minimums.

Table 4.9
Dimensions in millimeters of integral couplings for Type EB rigid PVC conduit

Metric designator	Inside diameter at inner end of socket			Inside diameter at entrance to socket			Minimum socket depth ^a	Minimum thickness at any point of socket
	Average	Maximum	Minimum	Average	Maximum	Minimum		
53	60.40 ±0.20	61.16	59.64	60.86 ±0.23	61.62	60.10	44.45	1.52
78	88.98 ±0.25	89.74	88.21	89.64 ±0.36	90.40	88.87	73.02	1.55
91	101.68 ±0.28	102.95	100.40	102.39 ±0.38	103.66	101.12	79.38	1.83
103	114.35 ±0.30	115.62	113.08	115.14±0.41	116.40	113.87	85.72	2.08
129	141.35 ±0.33	142.62	140.08	142.27 ±0.46	143.54	141.00	101.60	2.62
155	168.33 ±0.36	169.60	167.06	168.40±0.58	170.66	168.12	127.00	3.18

^a Socket depth shall be measured from the entrance edge to the shoulder stop. Tests are not needed on sockets complying with these minimums.

4.7 Elbows

4.7.1 Elbows for use with rigid PVC conduit shall be formed from lengths of straight conduit that are of any convenient length (see 4.7.2) but otherwise comply with the requirements in this standard. The axial length of a finished elbow shall not exceed 10 feet (3.05 m). Each finished elbow shall not have any kinks or creases. A coupling need not be attached to an elbow if it is shipped from the factory.

4.7.2 If the lengths of rigid PVC conduit from which elbows are formed are longer or shorter than 10 feet (3.05 m), and are shipped to another of the conduit manufacturer's factories or to a second manufacturer, each length or bundle of lengths shall be tagged or otherwise marked to indicate that the conduit is intended for further processing.

4.7.3 Examples of elbows are illustrated in Figure 4.1. No bend other than at the end curve of a gooseneck shall be sharper than 90 ±2 degrees. No end curve shall be sharper than 135 degrees. No elbow shall be shallower than 11.25 degrees. The length Ls of the straight portions at the ends of an elbow

and the radius R of an elbow shall not be smaller than indicated in [Table 4.10](#) for each size of rigid PVC conduit. The straight end portions of elbows shall comply with the dimensions specified in [Table 4.10](#).

Figure 4.1

Elbows

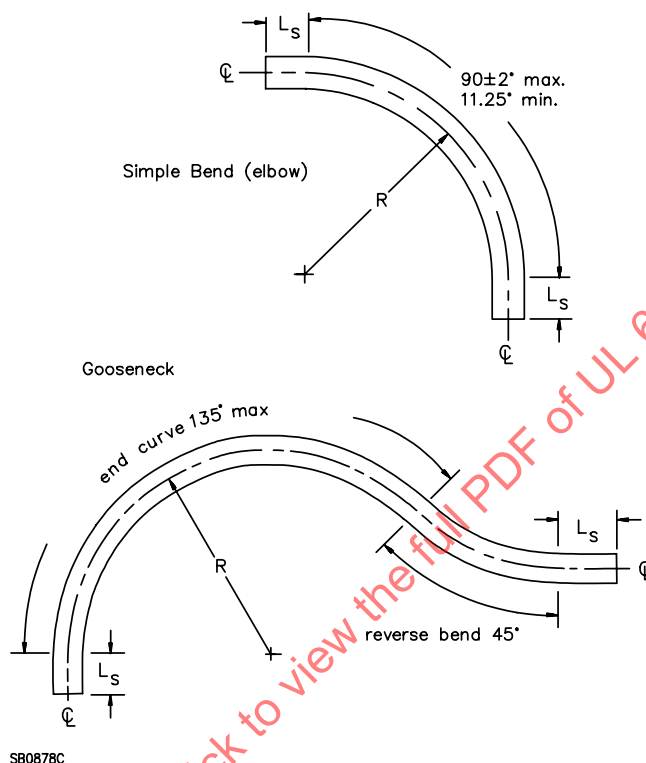


Table 4.10
Minimum dimensions of elbows

Trade size of conduit in inches	(metric designator)	Radius R of bend to center line of conduit,		Length L_s of straight end portion,	
		inches	(mm)	inches	(mm)
1/2	(16)	4	(100)	1-1/2	(38)
3/4	(21)	4-1/2	(114)	1-1/2	(38)
1	(27)	5-3/4	(146)	1-7/8	(48)
1-1/4	(35)	7-1/4	(184)	2	(50)
1-1/2	(41)	8-1/4	(210)	2	(50)
2	(53)	9-1/2	(241)	2	(50)
2-1/2	(63)	10-1/2	(267)	3	(76)
3	(78)	13	(330)	3-1/8	(79)
3-1/2	(91)	15	(380)	3-1/4	(83)
4	(103)	16	(400)	3-3/8	(86)
5	(129)	24	(600)	3-5/8	(92)
6	(155)	30	(760)	3-3/4	(95)

5 Rigid PVC Conduit Fittings

5.1 General

5.1.1 A rigid PVC conduit fitting shall be constructed of an unplasticized polyvinyl chloride material, with or without components made of other materials, that has been determined to be acceptable for the application.

5.1.2 The inner and outer surfaces of a fitting shall not be subject to peeling, scaling, or flaking and shall be smooth and free from blisters, cracks, and other defects. The fitting shall have a smooth rounded inlet hole to afford protection to the conductors. In the case of a molded product, excess flashing shall be removed from the mold line of all interior surfaces so that there are no sharp edges or obstructions to the passage of wiring or mating of parts in the intended use of the product.

5.1.3 A fitting shall be constructed so that it can be secured to polyvinyl chloride (PVC) conduit without damage to the fitting or conduit.

5.1.4 To preclude snags and restrictions in a finished rigid PVC conduit system, the socket and threaded surfaces of an internally or externally threaded polyvinyl chloride (PVC) adapter or a coupling shall have a circular cross section. The socket shall be tapered. The socket shall be provided, other than noted in [5.1.5](#) with an end or centering stop:

- a) On which there are no burrs or sharp edges to damage wires being pulled over the stop; and
- b) That limits the depth of penetration of rigid PVC conduit and, in the case of an internally threaded adapter, also limits the depth of penetration of threaded rigid metal conduit.

5.1.5 A centering stop is not required in a coupling that is intended for attachment to rigid PVC conduit only at the conduit factory. If a factory-applied coupling is provided with a centering stop:

- a) The minimum throat diameter shall comply with the last two columns of [Table 5.1](#);
- b) The stop need not extend entirely around the circumference of the coupling; and
- c) The stop shall not project into the conduit for which the coupling is intended; for example, the minimum acceptable throat diameter is the maximum acceptable inside diameter of the thin- or heavy-wall conduit for which the coupling is intended.

Table 5.1
Throat diameters at any point in fittings other than adapters

Trade size of conduit	(metric designator)	Minimum throat diameter, in (mm)					
		Field-attached couplings and fittings other than adapters ^a		Factory-applied couplings with stops			
				For use with heavy-wall conduit		For use with thin-wall conduit	
1/2	(16)	0.630	(16.00)	0.630	(16.00)	0.728	(18.49)
3/4	(21)	0.834	(21.18)	0.834	(21.18)	0.840	(21.34)
1	(27)	1.059	(26.90)	1.059	(26.90)	1.205	(30.61)
1-1/4	(35)	1.392	(35.36)	1.392	(35.36)	1.532	(38.91)
1-1/2	(41)	1.622	(41.20)	1.622	(41.20)	1.752	(44.50)
2	(53)	2.079	(52.81)	2.079	(52.81)	2.187	(55.55)

Table 5.1 Continued on Next Page

Table 5.1 Continued

Trade size of conduit	(metric designator)	Minimum throat diameter, in (mm)					
		Field-attached couplings and fittings other than adapters ^a		Factory-applied couplings with stops			
				For use with heavy-wall conduit		For use with thin-wall conduit	
2-1/2	(63)	2.484	(63.09)	2.484	(63.09)	2.670	(67.82)
3	(78)	3.083	(78.31)	3.083	(78.31)	3.365	(85.47)
3-1/2	(91)	3.598	(91.39)	3.598	(91.39)	3.760	(95.50)
4	(103)	4.076	(103.53)	4.076	(103.53)	4.250	(107.95)
5	(129)	5.097	(129.46)	5.097	(129.46)	—	—
6	(155)	6.115	(155.32)	6.115	(155.32)	—	—
^a For reducers, the throat for the smaller of the two sizes of conduit applies.							
^b It is not prohibited that the minimum average throat diameters of fittings described in 5.4 comply with Table 4.3.							

5.1.6 The walls of a polyvinyl chloride (PVC) conduit fitting shall be at least as thick as specified in Table 5.2. The dimensions of a PVC externally threaded adapter with tapered threads shall be as specified in Table 5.3.

Table 5.2
Dimensions of fittings and conduit connections

Trade size of conduit (metric designator)	Socket diameter, in (mm)						Minimum socket depth, in (mm)	Minimum thickness, in (mm)	
	At entrance			At bottom				Over male or female threads ^a	Wall of unthreaded portion
	Max	Min	Avg	Max	Min	Avg			
1/2 (16)	0.860 (21.84)	0.844 (21.44)	0.852±0.004 (21.64±0.10)	0.844 (21.44)	0.828 (21.03)	0.836±0.004 (21.23±0.10)	0.652 (16.56)	0.109 (2.77)	0.095 (2.41)
3/4 (21)	1.074 (27.28)	1.054 (26.77)	1.064±0.004 (27.03±0.10)	1.056 (26.82)	1.036 (26.31)	1.046±0.004 (26.57±0.10)	0.719 (18.26)	0.113 (2.87)	0.095 (2.41)
1 (27)	1.340 (34.04)	1.320 (33.53)	1.330±0.005 (33.78±0.13)	1.320 (33.53)	1.300 (33.02)	1.310±0.005 (33.27±0.13)	0.875 (22.23)	0.133 (3.38)	0.100 (2.54)
1-1/4 (35)	1.689 (42.90)	1.665 (42.29)	1.677±0.005 (42.60±0.13)	1.667 (42.34)	1.643 (41.73)	1.655±0.005 (42.04±0.13)	0.938 (23.83)	0.140 (3.56)	0.120 (3.05)
1-1/2 (41)	1.930 (49.02)	1.906 (48.41)	1.918±0.006 (48.72±0.15)	1.906 (48.41)	1.882 (47.80)	1.894±0.006 (48.11±0.15)	1.062 (26.97)	0.145 (3.68)	0.120 (3.05)
2 (53)	2.405 (61.09)	2.381 (60.48)	2.393±0.006 (60.78±0.15)	2.381 (60.48)	2.357 (59.87)	2.369±0.006 (60.17±0.15)	1.125 (28.58)	0.154 (3.91)	0.130 (3.30)
2-1/2 (63)	2.905 (73.79)	2.875 (73.03)	2.890±0.007 (73.41±0.18)	2.883 (73.23)	2.853 (72.47)	2.868±0.007 (72.85±0.18)	1.469 (37.31)	0.203 (5.16)	0.165 (4.19)
3 (78)	3.530 (89.66)	3.500 (88.90)	3.515±0.008 (89.28±0.20)	3.507 (89.08)	3.477 (88.32)	3.492±0.008 (88.70±0.20)	1.594 (40.49)	0.216 (5.49)	0.216 (5.49)
3-1/2 (91)	4.065 (103.25)	3.965 (100.71)	4.015±0.008 (101.98±0.20)	4.007 (101.78)	3.977 (101.02)	3.992±0.008 (101.40±0.20)	1.687 (42.85)	0.226 (5.74)	0.226 (5.74)
4	4.565	4.465	4.515±0.009	4.506	4.476	4.491±0.009	1.750	0.237	0.237

Table 5.2 Continued on Next Page

Table 5.2 Continued

Trade size of conduit (metric designator)	Socket diameter, in (mm)						Minimum socket depth, in (mm)	Minimum thickness, in (mm)	
	At entrance			At bottom				Over male or female threads ^a	Wall of unthreaded portion
	Max	Min	Avg	Max	Min	Avg			
(103)	(115.95)	(113.41)	(114.68±0.23)	(114.45)	(113.69)	(114.07±0.23)	(44.45)	(6.02)	(6.02)
5	5.643	5.543	5.593±0.010	5.583	5.523	5.553±0.010	1.937	0.258	0.258
(129)	(143.33)	(140.79)	(142.06±0.25)	(141.81)	(140.28)	(141.05±0.25)	(49.20)	(6.55)	(6.55)
6	6.708	6.608	6.685±0.011	6.644	6.584	6.614±0.011	2.125	0.280	0.280
(155)	(170.38)	(167.84)	(169.11±0.28)	(168.76)	(167.23)	(168.00±0.28)	(53.98)	(7.11)	(7.11)

^a The thickness is to be measured at the end of the fitting from the crest of the thread through the material to the smooth wall surface.

Table 5.3
Dimensions of polyvinyl chloride externally threaded adapters with tapered threads

Trade size of conduit (metric designator)	Minimum wall thickness over tapered threads,		Effective thread length for five full, perfect threads,	
	in	(mm) ^a	in	(mm) ^b
1/2 (16)	0.097	(2.46)	0.357	(9.07)
3/4 (21)	0.102	(2.59)	0.357	(9.07)
1 (27)	0.119	(3.02)	0.435	(11.05)
1-1/4 (35)	0.126	(3.20)	0.435	(11.05)
1-1/2 (41)	0.131	(3.33)	0.435	(11.05)
2 (53)	0.140	(3.56)	0.435	(11.05)
2-1/2 (63)	0.183	(4.65)	0.625	(15.88)
3 (78)	0.197	(5.00)	0.625	(15.88)
3-1/2 (91)	0.207	(5.26)	0.625	(15.88)
4 (103)	0.217	(5.51)	0.625	(15.88)
5 (129)	0.239	(6.07)	0.625	(15.88)
6 (155)	0.261	(6.63)	0.625	(15.88)

^a The thickness is to be measured at the end of the fitting from the crest of the thread through the material to the inner wall surface

^b See [5.5.3](#).

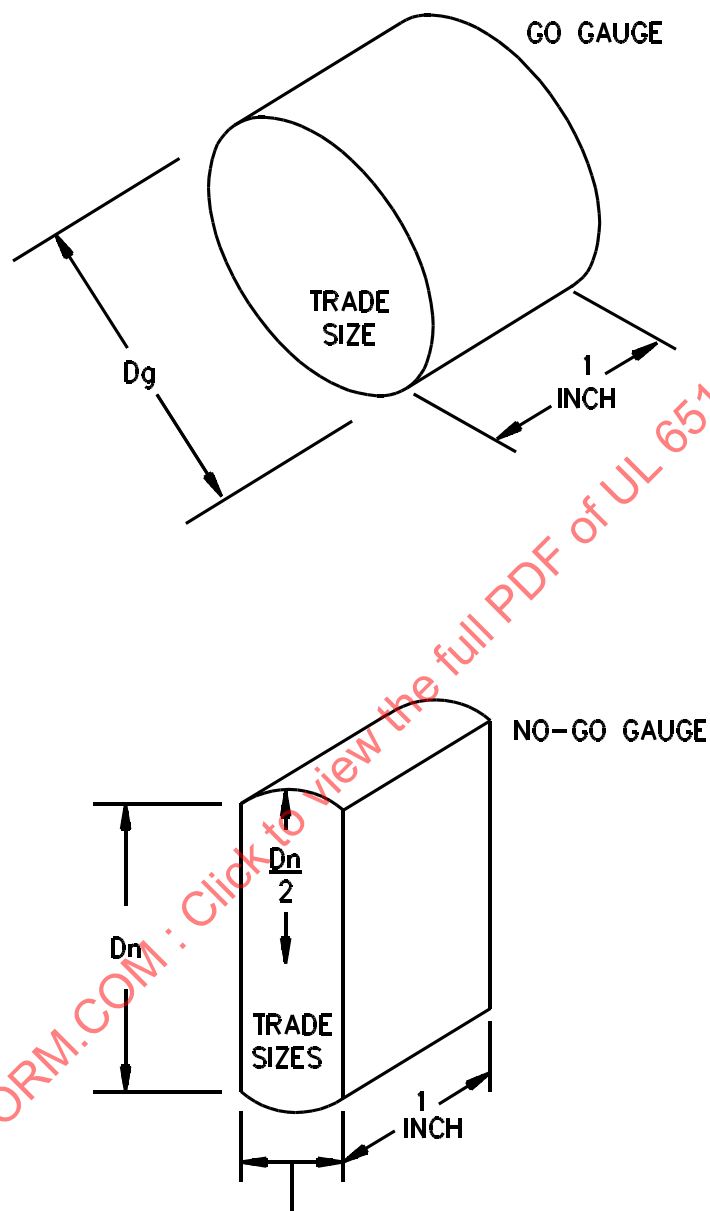
5.1.7 The socket depth and diameters of a conduit fitting shall be within the limits specified in [Table 5.2](#) and shall permit assembly to polyvinyl chloride (PVC) conduit in a manner that provides acceptable strength for both the joint and the assembly. Sockets complying with the minimum dimensions specified in [Table 5.2](#) are considered to permit assembly to polyvinyl chloride (PVC) conduit in a manner that provides acceptable strength for both the joint and the assembly. Sockets that have dimensions less than the minimum dimensions specified in [Table 5.2](#) shall to be evaluated by the bending and pull tests in Bending Test, [7.2.8](#), and Pull Test, [7.2.9](#) to demonstrate their ability to permit assembly to polyvinyl chloride (PVC) conduit in a manner that provides acceptable strength for both the joint and the assembly.

Exception: A socket depth greater than the maximum specified in [Table 5.2](#) is acceptable if the fitting is marked in accordance with [9.2.3](#).

5.1.8 The throat diameter of a coupling and a fitting other than an internally and externally threaded adapter shall not be less than specified in [Table 5.1](#) as determined either by application of the limit gauges illustrated in [Figure 5.1](#) or by measurement as described in [5.1.10](#) and [5.1.11](#). The dimensions of the gauges are given in [Table 5.4](#) and [Table 5.5](#).

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Figure 5.1
Hardened tool steel limit gauges for throats of fittings



$\frac{1}{4}$ INCH FOR THE $\frac{1}{2}$ -2 TRADE SIZES

$\frac{1}{2}$ INCH FOR THE $2\frac{1}{2}$ -6 TRADE SIZES

SB0911A

Note – SI values for the dimensions in this figure are:

Inch	(mm)
$\frac{1}{4}$	(6.4)
$\frac{1}{2}$	(12.7)
1	(25.4)

Table 5.4
Dimensions of limit gauges for throats of fittings

Trade size of conduit	(metric designator)	For internally and externally threaded adapters				Diameter (Dg) of go gauge for factory-attached couplings that have stops and are for use with thin-wall PVC conduit,		Diameter (Dg) of go gauge for all field-attached couplings and for factory-attached couplings that have stops and are for use with heavy-wall PVC conduit and for fittings other than adapters,	
		Diameter (Dg) of go gauge,		Diameter (Dn) of no-go gauge,					
		in	(mm) ^a	in	(mm) ^a	in	(mm) ^a	in	(mm) ^a
1/2	(16)	0.5900	(14.986)	0.6230	(15.824)	0.7270	(18.466)	0.6290	(15.977)
3/4	(21)	0.7820	(19.863)	0.8250	(20.955)	0.8390	(21.311)	0.8330	(21.158)
1	(27)	0.9960	(25.298)	1.0500	(26.670)	1.2040	(30.582)	1.0580	(26.873)
1-1/4	(35)	1.3100	(33.274)	1.3810	(35.077)	1.5310	(38.887)	1.3910	(35.331)
1-1/2	(41)	1.5280	(38.811)	1.6110	(40.919)	1.7510	(44.475)	1.6210	(41.173)
2	(53)	1.9630	(49.860)	2.0680	(52.527)	2.2860	(58.064)	2.0780	(52.781)
2-1/2	(63)	2.3450	(59.593)	2.4700	(62.738)	2.6690	(67.793)	2.4830	(63.068)
3	(78)	2.9140	(74.016)	3.0690	(77.953)	3.3640	(85.446)	3.0820	(78.283)
3-1/2	(91)	3.3700	(85.598)	3.5490	(90.145)	3.7590	(95.479)	3.5970	(91.364)
4	(103)	3.8240	(97.130)	4.0270	(102.286)	4.2490	(107.925)	4.0750	(103.505)
5	(129)	4.7940	(121.768)	5.0480	(128.219)	5.0960	(129.438)	5.0960	(129.438)
6	(155)	5.7610	(146.329)	6.0660	(154.076)	6.1140	(155.296)	6.1140	(155.296)

^a A tolerance of ± 0.0005 inch (0.013 mm) applies.

Table 5.5
Diameters of limit gauges for throats of bushings

Trade size of conduit	(metric designator)	Diameter (Dg) of go gauge,		Diameter (Dn) of no-go gauge,	
		in ^a	(mm)	in ^a	(mm)
3/8	(12)	0.4430	(11.252)	0.4940	(12.548)
1/2	(16)	0.5590	(14.199)	0.6230	(15.824)
3/4	(21)	0.7410	(18.821)	0.8250	(20.955)
1	(27)	0.9430	(23.952)	1.0500	(26.670)
1-1/4	(35)	1.2410	(31.521)	1.3810	(35.077)
1-1/2	(41)	1.4480	(36.779)	1.6110	(40.919)
2	(53)	1.8590	(47.219)	2.0680	(52.527)
2-1/2	(63)	2.2210	(56.413)	2.4700	(62.738)
3	(78)	2.7600	(70.104)	3.0690	(77.953)
3-1/2	(91)	3.1920	(81.077)	3.5490	(90.145)
4	(103)	3.6220	(91.999)	4.0270	(102.286)
5	(129)	4.5410	(115.341)	5.0480	(128.219)
6	(155)	5.4570	(138.608)	6.0660	(154.076)

^a A tolerance of ± 0.0005 inch (0.013 mm) applies.

5.1.9 The curved surfaces of the limit gauges illustrated in [Figure 5.1](#) are to be ground and lapped to the diameters specified in [Table 5.4](#) within the tolerances specified in [Table 5.4](#). The handles for these gauges are not specified, nor is the means by which the handles are joined to the gauges. Each gauge for an internally threaded adapter is to have the letters "FEM" or some other designation on the same face on which the size appears.

5.1.10 When comparing the throat diameter of a finished fitting to the values in [Table 5.1](#), measurements are to be made by means of a machinist's inside micrometer caliper that is equipped with a ratchet. The calibration of the scale is to facilitate estimation of each measurement to 0.0001 inch (0.003 mm).

5.1.11 The throat diameter at any point in a fitting shall be equal to or greater than the applicable value specified in [Table 5.1](#). Four measurements of the throat diameter of each fitting are to be made to make certain that the smallest diameter has been included. Each measurement is to be estimated to the nearest 0.0001 inch (0.003 mm) and recorded. The smallest of all of the recorded diameters is to be rounded to the nearest 0.001 inch (0.03 mm). When rounding, an even number in the third decimal place is unchanged if the number in the fourth decimal place is five and there is no number or zero in the fifth place.

5.1.12 The throat diameter of the stop in an internally or externally threaded adapter shall be within the limits specified in [Table 5.6](#) as determined by application of the limit gauges illustrated in [Figure 5.1](#). The dimensions of the gauges are specified in [Table 5.4](#).

Table 5.6
Throat diameters of threaded adapters

Trade size of conduit	(metric designator)	Throat diameter, in (mm)			
		Maximum		Minimum	
1/2	(16)	0.622	(15.80)	0.591	(15.01)
3/4	(21)	0.824	(20.93)	0.783	(19.89)
1	(27)	1.049	(26.64)	0.997	(25.32)
1-1/4	(35)	1.380	(35.05)	1.311	(33.30)
1-1/2	(41)	1.610	(40.89)	1.529	(38.84)
2	(53)	2.067	(52.50)	1.964	(49.89)
2-1/2	(63)	2.469	(62.71)	2.346	(59.59)
3	(78)	3.068	(77.93)	2.915	(74.04)
3-1/2	(91)	3.548	(90.12)	3.371	(85.62)
4	(103)	4.026	(102.26)	3.825	(97.16)
5	(129)	5.047	(128.19)	4.795	(121.79)
6	(155)	6.065	(154.05)	5.762	(146.35)

5.2 Fabricated fittings

5.2.1 If a rigid polyvinyl chloride (PVC) conduit fitting is fabricated or machined from a length of PVC conduit, the conduit used shall comply with requirements in Sections [1 – 4](#) and [6](#), but the fittings need not be subjected to the tests specified in [7.2.3](#), [7.2.4](#), [7.2.5](#), [7.2.7](#), [7.2.8](#), and [7.2.9](#).

5.2.2 A rigid polyvinyl chloride (PVC) conduit fitting fabricated from a nonstandard size of rigid PVC pipe is acceptable. That pipe need not be investigated for compliance with all of the requirements applicable to rigid PVC conduit if:

- a) An acceptable compound is employed using the same extrusion techniques as are used for rigid PVC conduit; and
- b) The pipe is subjected to and complies with the extrusion-process requirements applicable to rigid PVC conduit.

5.2.3 If an offset rigid polyvinyl chloride (PVC) conduit fitting is fabricated or machined solely from a length of PVC conduit, the conduit used shall comply with requirements in Sections [1](#) – [4](#) and [6](#), prior to fabrication or machining.

5.2.4 An offset rigid polyvinyl chloride (PVC) conduit fitting that is fabricated or machined solely from a length of PVC conduit, need not comply with the minimum average inside diameter of Schedule 40 and 80 rigid PVC conduit requirements found in [Table 4.3](#), nor be subjected to the tests specified in [7.2.3](#), [7.2.4](#), [7.2.5](#), [7.2.7](#), [7.2.8](#), and [7.2.9](#).

5.3 Junction-box adapters

5.3.1 A junction-box adapter shall be capable of being secured by means of a solvent type cement in a hole that is field cut – drilled or sawn – in a wall of a polyvinyl chloride (PVC) box. The adapter shall have smooth, rounded surfaces and shall have a flange wide enough to completely cover the edges of the hole in the box. The flange shall be at least 1/8 inch (3.2 mm) wide on adapters for 1-1/2 (41) and smaller sizes of rigid PVC conduit and shall be at least 1/4 inch (6.4 mm) wide for larger trade sizes of conduit.

5.3.2 When assembled to a box with a coupling as intended, an adapter shall provide a positive end stop for rigid PVC conduit. The outside diameter of the adapter, at the point where it enters the coupling, shall be within the applicable limits specified in [Table 4.1](#) and [Table 4.2](#).

5.4 Expansion, expansion-deflection, or deflection joints

5.4.1 An expansion joint is intended to compensate only for linear thermal expansion of a span of rigid PVC conduit.

5.4.1.1 An expansion-deflection joint is intended to compensate for linear expansion and compensate for lateral or angular deflection in a span of rigid PVC conduit.

5.4.1.2 A deflection joint intends to compensate only for lateral or angular deflection in a span of rigid PVC conduit.

5.4.1.3 An expansion, expansion-deflection or deflection joint shall be capable of being connected to rigid PVC conduit or a coupling at both ends by means of a solvent type cement.

5.4.2 Unless a joint, which allows movement between the joint and adjacent conduit lengths is fastened at one end to rigid PVC conduit, a stop shall be provided to prevent the movable member of the joint from exposing either of the cut ends of the conduit lengths to which the joint is connected.

5.4.3 The inside end or ends of rigid PVC conduit and the joint at their interface, regardless of the adjustment position, shall be free of any snags that would impede fish tape or wires from being passed through the joint. The ends shall be beveled to remove any existing snags.

5.5 Threaded adapters

5.5.1 A threaded adapter shall be internally or externally threaded.

5.5.2 All threads shall be full and cleanly cut or molded and shall comply with Pipe Threads, General Purpose (Inch), ASME B1.20.1-1983.

5.5.3 The threaded portion shall be long enough so that the fitting complies with Bending Test, [7.2.8](#), and Pull Test, [7.2.9](#). There shall not be fewer than five full perfect threads.

5.5.4 The threads shall be straight or, if tapered, have a taper of 3/4 inch or less per foot (5 mm or less per 80 mm).

5.6 Service entrance head

5.6.1 A nonmetallic service-entrance head shall comply with the tests for Nonmetallic Service-Entrance Heads specified in [7.3](#).

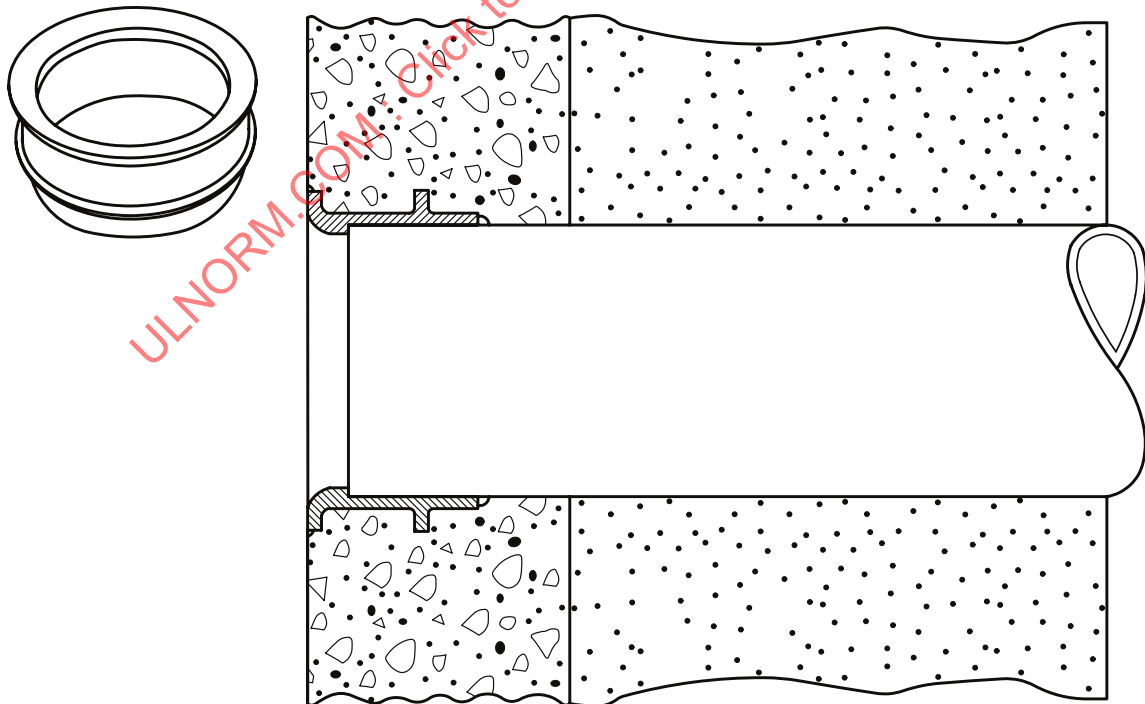
5.7 Wet-location fittings

5.7.1 A fitting intended for use in a wet location shall comply with the Wet-Locations Test, [7.3.2](#).

5.8 End bells

5.8.1 End bells shall be intended for connection to the end of rigid PVC conduit entering a manhole or handhole enclosure but not a junction box. See [Figure 5.2](#). An end bell fitting is not required to comply with the minimum thickness of the wall of the unthreaded portion as specified in [Table 5.2](#).

Figure 5.2
End bell application



5.9 Push-fit fittings

5.9.1 A push-fit fitting shall be constructed as described in [5.1](#).

5.9.2 A nonmetallic push-fit fitting shall comply with the tests for push-fit fittings specified in [7.6](#).

5.9.3 A push-fit fitting intended for use in a wet location shall comply with the Wet-Locations Test, [7.3.2](#).

5.9.4 A push-fit fitting intended to be installed, uninstalled and then reinstalled not more than 10 times may be marked for “re-use” or “reusable” when the fittings have subjected to the conditioning as indicated in [7.6.1.6](#) and yield compliant results when subjected to the performance tests of [7.6.1.1](#) through [7.6.1.5](#).

PERFORMANCE

6 Rigid PVC Conduit

6.1 General

6.1.1 Specimens of rigid PVC conduit shall be subjected to the tests specified in [Table 6.1](#). Modified tests, or additional tests other than those specified in [Table 6.1](#), may be determined necessary. Other test requirements to be considered include the installation of wires, resistance to arcing, and dimensional stability.

Table 6.1
Tests for rigid PVC conduit

Test	Location
Tensile strength	6.2
Extrusion	6.3
Water absorption	6.5
Resistance to impact	6.6
Identification of compounds	6.7
Deflection under load	6.8
Resistance to crushing	6.9
Integral couplings	6.10
Flame	6.11
Directional boring underground conduit – Schedule 40 and 80	6.12
Joint water tightness	6.12.1
Joint separation	6.12.2
Pipe stiffness	6.12.3
Elastomeric materials accelerated aging	6.12.4
Resistance to specific reagents	6.13
Sunlight resistance	6.14
Schedule 40 and 80 for use with 90° wire	6.15
Permanence of printing	6.16
Stiffness of Type EB	6.17

6.1.2 Schedule 40 rigid PVC conduit intended for underground use only is not required to be subjected to performance tests for Flame, [6.11](#), or Sunlight Resistance, [6.14](#).

6.1.3 Unless otherwise specified all specimens for each of the performance tests in this standard shall be preconditioned for at least 24 hours, in still air, at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$).

6.2 Tensile strength

6.2.1 Preparation of specimens

6.2.1.1 General

6.2.1.1.1 The average tensile strength of three aged specimens of finished rigid PVC conduit shall equal or exceed 95 percent of the average tensile strength of three unaged specimens of conduit. The procedures (similar to those described in the Standard Test Method for Tensile Properties of Plastics, ASTM D 638) for preparing and conditioning the specimens, for making the measurements, and for calculating the average tensile strengths are indicated in [6.2.1](#) – [6.2.3](#). The average tensile strength of the unaged specimens shall comply with the limit established for the compound used but, in any case, shall not be less than:

- a) 5,000 psi (34.5 MN/m^2) (3.45 kN/cm^2) (3515 gf/mm^2) for Schedule 40 and 80 rigid PVC conduit and
- b) 4000 lbf/in² (27.6 MN/m^2 or 2.76 kN/cm^2 or 2812 gf/mm^2) for Type A and EB rigid PVC conduit.

6.2.1.1.2 Six specimens are to be cut from sample lengths of each trade size of finished conduit. Each cut is to be made in a plane perpendicular to the longitudinal axis of the conduit. Each trade size is to be tested on the available power-driven machine. Each sample of:

- a) Schedule 40, Schedule 80, Type A conduit is to be 15 inches (380 mm) long;
- b) Each sample of Type EB rigid PVC conduit is to be minimum 8-1/2 inches (216 mm) long.

6.2.1.1.3 Measurements are to be made by means of two machinist's micrometer calipers, each with a ratchet and a flat-ended spindle. The calibration of the scale on each caliper is to facilitate estimation of each measurement to 0.0001 inch or 0.001 mm. The anvil is to be:

- a) Hemispherical on the caliper used for thickness measurements of each sample of Schedule 40, Schedule 80, Type A and EB rigid PVC conduit and
- b) Flat on the caliper used for diameter measurements of each sample of Schedule 40, Schedule 80 and Type A rigid PVC conduit.

6.2.1.1.4 The rigid PVC conduit is to be smooth and clean wherever it is touched by a spindle or anvil. While measurements are being made, the conduit and the air around it are to be in thermal equilibrium with one another at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$).

6.2.1.1.5 The wall thickness is to be measured at each end of each specimen by means of the caliper with the hemispherical anvil. At least four measurements are necessary at each end to make certain that the thickest and thinnest parts of the wall are found. Each measurement is to be estimated to the nearest 0.0001 inch or 0.001 mm and recorded. The average of all of the recorded thicknesses is to be determined to the nearest 0.001 inch or 0.01 mm for each specimen and recorded as T.

6.2.1.2 Schedule 40 and 80 and Type A

6.2.1.2.1 The outside diameter is to be measured at the center and each end of each specimen of Schedule 40, Schedule 80 and Type A conduit by means of the caliper with the flat anvil. At least four measurements (every 45 degrees) are necessary at each location to make certain that the largest and

smallest diameters are found. Each measurement is to be estimated to the nearest 0.0001 inch or 0.001 mm and recorded. The average of all of the recorded diameters is to be determined to the nearest 0.001 inch or 0.01 mm for each specimen and recorded as D .

6.2.1.2.2 The center 2-1/4 inch (57 mm) section of each specimen of Schedule 40, Schedule 80 and Type A conduit is to be reduced in diameter as illustrated in [Figure 6.1](#). The diameter D_r to which the section is to be reduced is to be determined from the expression:

$$D_r = D - 0.8T$$

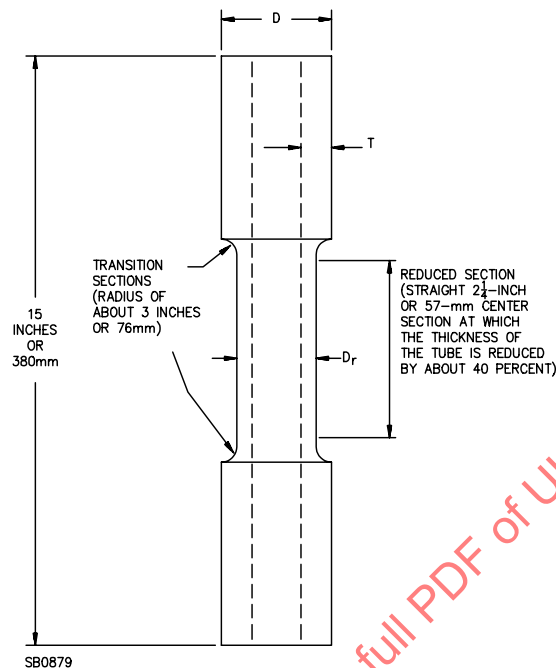
in which:

D is the outside diameter as determined in [6.2.1.2.1](#), and

T is the average thickness as determined in [6.2.1.1.5](#)

6.2.1.2.3 The resulting value (D_r) is to be recorded to the nearest 0.001 inch or 0.01 mm. With care being taken to maintain concentricity, a lathe is to be used to reduce the center section of each specimen of Schedule 40, Schedule 80 and Type A conduit approximately to D_r . As indicated in [Figure 6.1](#), each end of the reduced section is to be joined to the outside diameter, D , by a transition section having a radius of approximately 3 inches (76 mm). The transition and reduced sections are to be tangent to one another. Any marks left by the machining operation are to be removed by light sanding with No. 00 or finer abrasive paper. The direction of sanding is to be parallel to the longitudinal axis of the resulting specimen. On each specimen, the finished surface of the reduced section is to be smooth and is not to have any scratches or other visible imperfections. The diameter measured at any point in the straight 2-1/4 inch (57 mm) portion of the reduced section of any specimen is not to deviate more than 0.001 inch or 0.01 mm from the diameter measured at any other point of the straight portion of the reduced section. The diameter of the straight portion of the reduced section is to be measured in the manner indicated in [6.2.1.2.1](#) and is to be recorded as D_r for each specimen.

Figure 6.1
Specimen of PVC conduit



Note: The transition and reduced sections are to be mutually tangent.

6.2.1.2.4 The cross-sectional area of the straight portion of the reduced section is to be calculated and recorded in square inches or in mm² for each specimen Schedule 40, Schedule 80 and Type A conduit from the following expression. The area in m² can be obtained by multiplying the area calculated in mm² by 10⁻⁶. The area in cm² can be obtained by multiplying the area calculated in mm² by 10⁻⁴.

$$A = 0.7854(D_r^2 - D^2 - 4T^2 + 4DT)$$

in which:

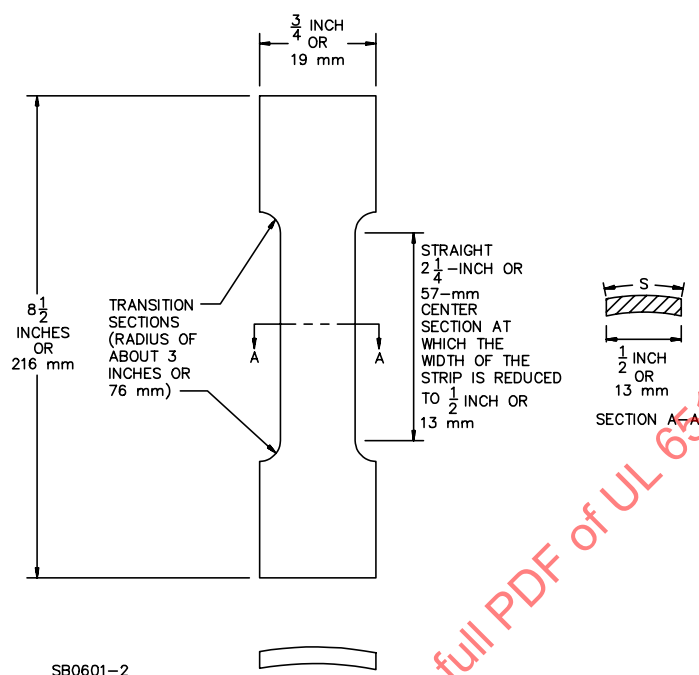
D_r , D , and T are as indicated in [6.2.1.2.2](#).

6.2.1.3 Type EB

6.2.1.3.1 A longitudinal strip 3/4 inch (19 mm) wide is to be cut from each tube of Type EB rigid PVC conduit. Each cut is not to be made radially but is to be made in a plane parallel to the longitudinal axis of the tube. The center 2-1/4-inch (57-mm) section of each strip is to be reduced in width to 1/2 inch (13 mm) as indicated in [Figure 6.2](#), and each end of the reduced-width section is to be joined to the wider end section by a transition section having a radius in the neighborhood of 3 inches (76 mm). The transition and reduced-width sections are to be tangent to one another. As indicated in Section A-A of [Figure 6.2](#), each edge of the reduced-width section is to be in a plane parallel to the longitudinal axis of the resulting specimen. Any marks left by the machinery operation are to be removed by light sanding with No. 00 or finer abrasive paper. The direction of sanding is to be parallel to the longitudinal axis of the specimen. On each specimen, the finished surface of each edge of the reduced-width section is to be smooth and without any scratches or other visible imperfections. The width measured at any point in the straight 2-1/4-inch (57-mm) portion of the reduced-width section of any specimen is not to deviate more than 0.001 inch or 0.01 mm from the width measured at any other point of the straight portion of the reduced-width section.

Figure 6.2

Shape and dimensions of curved-strip specimen of Type EB rigid PVC conduit



Note: The transition and reduced sections are to be mutually tangent.

6.2.1.3.2 The curved dimension S (see Figure 6.2) of the reduced-width section of each specimen of Type EB rigid PVC conduit is to be measured by means of a flexible measuring tape. The measurement is to be made at the center of the reduced-width section and is to be recorded as S for each section.

6.2.1.3.3 The cross-sectional area of the straight portion of the reduced section is to be calculated and recorded in square inches (mm^2) for each curved-strip specimen of Type EB rigid PVC conduit from the expression:

$$A = ST$$

in which:

S is the curved dimension as determined in 6.2.1.3.2, and

T is as defined previously.

6.2.1.3.4 The area in m^2 can be obtained by multiplying the area calculated in mm^2 by 10^{-6} . The area in cm^2 can be obtained by multiplying the area calculated in mm^2 by 10^{-4} .

6.2.2 Conduct of test

6.2.2.1 After performing the applicable measurements in 6.2.1, three specimens are to be supported in a full-draft circulating-air oven preheated at a full draft to $113.0 \pm 1.0^\circ\text{C}$ ($235.4 \pm 1.8^\circ\text{F}$). The specimens are to be arranged and supported so that they do not touch each other or the walls of the oven. One method is to space the specimens on an open-mesh shelf about 2 inches (50 mm) above the floor of the oven to maintain the full circulation of air around and through the specimens. The oven is to be operated at full

draft for 168 hours at $113.0 \pm 1.0^{\circ}\text{C}$ ($235.4 \pm 1.8^{\circ}\text{F}$). The specimens are then to be removed from the oven and cooled in still air.

6.2.2.2 No sooner than 16 hours and no later than 96 hours after the three specimens mentioned in [6.2.2.1](#) are removed from the oven, all six specimens are to be tested in succession. While the testing is in progress, the specimens, the test equipment, and the surrounding air are to be in thermal equilibrium with one another at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$).

6.2.2.3 A right-circular metal plug is to be inserted in each end of each tubular specimen, if necessary, to keep the specimens from being crushed by the grips on the testing machine. Each plug is to fit snugly for its entire length and is to extend 1 inch (25 mm) farther into the specimen than the end of the grips.

6.2.2.4 Each tubular and curved-strip specimen is to be tested until it parts on a power-driven machine on which the grips separate at the rate of $1/2 \pm 1/8$ inch (10.0 ± 2.5 mm) per minute. The maximum load L observed for each specimen is to be recorded in pounds force or newtons or gram force.

6.2.3 Results

6.2.3.1 The tensile strength of each specimen is to be calculated by dividing the maximum load L by the cross-sectional area A. The average tensile strengths of the three conditioned specimens and of the three unaged specimens are to be determined and recorded for comparison with the requirements in [6.2.1.1.1](#).

6.3 Extrusion

6.3.1 The processes of extrusion shall result in finished rigid PVC conduit whose surfaces do not exhibit any evidence of incomplete fusion after immersion of the conduit in anhydrous acetone when specimens are prepared and tested as indicated in [6.3.2](#) and [6.3.3](#). These procedures are similar to those described in the Standard Test Method for Adequacy of Fusion of Extruded Poly (Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion, ASTM D 2152.

6.3.2 Acetone [dimethyl ketone ($\text{CH}_3)_2\text{CO}$] is an extremely volatile liquid whose vapors form explosive mixtures with air. Open flames, glowing cigarettes, and other sources of ignition must be kept away. Acetone and acetone-PVC products are toxic, damaging to clothing, and rapidly absorb moisture from air, the skin, and other sources. They should not touch the skin, nor should the vapors of these substances be inhaled. Because acetone with moisture is ineffective, the test is to be conducted with each specimen in its own covered container. Acetone can be dehydrated by filtering it through anhydrous calcium sulphate (CaSO_4).

6.3.3 A specimen 1 inch (25 mm) long is to be cut from a length of finished rigid PVC conduit. With prudent attention to health and fire risks (see [6.3.2](#)), the specimen is to be immersed in anhydrous acetone of the American Chemical Society reagent grade for 20 minutes at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and then examined. For conduit having a nominal wall thickness greater than 0.125 inch (3.18 mm), a portion of the wall at one location shall be removed so that approximately 1/16 inch (1.5 mm) remains. Removal shall be affected by filing, sanding or another means at a rate that does not result in localized heating of the surface. There shall be no evidence of flaking on most of any surface (interior, exterior, or that exposed by material removal) of the sample. Flaking on the cut edges is to be disregarded. See [Figure 6.3](#) for examples.

Figure 6.3
Samples after extrusion/molding-process test



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NOTES –

1. Upper left corner – Acceptable flaking (mild and covers only part of surface).
2. Upper right corner – Unacceptable flaking and peeling (severe and covers most surfaces).
3. Lower left corner – Acceptable weld line (uniform width and depth with no cracks).
4. Lower right corner – Unacceptable weld line (uneven depth and definite crack in center).

6.4 Low-temperature handling

6.4.1 Deleted

6.4.2 Deleted

6.5 Water absorption

6.5.1 Finished rigid PVC conduit shall not absorb any more water than 0.50 percent of its own weight while immersed for 24 hours in distilled water. The test is to be done as indicated in [6.5.2](#) – [6.5.4](#) (similar to the 24-hour immersion in Standard Test Method for Water Absorption of Plastics, ASTM D 570).

6.5.2 Specimens are to be preconditioned by drying in a full-draft circulating-air oven at a temperature of $50.0 \pm 3.0^{\circ}\text{C}$ ($122.0 \pm 5.4^{\circ}\text{F}$) for 24 hours, after which they are to remain in still air at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) for 24 hours.

6.5.3 A clean, dry specimen of finished rigid PVC conduit at least 6 inches (150 mm) long is to be preconditioned as indicated in [6.5.2](#); weighed (W_1) to within 5 mg of balance; and then immersed for 24 hours in distilled water that is at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$). The specimen is then to be removed from the water, dried quickly inside and out with a clean piece of soft lintless cloth, and immediately reweighed (W_2) to within 5 mg of balance. W_2/W_1 shall not be larger than 1.0050.

6.5.4 If a sample is known to contain, or is suspected of containing, appreciable amounts of water-soluble material, two specimens are to be preconditioned by drying in a full-draft circulating-air oven at a temperature of $50.0 \pm 3.0^{\circ}\text{C}$ ($122.0 \pm 5.4^{\circ}\text{F}$) for 24 hours, cooled in a desiccator for 24 hours, and immediately weighed (W_1). The specimens are then to be immersed in distilled water for 24 hours with the water at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$). Immediately following this immersion, the specimens are to be reconditioned for 24 hours in the oven at $50.0 \pm 3.0^{\circ}\text{C}$ ($122.0 \pm 5.4^{\circ}\text{F}$), cooled in a desiccator for 24 hours, and immediately reweighed (W_2). The rigid PVC conduit is to be separately evaluated if W_2 is less than W_1 .

6.6 Resistance to impact

6.6.1 A crack or tear longer than 1/32 inch (0.8 mm) shall not appear in seven out of ten finished rigid PVC conduit specimens as the result of the impact described in [6.6.2](#).

6.6.2 Ten 6-inch (150-mm) specimens without cracks, tears, or other imperfections are to be cut from finished lengths of each trade size of rigid PVC conduit. The specimens are to be conditioned in air at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) for a minimum period of 4 hours before being tested. The specimens are to be tested separately, within 15 seconds after conditioning, while resting on a solid, flat, steel plate that is at least 1/2 inch (13 mm) thick and is firmly anchored with its upper surface horizontal. A protective cage is to surround the plates and specimen to reduce the likelihood of injury from pieces of broken conduit in the event that the conduit flies apart. A steel weight in the form of a solid, right-circular cylinder with a flat impact face having rounded edges is to fall freely through a vertical guide from the height indicated in [Table 6.2](#). For Schedule 40, Type A and EB rigid PVC conduit, the weight shall be 20 lbs (9.1 kg) and the cylinder shall have a diameter of 2 inches (51 mm). For Schedule 80 conduit the weight shall be 75 lb (34 kg) and the cylinder shall have a diameter of 6 inches (150 mm). The flat face of the weight is to strike the center of the specimen across the diameter and along the longitudinal axis once (provision is to be made for keeping the weight from striking the specimen more than once).

6.6.3 The rigid PVC conduit shall not crack or tear longer than 1/32 inch (0.8 mm) along the outer surface of more than three of the ten specimens.

Table 6.2
Impact test

Trade size	(Metric designation)	Height of the face of the weight above the specimen before the weight is released							
		Schedule 40		Schedule 80		Type A PVC		Type EB PVC	
		feet	(m)	feet	(m)	feet	(m)	feet	(m)
1/2	16	2-1/2	0.762	1-1/4	0.381	1-1/2	0.457	a	a
3/4	21	4	1.22	1-1/4	0.381	2	0.610	a	a
1	27	5	1.52	2	0.610	4	1.22	a	a
1-1/4	35	6	1.83	2-1/4	0.686	6	1.83	a	a
1-1/2	41	7-1/2	2.29	2-1/2	0.762	7-1/2	2.29	a	a
2	53	9-1/2	2.90	4	1.22	9-1/2	2.90	2-1/2	0.762
2-1/2	63	10-1/2	3.20	5	1.52	10-1/2	3.20	2-1/2	0.762
3 – 6	78 – 155	11	3.35	7	2.13	11	3.35	2-1/2	0.762

^a These requirements will be added as these sizes are investigated and determined to be acceptable.

6.7 Identification of compounds

6.7.1 The material of which rigid PVC conduit is constructed shall be subjected to the infrared spectroscopy (IR), thermogravimetric analysis (TGA), and differential scanning calorimetry (DSC) tests specified in accordance with Polymeric Materials – Short Term Property Evaluations, UL 746A.

6.8 Deflection under load – Schedule 40 and 80 and Type A

6.8.1 General

6.8.1.1 The average temperature at which simply-supported, center-loaded bar specimens machined from finished Schedule 40, Schedule 80 and Type A rigid PVC conduit deflect 0.010 inch (0.25 mm) shall not be lower than:

- a) 70.0°C (158.0°F) at a stress of 66 psi (455 kN/m²) (45.5 N/cm²) (46.4 gf/mm²) and
- b) 62.0°C (143.6°F) at a stress of 264 psi (1.82 MN/m²) (182 N/cm²) (186 gf/mm²).

6.8.1.2 The specimens referenced in [6.8.1.1](#) are to be prepared and the test conducted as indicated in [6.8.2](#) – [6.8.4](#).

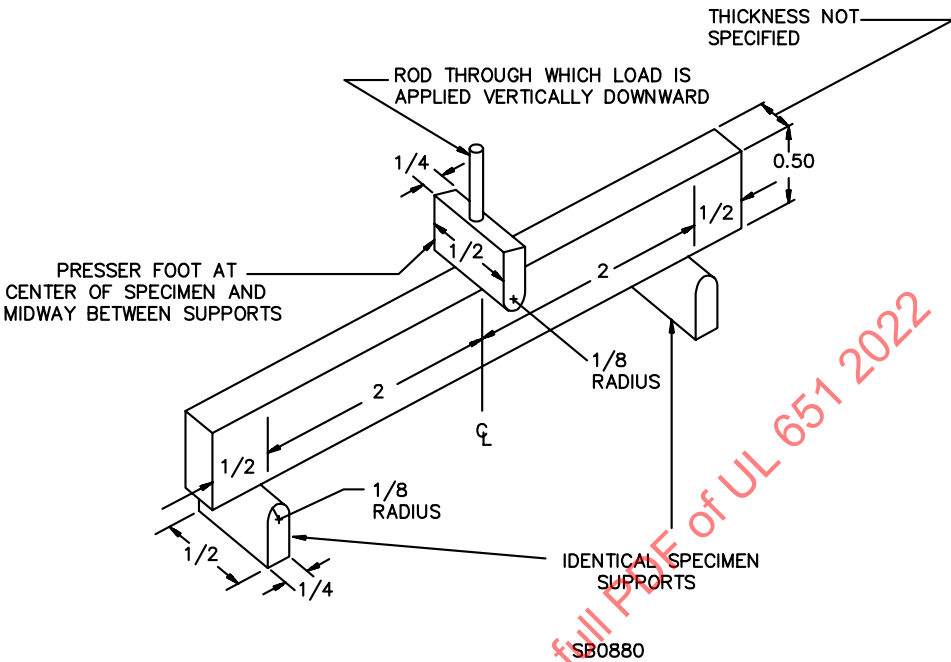
6.8.2 Preparation of specimens

6.8.2.1 At least six rectangular specimens that are of any convenient but uniform thickness, 0.50 inch (13 mm) high and 5.0 inches (127 mm) long, are to be machined from sample lengths of finished of Schedule 40, Schedule 80 and Type A rigid PVC conduit of the 4 (103) or larger trade size. All adjacent surfaces of each specimen are to be mutually perpendicular and smooth, flat, and without any visible imperfections such as scratches.

6.8.3 Test apparatus

6.8.3.1 The apparatus is to consist of a container in which a specimen can be supported and loaded as shown in [Figure 6.4](#) while immersed in a liquid heat-transfer medium as shown in [Figure 6.5](#). The coefficients of linear thermal expansion of the rod through which the load is applied, and of the vertical members that connect the specimen supports to the upper plate, are to be equal. A dial micrometer, on whose scale the smallest division represents 0.0005 inch (0.01 mm), is to be coupled to the loading rod for the purpose of measuring the deflection at the center of the specimen.

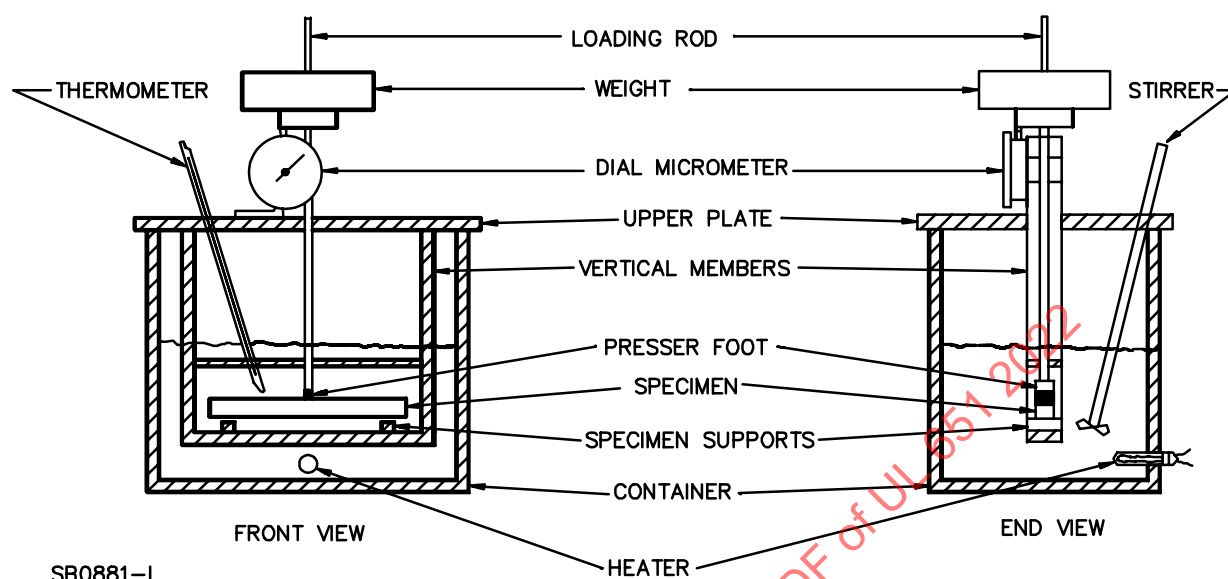
Figure 6.4
Details of support and loading of specimen



All dimensions are in inches with mm tabulated below

Dimension in drawing in inches	Dimension in mm
1/8	3
1/4	6.5
1/2	13
2	51

Figure 6.5
Test apparatus for deflection



6.8.3.2 The liquid used as the heat-transfer medium is to be one that does not affect the rigidity of the specimen at room or elevated temperature.

6.8.3.3 An immersion or other heater, whose output is adjusted by a means such as a rheostat or a variable transformer, is to be provided for heating the liquid at the rate of $2.00 \pm 0.20^{\circ}\text{C}$ ($3.60 \pm 0.36^{\circ}\text{F}$) per minute. A means is to be provided for stirring or otherwise circulating the liquid continuously during the heating period.

6.8.3.4 An accurate mercury or other thermometer covering a range of at least $20 - 75^{\circ}\text{C}$ ($68 - 167^{\circ}\text{F}$) is to be mounted where its bulb is close to but not touching the top surface of a specimen whenever a specimen is in place. The bulb is not to be farther away from a specimen than $1/8$ inch (3 mm).

6.8.3.5 A device that does not affect the load on a specimen may be included in the apparatus to disconnect the heater and energize a lamp, bell, or other indicator when a deflection of 0.010 inch (0.25 mm) occurs.

6.8.4 Conduct of test

6.8.4.1 A specimen is to be placed as indicated in [Figure 6.4](#) and [Figure 6.5](#) with the presser foot not touching the specimen. The liquid is to be poured into the container to a depth that covers the thermometer to the level specified in its calibration. The stirring or circulating device is to be started and the temperature is to be noted. The apparatus, specimen, and liquid are to be in thermal equilibrium with one another and with the surrounding air at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) before proceeding further.

6.8.4.2 The total force, F , to be exerted by the presser foot on a specimen is to be determined from whichever of the following formulas is applicable. In each case, the weight W that is to be added to the loading rod to make the presser foot bear on a specimen with force F is equal to F minus the weight of the loading rod minus the force of the spring in the dial micrometer.

$$\text{grams } F_{66\text{ psi}} = 19,958 \frac{T_{in} H_{in}^2}{L_{in}}$$

in which:

$F_{66\text{ psi}}$ is the force in grams to stress the specimen to 66 psi;

T_{in} is the measured thickness of the specimen in inches;

H_{in} is the measured height of the specimen in inches; and

L_{in} is the measured distance between the centers of the specimen supports in inches.

$$\text{newtons } F_{455\text{ kN/m}^2} = 0.3 \frac{T_{mm} H_{mm}^2}{L_{mm}}$$

in which:

$F_{455\text{ kN/m}^2}$ is the force in newtons to stress the specimen to 455 kN/m² (45.5 N/cm²);

T_{mm} is the measured thickness of the specimen in millimeters;

H_{mm} is the measured height of the specimen in millimeters; and

L_{mm} is the measured distance between the centers of the specimen supports in millimeters.

$$\text{grams } F_{46.4\text{ gf/mm}^2} = 31 \frac{T_{mm} H_{mm}^2}{L_{mm}}$$

in which:

$F_{46.4\text{ gf/mm}^2}$ is the force in grams to stress the specimen to 46.4 gf/mm² and

T_{mm} , H_{mm} , and L_{mm} are as explained previously.

6.8.4.3 The presser foot is to be lowered gently and left to bear on the specimen for 5 minutes (no waiting period is necessary if it is known that the material of which the specimen is made does not creep appreciably in 5 minutes). The scale on the dial micrometer is then to be adjusted to zero and the heater is to be energized to raise the temperature of the liquid at the rate of 2.00 ± 0.20°C (3.60 ± 0.36°F) per minute. The heating is to continue until the micrometer indicates that the specimen is deflected 0.010 inch (0.25 mm), at which point the temperature is to be noted and recorded.

6.8.4.4 The procedure in [6.8.4.1](#) – [6.8.4.3](#) is to be repeated on two more specimens of Schedule 40, Schedule 80 and Type A rigid PVC conduit. The average of the three temperatures shall not be lower than 70.0°C (158.0°F).

6.8.4.5 After the apparatus has cooled, the procedure in [6.8.4.1](#) – [6.8.4.4](#) is to be repeated on the second set of three specimens of Type A PVC conduit but with the presser foot bearing on a specimen

with a force that stresses the specimen to 264 psi (1.82 MN/m² or 182 N/cm² or 1856 gf/mm²). The total force F_{264} to be exerted by the presser foot is to be determined from whichever of the following formulas is applicable:

$$\text{grams } F_{264 \text{ psi}} = 79,832 \frac{T_{in} H_{in}^2}{L_{in}}$$

in which:

$F_{264 \text{ psi}}$ is the force in grams to stress the specimen to 264 psi,

T_{in} is the measured thickness of the specimen in inches,

H_{in} is the measured height of the specimen in inches, and

L_{in} is the measured distance between the centers of the specimen supports in inches.

$$\text{newtons } F_{1.82 \text{ MN/m}^2} = 1.2 \frac{T_{mm} H_{mm}^2}{L_{mm}}$$

in which:

$F_{1.82 \text{ MN/m}^2}$ is the force in newtons to stress the specimen to 1.82 MN/m² or 182 N/cm²,

T_{mm} is the measured thickness of the specimen in mm,

H_{mm} is the measured height of the specimen in mm, and

L_{mm} is the measured distance between the centers of the specimen supports in mm.

$$\text{grams } F_{1856 \text{ gf/mm}^2} = 1237 \frac{T_{mm} H_{mm}^2}{L_{mm}}$$

in which:

$F_{1856 \text{ gf/mm}^2}$ is the force in grams to stress the specimen to 1856 gf/mm² and

T_{mm} , H_{mm} , and L_{mm} are as explained above.

6.8.4.6 The average of the three temperatures shall not be lower than 62.0°C (143.6°F).

6.9 Resistance to crushing – Schedule 40 and 80 and Type A

6.9.1 Six-inch (150-mm) specimens of finished rigid PVC conduit shall not flatten under the load indicated in [Table 6.3](#) to the point where they buckle. The minor axis measured inside each loaded specimen shall not be less than 70 percent of the inside diameter of the specimen measured before loading. The test is to be done as indicated in [6.9.2](#) (similar to the procedure described in Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading, ASTM D 2412).

6.9.2 Three 6-inch (150-mm) specimens are to be cut from finished lengths of each size of rigid PVC conduit. The specimens, the testing machine, and the surrounding air are to be in thermal equilibrium with one another at a temperature of 23.0 ± 2.0°C (73.4 ± 3.6°F) during the test. The inside diameter of each

specimen is to be measured. The specimens are then to be tested separately between a pair of rigid, flat, steel plates that are at least 6 inches (150 mm) long and are horizontal and parallel to one another. One plate is to be moved toward the other at the rate of $1/2 \pm 1/8$ inch (10.0 $\pm$ 2.5 mm) per minute, until the load specified in [Table 6.3](#) is applied as indicated on the dial on the machine. The rigid PVC conduit shall show no signs of pulling away from contact with either plate during or after application of the load (buckling). The minor axis measured inside any flattened specimen shall not be less than the [Table 6.3](#) percentage of the inside diameter of that specimen as measured before loading.

Table 6.3
Load for crushing test

Trade Size	(metric design.)	Load for a 6-inch (150-mm) specimen								
		Schedule 40 (70) ^a			Schedule 80 (70) ^a			Type A (70) ^a		
		lbf	N	kgf	lbf	N	kgf	lbf	N	kgf
1/2	16	1000	4450	453.6				300	1334	136
3/4	21	1000	4450	453.6				300	1334	136
1	27	1000	4450	453.6				300	1334	136
1-1/4	35	1000	4450	453.6				300	1334	136
1-1/2	41	750	3336	340.0				350	1557	159
2	53	700	3113	317.5	2000 for all sizes	8896 for all sizes	907 for all sizes	450	2000	204
2-1/2	63	1000	4450	453.6				425	1890	193
3	78	1000	4450	453.6				450	2000	204
3-1/2	91	1000	4450	453.6				550	2446	249
4	103	900	4003	408.2				525	2335	238
5	129	850	3780	385.5				b	b	b
6	155	850	3780	385.5				b	b	b

^a The figure in parentheses is the percentage of its original length to which the minor axis of the loaded specimen can be reduced by the load.

^b These requirements will be added as these sizes are determined to be acceptable

6.10 Tests on integral couplings – Schedule 40 and 80 and Type EB

6.10.1 Extrusion

6.10.1.1 One complete integral coupling of each trade size of Schedule 40, Schedule 80 and Type EB rigid PVC conduit shall be subjected to the extrusion-molding process test as described in Extrusion Process, [6.3](#).

6.10.2 Low-temperature handling

6.10.2.1 *Deleted*

6.11 Flame test – Schedule 40 and 80

6.11.1 General

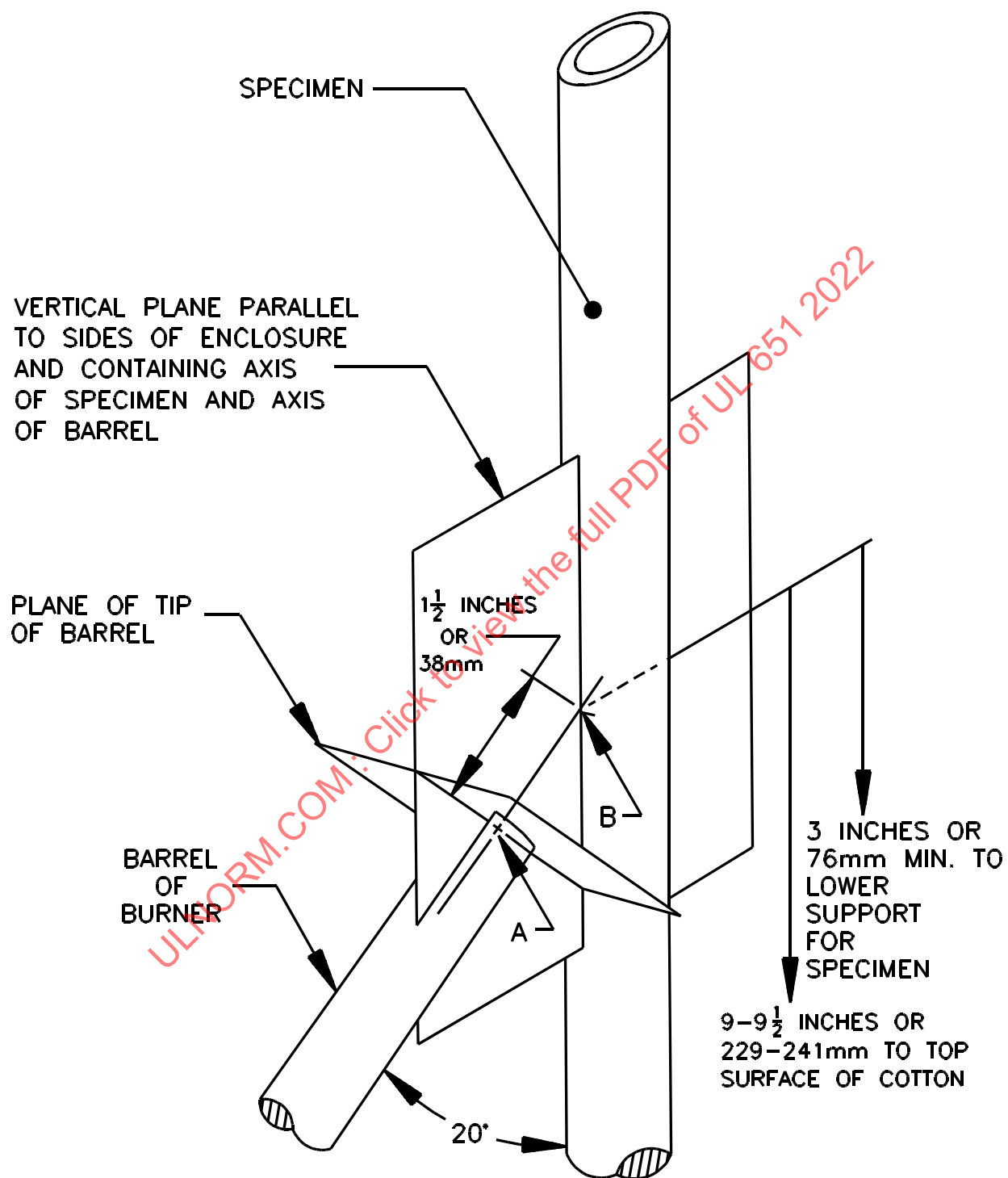
6.11.1.1 Vertical specimens of the finished Schedule 40, Schedule 80 rigid PVC conduit shall not flame for longer than 5 seconds following any of three 60-second applications of flame, the period between applications being 30 seconds. The conduit shall not be capable of igniting combustible materials in its vicinity during, between, or after the three applications of the test flame (see [6.11.4.1](#)).

6.11.2 Preparation

6.11.2.1 This test is to be performed on at least 3 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 rigid PVC conduit is to be secured with its longitudinal axis vertical in the center 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 inner cone of the test flame touches the specimen (as shown in [Figure 6.6](#)).

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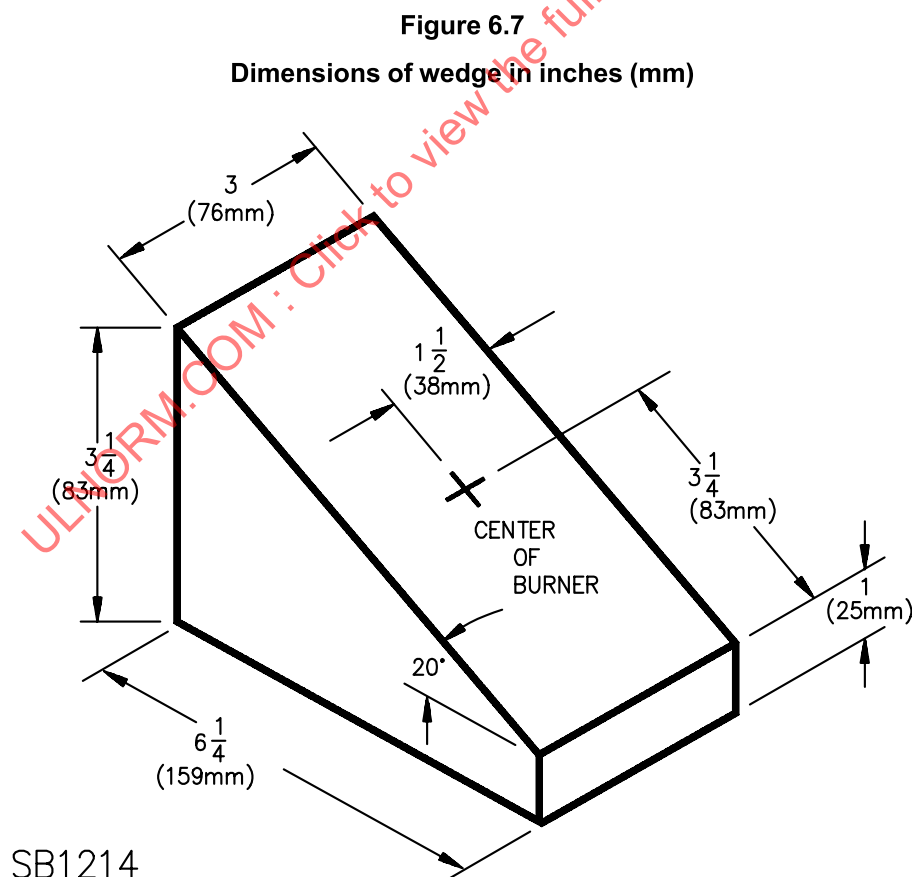
Figure 6.6
Essential dimensions in inches and mm for flame test



SC1808

6.11.2.2 Tirrill gas burner (such a burner differs from a Bunsen burner in that the air and gas flows are adjustable) with a gas pilot light attached is to supply the flame. The barrel of the burner is to extend 4 inches (102 mm) above the air inlets and its inside diameter is to be $\frac{3}{8}$ inch (9.5 mm). While the barrel is vertical and the burner is well away from the specimen, the overall height of the flame is to be adjusted to approximately 4 – 5 inches (100 – 125 mm). The blue inner cone is to be 1-1/2 inches (38 mm) high and the temperature at its tip is to be 816°C (1500°F) or higher as measured using a chromel-alumel (nickel-chromium and nickel-manganese-aluminum) thermocouple. Without disturbing the adjustments for the height of the flame, the valve supplying gas to the burner flame and the separate valve supplying gas to any pilot flame are to be closed.

6.11.2.3 A wedge (see [Figure 6.7](#)) is to be provided for tilting the barrel 20 degrees from the vertical while the longitudinal axis of the barrel remains in a vertical plane. The burner is to be secured to the wedge and the assembly is to be placed in an adjustable support jig. A layer of untreated surgical cotton $\frac{1}{4}$ – 1 inch (6 – 25 mm) thick is to be placed on the wedge and around the base of the burner. The jig is to be adjusted toward one side or the other of the enclosure to place the longitudinal axis of the barrel in the vertical plane that contains the longitudinal axis of the specimen. The plane is to be parallel to the sides of the enclosure. The jig shall also be adjusted toward the rear or front of the enclosure to position the point A, which is the intersection of the longitudinal axis of the barrel with the plane of the tip of the barrel, 1-1/2 inches (38 mm) from the point B at which the extended longitudinal axis of the barrel meets the outer surface of the specimen. Point B is the point at which the tip of the blue inner cone is to touch the center of the front of the specimen. The specimen is to be adjusted vertically to keep point B from being any closer than 3 inches (76 mm) to the lower clamp or other support for the specimen.



6.11.2.4 In the absence of a gas pilot light on the burner, the support for the burner and wedge is to be arranged to enable the burner to be quickly removed from and precisely returned to the position described

in [6.11.2.3](#) without disturbing the layer of cotton on the floor of the enclosure or the cotton on the wedge and around the base of the burner.

6.11.3 Conduct of test

6.11.3.1 If the burner has a gas pilot light, the valve supplying gas to the pilot is to be opened and the pilot lit. If the burner does not have a gas pilot light, the burner is to be supported as indicated in [6.11.2.4](#) in a position away from the specimen and then lit. This operation and the remainder of the test are to be conducted under a forced-draft exhaust hood or cabinet operating to remove smoke and fumes, but without drafts that affect the flame.

6.11.3.2 If the burner has a gas pilot light, the valve supplying gas to the burner is to be opened to apply the flame to the specimen automatically. This valve is to be held open for 60 seconds and then closed for 30 seconds. This procedure is to be repeated twice for a total of 3 applications of flame to the specimen.

6.11.4 Evaluation of results

6.11.4.1 The rigid PVC conduit is to be considered capable of conveying flame to combustible materials in its vicinity if any specimen:

- a) Emits 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) Continues to flame longer than 5 seconds after any application of the gas flame; or
- c) Is completely consumed during or after any application of the gas flame.

6.12 Directional boring underground conduit – Schedule 40 and 80

6.12.1 Joint water tightness

6.12.1.1 Coupled rigid PVC conduit shall not leak when tested in accordance with [6.12.1.2](#).

6.12.1.2 A 12.0 $\pm$ 0.125 inch (300 $\pm$ 3 mm) length of rigid PVC conduit shall be inserted into the integral coupling of the same length of conduit according to the manufacturer's installation instructions. In the case of a non-integral coupling, two 12.0 $\pm$ 0.125 inch (300 $\pm$ 3 mm) lengths of conduit shall be inserted into the coupling according to the manufacturer's instructions. One end of the assembly shall be capped with an enclosure. The assembly shall be placed in the vertical position, with the sealed end at the bottom, and filled with tap water. After a minimum of 4 hours, the specimen shall be visually examined to determine if there is any evidence of leakage at the joint.

6.12.2 Joint separation

6.12.2.1 Pull test

6.12.2.1.1 A joint (conduit and socket) shall not separate nor show a decrease in pressure when tested in accordance with [6.12.2.1.2](#).

6.12.2.1.2 One joint in each trade size is to be assembled as intended. The assembly, while in a protective enclosure, is to be pressurized to 80 psi (552 kPa) for one minute. While at this pressure, the joint shall be subjected to an axial pull applied to the assembly for one minute. The pull force shall be that specified by the manufacturer for the pull rating without bend. The method shall simulate pulling the rigid PVC conduit out of the socket. The pull force specified by the manufacturer shall be provided in the manufacturer's literature.

6.12.2.2 Bending and pull

6.12.2.2.1 A joint (conduit and socket) shall not separate nor show a decrease in pressure when tested in accordance with [6.12.2.2.2](#).

6.12.2.2.2 One joint in each trade size is to be assembled as intended. The assembly, while in a protective enclosure, is to be pressurized to 80 psi (552 kPa) for one minute. While at this pressure, the joint is to be deflected to have a minimum radius specified by the manufacturer. The pressure is to be released, and the joint shall then be subjected to an axial pull applied to the assembly for 1 minute. The pull force shall be that specified by the manufacturer for the pull rating with bend. The method is to simulate pulling the rigid PVC conduit out of the socket with a lateral load. The pull force specified by the manufacturer shall also be provided in the manufacturer's literature.

6.12.3 Pipe stiffness

6.12.3.1 Schedule 40, and Schedule 80 rigid PVC conduit that is intended for directional boring use shall have a minimum pipe stiffness of 120 psi (827 kPa) at 10 percent deflection when determined in accordance with the Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading, ASTM D 2412.

6.12.4 Elastomeric materials accelerated aging

6.12.4.1 Six samples of a sleeve or ring of elastomeric material that is used to comply with [6.12.2](#) shall be conditioned as described in [6.12.4.2](#). As a result of the conditioning, the sleeve or ring shall not show visible signs of deterioration.

6.12.4.2 The samples shall be conditioned for 70 hours at a temperature of $100 \pm 1^{\circ}\text{C}$ ($212 \pm 2^{\circ}\text{F}$) in a full-draft, air-circulating oven that has been preheated at full draft. After conditioning, the component shall be cooled to room temperature for not less than 4 hours before being handled.

6.13 Resistance to specific reagents – Schedule 40 and 80

6.13.1 General

6.13.1.1 Usually, a reagent is understood to be a substance used to produce a characteristic reaction in chemical analysis. For the purpose of this standard, however, it is convenient to consider the word in the less restrictive sense of any chemical, oil, or other substance that has a corrosive or degrading influence on Schedule 40, and Schedule 80 rigid PVC conduit. The tests in [6.13.2](#) and [6.13.3](#) apply to conduit intended for use where wet by or immersed in a specific reagent. The 1 (27) or smaller trade size of rigid PVC conduit is to be considered representative of the larger trade sizes of conduit.

6.13.2 Reagent absorption test

6.13.2.1 Specimens of the finished rigid PVC conduit, each 2 inches (50 mm) in length (see [6.13.3.2](#)), are to be immersed for 60 and 120 days in the specified reagent at the intended concentration and temperature. The conduit shall exhibit a 2.50 percent or smaller gain or loss in weight. If there is weight gain after 120 days exceeding 1.00 percent, that gain shall not be more than 1.65 times the gain after 60 days.

6.13.3 Crush strength test

6.13.3.1 Specimens of the finished rigid PVC conduit, each 2 inches (50 mm) in length (see [6.13.3.2](#)), are to be immersed for 60 and 120 days in the specified reagent at the intended concentration and

temperature. The conduit shall have at least 85 percent of the crushing strength of similar unaged specimens. The tests are to be done as indicated in [6.13.3.3](#) – [6.13.3.11](#).

6.13.3.2 The results of tests on the 1 (27) or smaller trade size of rigid PVC conduit are to be considered representative of the results that would be obtained from tests on the larger trade sizes of conduit.

6.13.3.3 Twelve specimens that are each 2 inches (50 mm) long are to be cut from clean sample lengths of the finished rigid PVC conduit (see [6.13.3.2](#)) and cleaned of loose particles and ragged edges. Six specimens are each to be weighed (W_1) and the remaining six are to be set aside for test unaged.

6.13.3.4 Care is to be taken throughout the procedure outlined in [6.13.3.5](#) – [6.13.3.11](#) to reduce the risk of injury from handling reagents that involve such a risk.

6.13.3.5 Each of the weighed specimens is to be immersed in the reagent in separate, covered containers that do not react with the reagent. Each container is to be filled with the reagent at the intended concentration and temperature. The specimen shall be completely covered. When the liquid comes to rest in each container, the specimens are to be stood on end in their containers. The containers are to be closed and kept at the intended temperature for 60 days without agitation of the reagent.

6.13.3.6 After 60 days, the specimens are to be removed from the reagent and given time to cool in still air before being rinsed carefully and wiped dry inside and out with a clean piece of lint-free, absorbent cloth. Each of the six dried specimens is to be weighed (W_2) to within 10 mg of balance. W_2 shall not be more than 2.50 percent heavier or lighter than W_1 .

6.13.3.7 Three of the specimens immersed for 60 days and three of the unaged specimens are to be brought into thermal equilibrium with one another, the testing machine, and the surrounding air at a temperature of $23.0 \pm 2.0^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and are to be kept so throughout the test. The inside diameter of each specimen is to be measured. The specimens are then to be tested separately between a pair of rigid, flat, steel plates that are at least 6 inches (150 mm) long and horizontal and parallel to one another. One plate is to be moved toward the other at the rate of $1/2 \pm 1/8$ inch (10.0 ± 2.5 mm) per minute until the surface of the specimen pulls away from contact with either plate – until the specimen buckles, or until the minor axis measured inside the flattening specimen is 60 percent of the inside diameter measured before the test.

6.13.3.8 The crushing loads at the buckling and 60-percent points are to be noted from the dial on the machine and recorded for each specimen. The loads at each of these points are to be averaged for each of the three sets of specimens. The average loads at each of these points for the aged specimens are to be divided by the average loads at each of these points for the unaged specimens. The resulting ratios shall not be less than 0.85 and the specimens shall not crack or collapse before the buckling or 60 percent points are reached.

6.13.3.9 The three remaining specimens immersed for 60 days are to be returned to their containers and the immersion continued for an additional 60 days at the intended temperature. After the full 120 days, the specimens are to be removed from the reagent and cooled in still air before being rinsed carefully and wiped dry inside and out with a clean piece of lint-free absorbent cloth. The three dried specimens are to be weighed (W_3) to within 10 mg of balance. W_3 shall not be more than 2.50 percent heavier or lighter than W_1 . If W_3 is more than 1.00 percent heavier than W_1 , W_3 minus W_1 shall not be more than 1.65 (W_2 minus W_1).

6.13.3.10 The three specimens immersed for 120 days and the last three of the unaged specimens are to be brought into thermal equilibrium with one another, the testing machine, and the surrounding air at a temperature of $23.0 \pm 2.0^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and are to be kept so throughout the test. The inside diameter of each specimen is to be measured. The specimens are then to be tested separately between a pair of rigid, flat, steel plates that are at least 6 inches (150 mm) long and horizontal and parallel to one another. One

plate is to be moved toward the other at the rate of $1/2 \pm 1/8$ inch (10.0 ± 2.5 mm) per minute until the surface of the specimen pulls away from contact with either plate - until the specimen buckles - or until the minor axis measured inside the flattening specimen is 60 percent of the inside diameter measured before the test.

6.13.3.11 The crushing loads at the buckling and 60-percent points are to be noted from the dial on the machine and recorded for each specimen. The loads at each of these points are to be averaged for each of the three sets of specimens. The average loads at each of these points for the aged specimens are to be divided by the average loads at each of these points for the unaged specimens. The resulting ratios shall not be less than 0.85 and the specimens shall not crack or collapse before the buckling or 60 percent points are reached.

6.14 Sunlight resistance – Schedule 40 and 80

6.14.1 Notched specimens prepared from unaged bar samples machined from the finished Schedule 40 or Schedule 80 rigid PVC conduit shall have an average Izod impact strength of at least 0.5 ft-lbf/inch (27 J/m) of notch width. Similar specimens prepared from samples conditioned for 720, 1080, and possibly 1440 hours shall have average Izod impact strengths that comply with [Table 6.4](#). The samples are to be cut and conditioned and the specimens are to be prepared and tested as indicated in [6.14.2](#) – [6.14.12](#). The procedures described in these paragraphs are similar to Method A as described in the Test Method for Determining the Izod Pendulum Impact Resistance of Plastics, Standard ASTM D 256.

Table 6.4
Acceptability criteria for izod impact

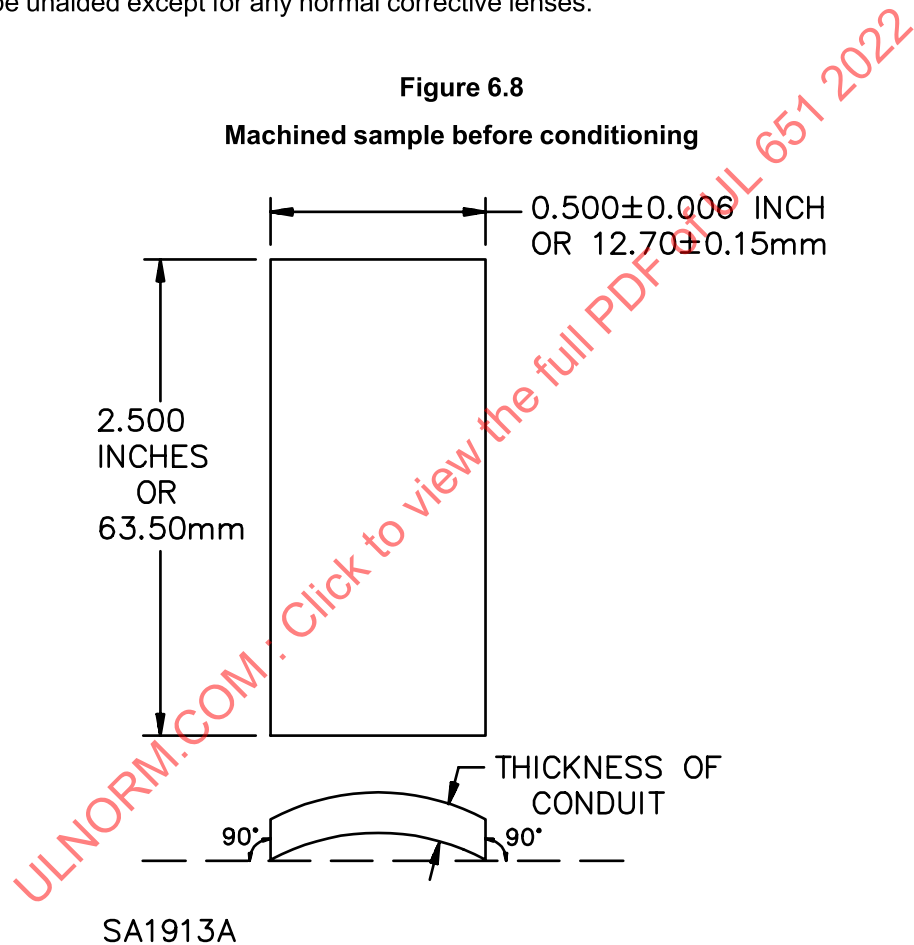
Average izod impact strength of unaged specimens	Conditioning period in hours	Percent decrease in average izod impact strength at the end of the conditioning period indicated in the previous column	Acceptability of conduit
0.5 – 1.5 ft-lbf/inch (27 – 81 J/m) of notch width	0 – 720	–	No requirement ^a
	720 – 1080	0 – 5	Acceptable
		Over 5 but under 7.5	Not acceptable unless specimens comply after 1440 hours ^b
	1080 – 1440 ^b	7.5 or more	Not acceptable
		0 – 5	Acceptable
		Over 5	Not acceptable
Over 1.5 ft-lbf/inch (81 J/m) of notch width	0 – 720	–	No requirement ^a
	720 – 1080	0 – 10	Acceptable
		Over 10 but under 15	Not acceptable unless specimens comply after 1440 hours ^b
	1080 – 1440 ^b	15 or more	Not acceptable
		0 – 10	Acceptable
		Over 10	Not acceptable

^a The average Izod impact strength after conditioning for 720 hours is to be used as the basis against which the average Izod impact strength after longer conditioning is compared.

^b Completion of the conditioning of specimens for test after the 360-hour period of 1080 – 1440 hours may be discontinued if the percentage decrease in the average Izod impact strength is acceptable for specimens conditioned for 720 – 1080 hours.

6.14.2 Longitudinal strips slightly wider than 1/2 inch (12.7 mm) are to be cut from straight lengths of finished rigid PVC conduit of the 4 (103), 5 (129), or 6 (155) trade size. To keep the resulting specimens the same nominal thickness, all of the strips are to be cut from the same trade size of conduit. Each cut is not to be made radially but is to be made in a plane parallel to the longitudinal axis of the conduit. Each strip is to be cut into samples that are slightly longer than 2-1/2 inches (63.5 mm) with each cut made in a plane perpendicular to the longitudinal axis of the strip. At least 60 samples are needed.

6.14.3 Each sample is to be machined to the dimensions indicated in [Figure 6.8](#) with the machining done only on the four cut surfaces. The end surfaces are to be flat, parallel, and in planes perpendicular to the longitudinal axis of the rigid PVC conduit. The longitudinal surfaces are to be flat, parallel, and in planes parallel to the longitudinal axis of the conduit. A sample is to be discarded after this preparation if either or both of its curved surfaces show any scratches or other defects that are visible to the examiner's eyes, which are to be unaided except for any normal corrective lenses.



6.14.4 Fifteen of the machined samples are to be set aside to be notched and then tested unaged. Forty-five of the machined samples are to be subjected to the following test:

Xenon-arc, Type B, in accordance with Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials, ASTM G 155 – continuous exposure to light and intermittent exposure to water spray, with a programmed cycle of 120 minutes consisting of 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, orosilicate glass inner and outer optical filters, a spectral irradiance of 0.35 W/m²/nm at 340 nm, and a black-panel temperature of 63 ± 3°C (145 ± 5°F).

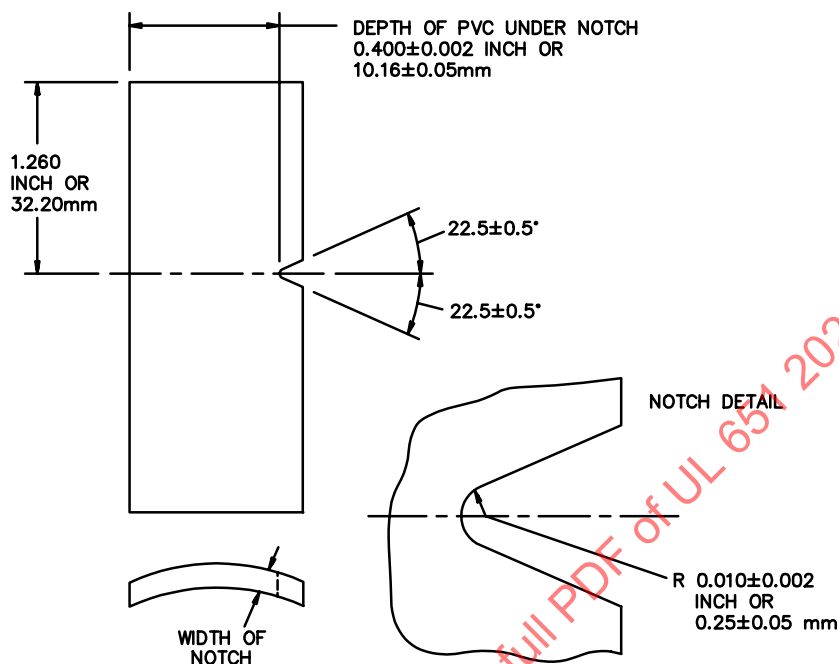
6.14.5 A positive, non-makeshift means shall be used to keep radiation from the arcs from reaching persons within sight of the apparatus. Ventilation shall be provided to keep the combustible products in the arcs from contaminating the samples. There shall not be any significant concentration of ozone or other combustible product in the air breathed by persons.

6.14.6 Each sample to pass through a fine spray of water once during each revolution of the drum in the repeated cycle of 3 and 17 minutes as noted in [6.14.7](#). The water is to be clean, its temperature $16.0 \pm 5.0^{\circ}\text{C}$ ($60.0 \pm 9.0^{\circ}\text{F}$) and pH 6.0 - 8.0. The water is not to be recirculated unless these conditions are maintained. While the arcs are in operation but the spray is off, the equilibrium black-panel temperature of the drum is to be $63 \pm 5^{\circ}\text{C}$ ($145 \pm 9^{\circ}\text{F}$).

6.14.7 With the drum revolving continuously at one revolution per minute, the arcs operating continuously and carrying a current of 15 – 17 A each at a drop in potential of 120 – 145 V rms, and with prudent attention to eyesight and other health risks presented by the arcs, the spray is to be operated for 3 minutes on and 17 minutes off. This cycle is to be repeated six times so that each sample is subjected to radiation from the arcs for a total of 102 minutes and to the water spray with radiation from the arcs for a total of 18 minutes. This sequence is to be repeated resulting in a total elapsed operating time of 1440 hours. Fifteen of the samples are to be removed after 720 hours, another 15 samples are to be removed after 1080 hours, and the remaining 15 samples are to be removed after 1440 hours. The apparatus is to be turned off to remove each set of 15 samples, and all of the samples are to cool to room temperature before any samples are removed from the drum.

6.14.8 Each unaged and conditioned sample is to be notched to the dimensions indicated in [Figure 6.9](#) on a milling machine, engine lathe, or similar machine tool having an accuracy of at least 0.001 inch or 0.01 mm. The cutter and feed speeds and the cutting action are to produce the notch without alteration of the PVC. Under 60 power magnification, each completed notch is to show as a clean and sharp cut without any nicks, cracks, or thermal deformation, having the angle and radius indicated in [Figure 6.9](#). A micrometer having an anvil contoured to fit in the notch is to be used to verify that the depth of PVC under the notch is within the limits indicated in [Figure 6.9](#). The notched surface is to be within 0.001 inch (0.025 mm) of being parallel to the other long machined surface and is to have less than 0.002 inch (0.050 mm) of twist. The plane bisecting the notch is to be within 2 degrees of being perpendicular to the notched surface. A specimen that departs from one or more of these requirements may be machined further to make it comply. A specimen is to be discarded after this preparation if either or both of its curved surfaces (the original inside and outside surfaces of the rigid PVC conduit) show any scratches or other defects. The width of each specimen retained is to be measured at the notch and recorded to the nearest 0.001 inch or 0.01 mm.

Figure 6.9
Specimen showing notch



SA1914

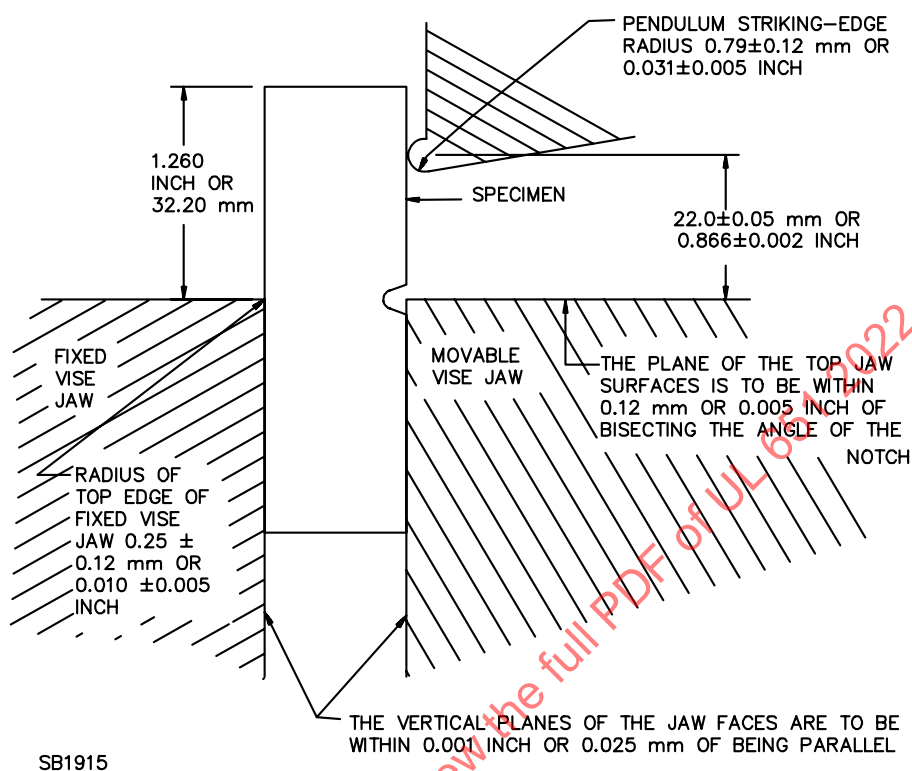
6.14.9 The notched specimens are to rest in still air at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and humidity of 50 ± 5 percent for 40 hours or longer before being tested. The test is to be made within this range of temperature and humidity.

6.14.10 The test apparatus and its calibration and A and B energy-loss factors are to be in accordance with the Standard Test Method for Determining the Izod Pendulum Impact Resistance of Plastics, ASTM D 256.

6.14.11 At least 10 each of the unaged specimens and specimens prepared from samples conditioned for 720 and 1080 hours are to be tested in close succession after completion of the 1080 hours of conditioning without waiting for completion of the conditioning of the 1440-hour samples. If the results after 1080 hours are within the limits indicated in [Table 6.4](#), conditioning of the 1440-hour samples may be discontinued and the 1440-hour samples may be discarded.

6.14.12 Each specimen in turn is to be positioned precisely and clamped rigidly (tightly but not to the point of damaging the specimen) in the vise as shown in [Figure 6.10](#), and the pendulum is to be released. The Izod impact strength of each specimen and the average Izod impact strength of each group of specimens (unaged, 720 hour, 1080 hour, and possibly 1440 hour) are to be determined as described in the Standard Test Method for Determining the Izod Pendulum Impact Resistance of Plastics, ASTM D 256. The average Izod impact strength of the unaged specimens shall not be less than 0.5 ft·lbf/inch (27 J/m) of notch width (see [6.14.1](#)). The average Izod impact strengths of the specimens prepared from samples conditioned longer than 720 hours shall comply with [Table 6.4](#).

Figure 6.10
Positioning for izod impact test



6.15 Schedule 40 and 80 for use with 90° wire

6.15.1 General

6.15.1.1 Materials used in the construction of Schedule 40 or Schedule 80 rigid PVC conduit that is intended for use with 90°C (194°F) wiring shall not experience any significant reduction of critical properties when specimens of the finished product are operated continuously under the normal conditions that result in the PVC attaining maximum temperature.

6.15.1.2 To determine whether rigid PVC conduit complies with the requirement in [6.15.1.1](#), the physical property of impact strength is to be investigated as representing all critical properties in an accelerated-aging program.

6.15.1.3 A total of 215 specimens of the 2 (53) trade size of rigid PVC conduit, each 6 inches (150 mm) long, are to be used for the test (see [6.15.2.1.1](#) concerning extra specimens needed for preliminary tests). 198 specimens, are to be placed upright in a full-draft circulating-air oven maintained at a temperature of 80.0 ± 1.0°C (176.0 ± 1.8°F) on open wooden racks and spaced to maintain the full circulation of air around and through the specimens. The remaining 17 specimens are to be unaged and unconditioned. At the end of each of the eleven time intervals indicated below, a set of 18 specimens is to be removed from the oven (3 specimens for preliminary tests (as necessary) and 15 specimens for test) and given 16 – 96 hours to cool in still air to a temperature of 23.0 ± 2.0°C (73.4 ± 3.6°F). The specimens are to be laid one at a time on a flat steel plate that is 1/2 inch (13 mm) thick and are to be impacted by means of a solid right-circular steel cylinder with a flat impact face having rounded edges. The cylinder used is to be chosen as indicated in [6.15.2.1.1](#) having a diameter of 2 inches (51 mm) and a weight not less than 10 lb (4.54 kg). All 15 specimens, for test, of the unaged and unconditioned specimens are to be impacted after respective periods of oven aging for 60, 90, 120, 150, 180, 210, 240, 270, 300, 330, and 360 days. The up-and-down method described in [6.15.2](#) is to be used.

6.15.1.4 The average impact strength is to be determined as indicated in [6.15.2.3](#) for each of the twelve sets of specimens tested. The twelve averages are then to be plotted as a function of time (the set of unaged specimens is to be plotted as having been aged for zero days). The points so plotted are to be joined by a smooth curve. The resulting impact-strength degradation curve shall show a leveling off of impact strength at 50 percent or more of the average impact strength calculated for the set of unaged specimens. If a plateau is reached at 180 days, at 240 days or beyond at any of the other identified points, aging of the 360-day specimens may be discontinued and those specimens may be discarded without being tested.

6.15.2 Up-and-down method

6.15.2.1 Choice of cylinders

6.15.2.1.1 Preliminary tests are to be conducted, using as many extra specimens as needed, to determine the approximate height from which the steel cylinder has to fall to produce a crack, split, or tear that is visible on the outside surface of a specimen. An unacceptable result is to be recorded if the impact made by the steel cylinder causes any crack, split, or tear longer than 1/32 inch (0.8 mm) on the outer surface of a specimen. The weight of the steel cylinder to be used in the preliminary tests is the weight that produces an unacceptable crack, split, or tear in a specimen from a height of 24 – 120 inches (600 – 3000 mm) taken in increments of 6 inches (150 mm). The approximate height determined from this procedure is to be recorded in inches or mm as H_0 .

6.15.2.2 Conduct of test

6.15.2.2.1 The 15 specimens in each set being tested are to be labeled from one to fifteen. The order of testing is to be determined by random selection. The steel cylinder used in [6.15.2.1.1](#) shall be dropped on the first specimen from a height H_1 in inches equal to H_0 in inches minus a 6-inch increment, or from a height H_1 in mm equal to H_0 in mm minus a 150-mm increment. The result shall be recorded as "A" for "acceptable" and "N" for not acceptable. The same increment is to be used for the remainder of the test. If an unacceptable result occurs, the second specimen is to be tested at a height of H_2 equal to H_1 minus the increment used for the first specimen. If the result for the first specimen is acceptable, the second specimen is to be tested from a height H_2 equal to H_1 plus the increment used for the first specimen. The drop distance for the weight (height) to the remaining specimens is to be determined from the height and results of the previous test. The height and result are to be recorded for each specimen in the set of 15 specimens tested.

6.15.2.3 Calculations

6.15.2.3.1 D , the median height of fall for each set of 15 specimens, is to be determined from the test data for that set by means of the formula:

$$D = D_0 \pm \frac{d}{2} + \frac{dkn_k}{R}$$

in which:

D is the median height of fall in inches or mm;

D_0 is the lowest height of fall in inches or mm at which any one of R occurs;

d is the increment in height of fall in inches or mm;

k takes on values beginning with 1 and increasing in whole-number numerical order (k is 1 for the second lowest height of fall recorded in the tabulation of results at which any one of R occurs, k is 2 for the third lowest height, k is 3 for the fourth lowest height, and so forth);

n_k is the number of acceptable or unacceptable results obtained at the height associated with the subscript k ; and

R is the total number of unacceptable or acceptable results, whichever is less;

In the formula, the negative sign is to be used when R is the number of unacceptable results and the positive sign is to be used when R is the number of acceptable results.

6.15.2.3.2 The average impact resistance is to be calculated for each set of specimens. For specimens where the increments in height are measured in inches, D in inches is to be divided by 12 and then multiplied by the weight of the cylinder in lb to obtain the average impact resistance in ft-lbf. For specimens where the increments in height are measured in mm, D in mm is to be divided by 1000 and then multiplied by the weight of the cylinder in kg x 9.807 to obtain the average impact resistance in J. The six average impact resistances are to be plotted as indicated in [6.15.1.4](#).

6.15.2.3.3 The following is a nonmetric example of the calculation referenced in [6.15.2.3.1](#).

a) Step 1: Using a weight of 10 lbf to impact extra specimens and starting from the maximum height of 120 inches and working downward in the specified steps of 6 inches:

- 1) A long crack occurs with the weight falling from a height of 120 inches,
- 2) A crack of 3/64 inch occurs with the weight falling from a height of 114 inches (6 inches lower than 120 inches), and
- 3) No damage is apparent after a fall from 108 inches (6 inches lower than 114 inches).

Because 114 inches is the lowest height from which an unacceptable long crack is produced, $H_0 = 114$ inches.

b) Step 2: Using the same weight and increment (as specified) on a set of 15 specimens, the results are as follows ("A" means acceptable and "N" means not acceptable):

Height of fall in inches	Result
$H_1 = H_0 - 6 = 114 - 6 = 108$	N
$H_2 = H_1 - 6 = 108 - 6 = 102$	N
$H_3 = H_2 - 6 = 102 - 6 = 96$	N
$H_4 = H_3 - 6 = 96 - 6 = 90$	A
$H_5 = H_4 + 6 = 90 + 6 = 96$	A
$H_6 = H_5 + 6 = 96 + 6 = 102$	A
$H_7 = H_6 + 6 = 102 + 6 = 108$	N
$H_8 = H_7 - 6 = 108 - 6 = 102$	N
$H_9 = H_8 - 6 = 102 - 6 = 96$	A
$H_{10} = H_9 + 6 = 96 + 6 = 102$	N
$H_{11} = H_{10} - 6 = 102 - 6 = 96$	N
$H_{12} = H_{11} - 6 = 96 - 6 = 90$	A
$H_{13} = H_{12} + 6 = 90 + 6 = 96$	N
$H_{14} = H_{13} - 6 = 96 - 6 = 90$	A
$H_{15} = H_{14} + 6 = 90 + 6 = 96$	A

c) Step 3: The number of unacceptable (N) results is 8.

d) Step 4: The number of acceptable (A) results is 7.

e) Step 5: Because the total for A is less than the total for N, $R = \text{total for A} = 7$.

f) Step 6: $D_0 = \text{lowest of the seven A heights} = 90 \text{ inches}$.

g) Step 7: $k = 1$ for the second lowest (96 inches) of the seven A heights, and $k = 2$ for the third lowest (102 inches) of the seven heights. There are no other A heights, so $k = 3, 4$, etc. does not apply.

h) Step 8: n_1 is the number of results (3) at the $k = 1$ height of 96 inches, so $n_1 = 3$. n_2 is the number of results (1) at the $k = 2$ height of 102 inches, so $n_2 = 1$.

i) Step 9: Because $R = 7$ is for acceptable results, the plus sign is to be used for $d/2$ in the formula.

j) Step 10: $d = \text{increment of height used in the test} = 6 \text{ inches}$.

k) Step 11:

$$D = 90 + \frac{6}{2} + \frac{6 \times 1 \times 3}{7} + \frac{6 \times 2 \times 1}{7} = 97.28 \text{ inches}$$

l) Step 12:

$$\text{Average impact resistance for the set} = \frac{97.28}{12} \times 10 = 81 \text{ ft-lb}$$

m) Step 13: The impact value of 81 ft-lbf is to be plotted as the point on the graph for the number of days of oven aging for the particular set of specimens. The six points so plotted are to be joined by a smooth curve and the curve is to be evaluated as indicated in [6.15.1.4](#).

6.15.2.3.4 The following is a Metric Example of the calculation referenced in [6.15.2.3.1](#).

a) Step 1: Using a weight of 4.54 kg to impact extra specimens and starting from the maximum height of 3000 mm and working downward in the specified steps of 150 mm:

1) A long crack occurs with the weight falling from a height of 3000 mm,

2) A crack of 1.2 mm occurs with the weight falling from a height of 2850 mm (150 mm lower than 3000 mm), and

3) No damage is apparent after a fall from 2700 mm (150 mm lower than 2850 mm).

Because 2850 mm is the lowest height from which an unacceptable long crack is produced, $H_0 = 2850 \text{ mm}$.

b) Step 2: Using the same weight and increment (as specified) on a set of 15 specimens, the results are as follows ("A" means acceptable and "N" means not acceptable):

Height of fall in mm	Result
$H_1 = H_0 - 150 = 2850 - 150 = 2700$	N
$H_2 = H_1 - 150 = 2700 - 150 = 2550$	N
$H_3 = H_2 - 150 = 2550 - 150 = 2400$	N
$H_4 = H_3 - 150 = 2400 - 150 = 2250$	A
$H_5 = H_4 + 150 = 2250 + 150 = 2400$	A
$H_6 = H_5 + 150 = 2400 + 150 = 2550$	A
$H_7 = H_6 + 150 = 2550 + 150 = 2700$	N
$H_8 = H_7 - 150 = 2700 - 150 = 2550$	N

Height of fall in mm	Result
$H_9 = H_8 - 150 = 2550 - 150 = 2400$	A
$H_{10} = H_9 + 150 = 2400 + 150 = 2550$	N
$H_{11} = H_{10} - 150 = 2550 - 150 = 2400$	N
$H_{12} = H_{11} - 150 = 2400 - 150 = 2250$	A
$H_{13} = H_{12} + 150 = 2250 + 150 = 2400$	N
$H_{14} = H_{13} - 150 = 2400 - 150 = 2250$	A
$H_{15} = H_{14} + 150 = 2250 + 150 = 2400$	A

c) Step 3: The number of unacceptable (N) results is 8.

d) Step 4: The number of acceptable (A) results is 7.

e) Step 5: Because the total for A is less than the total for N, $R = \text{total for A} = 7$.

f) Step 6: $D_0 = \text{lowest of the seven A heights} = 2250 \text{ mm}$.

g) Step 7: $k = 1$ for the second lowest (2400 mm) of the seven A heights, and $k = 2$ for the third lowest (2550 mm) of the seven A heights. There are no other A heights, so $k = 3, 4$, etc. does not apply.

h) Step 8: n_1 is the number of results (3) at the $k = 1$ height of 2400 mm, so $n_1 = 3$. n_2 is the number of results (1) at the $k = 2$ height of 2550 mm, so $n_2 = 1$.

i) Step 9: Because $R = 7$ is for acceptable results, the plus sign is to be used for $d/2$ in the formula.

j) Step 10: $d = \text{increment of height used in the test} = 150 \text{ mm}$.

k) Step 11:

$$D + 2250 + \frac{150}{2} + \frac{150 \times 1 \times 3}{7} + \frac{150 \times 2 \times 1}{7} = 2432.1 \text{ mm}$$

l) Step 12: Average impact resistance for the set =

$$\frac{2432.1}{1000} \times 4.54 = 11.04 \text{ kgf-m. } 11.04 \times 9.807 = 108 \text{ J.}$$

m) Step 13: The impact value of 108 J is to be plotted as the point on the graph for the number of days of oven aging for the particular set of specimens. The six points so plotted are to be joined by a smooth curve and the curve is to be evaluated as indicated in [6.15.1.4](#).

6.16 Permanency of printing – Schedule 40 and 80

6.16.1 Schedule 40, and Schedule 80 rigid PVC conduit markings shall be permanent. Laser printing is considered to be permanent. Conduit with markings that have been laser printed shall not be subjected to the tests in this section.

6.16.2 The specimens used in this test shall be of the 1/2 (16) trade size. The printing on all the tested specimens of rigid PVC conduit shall be legible after being rubbed repeatedly with braided cotton tape as described in [6.16.3](#) – [6.16.7](#).

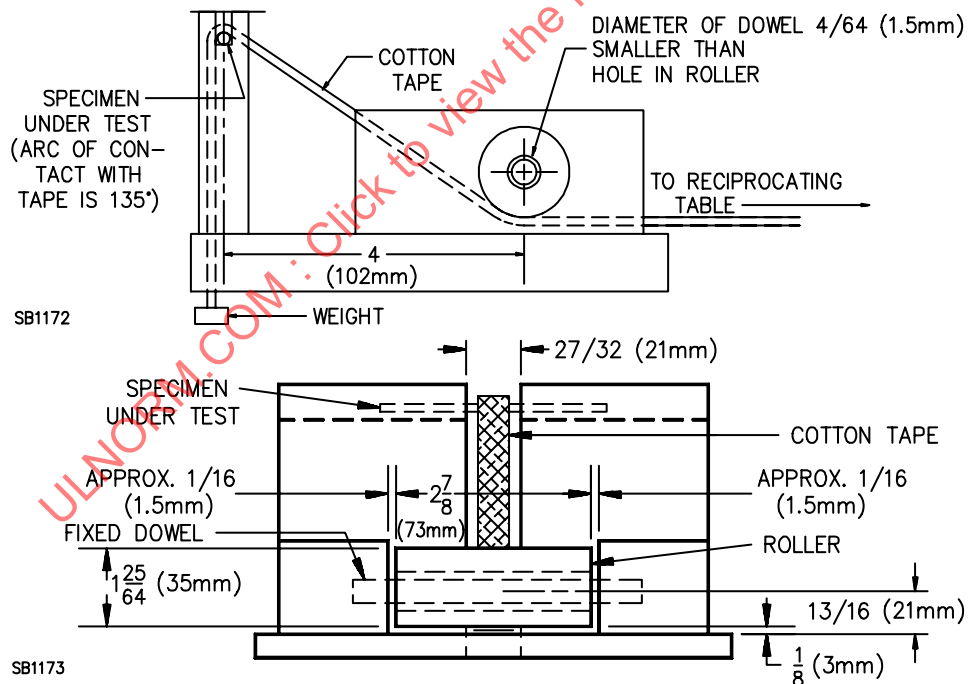
6.16.3 All specimens are to be wiped lightly with a clean lint-free cloth before being conditioned.

6.16.4 Two specimens are to be aged for 168 hours in a full-draft circulating-air oven operating at a temperature of $70.0 \pm 1.0^{\circ}\text{C}$ ($158.0 \pm 1.8^{\circ}\text{F}$) and then removed from the oven and cooled in still air to room temperature before being tested. Two other specimens are to be immersed for 24 hours in tap water kept at a temperature of $60.0 \pm 1.0^{\circ}\text{C}$ ($140.0 \pm 1.8^{\circ}\text{F}$) and then removed from the water, shaken to remove most of the water, and then given time to dry (without wiping) to reach room temperature in still air before being tested. Two different specimens are to be immersed in oil. The oil to be used is IRM 902 oil. The oil and specimens are to be kept at a temperature of $60.0 \pm 1.0^{\circ}\text{C}$ ($140 \pm 1.8^{\circ}\text{F}$) for 24 hours. The specimens are then to be removed from the oil, wiped with a cloth that is soft and clean, and given time to reach room temperature before being tested. Two specimens are to be tested without any conditioning.

6.16.5 The tests are to be made using the wooden apparatus illustrated in [Figure 6.11](#) or similar apparatus in multiple. The apparatus and the specimens are to be in thermal equilibrium with the surrounding air at a temperature of $23.0 \pm 8.0^{\circ}\text{C}$ ($73.4 \pm 14.4^{\circ}\text{F}$) and at a relative humidity of 50 ± 5 percent throughout the test. The tape is to be No. 50-2/20 unbleached cotton braid approximately 1/2 inch (13 mm) wide. A new length of tape is to be used for each specimen, and the tape is to be attached to the reciprocating table (while the table is at one end of its travel) and to a weight before any specimen is put in place. A weight of 1 lbf (4.4 N) (454 gf) is to be suspended from one end of the tape.

Figure 6.11

Side and roller-end views of printing test apparatus



Note: Dimensions are shown in inches (mm)

6.16.6 The tape is to be lifted and a specimen placed in the slot as shown in the illustration, with the printing at the center of the arc of contact between the tape and specimen. The ends of the specimen are to be secured to keep the printed area of the rigid PVC conduit from rotating out from under the tape. The tape is then to be lowered gently into place on the specimen.

6.16.7 The table is to be started in its horizontal reciprocating motion (simple harmonic motion) at the rate of approximately 28 cycles per minute, each cycle consisting of one complete back-and-forth motion [approximately a 6-1/4-inch (160-mm) stroke]. The table is to be stopped after 50 cycles. The conditioned specimens are to be examined for legibility of the printing. The three unconditioned specimens are to be subjected to an additional 50 cycles of rubbing with the other side of the cotton tape before being examined. The printing shall be legible on all specimens.

6.17 Stiffness of Type EB

6.17.1 Type EB rigid PVC conduit shall have a stiffness of at least 20 psi (89 N/m² or 357 gf/mm²) when tested as described in [6.17.2](#) and [6.17.3](#), 240 hours or more after manufacture. This test is similar to the procedure described in the Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading, ASTM D 2412.

6.17.2 Three specimens of the finished rigid PVC conduit that are 6 inches (150 mm) long are to be tested separately by compression between a pair of rigid, flat, steel plates that are at least 6 inches (150 mm) long, horizontal, and parallel to one another. One plate is to be moved toward the other at a rate of 1/2 ± 1/8 inch per minute or 10.0 ± 2.5 mm per minute until the vertical deflection is equal to 5 percent of the diameter measured vertically inside the conduit before the compression was begun. At this point, the compression load is to be noted in lbf, N, or gf.

6.17.3 The load F per unit of specimen length is to be calculated by one of the following methods:

- a) Dividing the load in pounds force by 6 inches to yield F inch pounds force per inch of length;
- b) Dividing the load in N by 6×0.0254 , or 0.1524, to yield F in newtons per meter of length; or
- c) Dividing the load in grams force by 6×25.4 , or 152.4, to yield F in grams force per millimeter of length.

6.17.4 The stiffness S of the rigid PVC conduit at 5 percent deflection is to be determined by means of the formula

$$S = F / V$$

in which:

F is calculated in [6.17.3](#) and

V is the vertical deflection of the inside diameter in inches, m , or mm .

7 Rigid PVC Conduit Fittings

7.1 General

7.1.1 If a fitting differs from the construction requirements previously specified, additional tests to those specified in [7.2](#) and [7.3](#) shall be considered. Items to consider are installation, resistance to arcing, dimensional stability, and resistance to the corrosive or degrading effects of reagents.

7.2 All types

7.2.1 Water absorption test

7.2.1.1 A fitting shall comply with the requirements for the Water Absorption Test, [6.5](#).

7.2.2 Flammability test

7.2.2.1 When tested as described in [7.2.2.2](#):

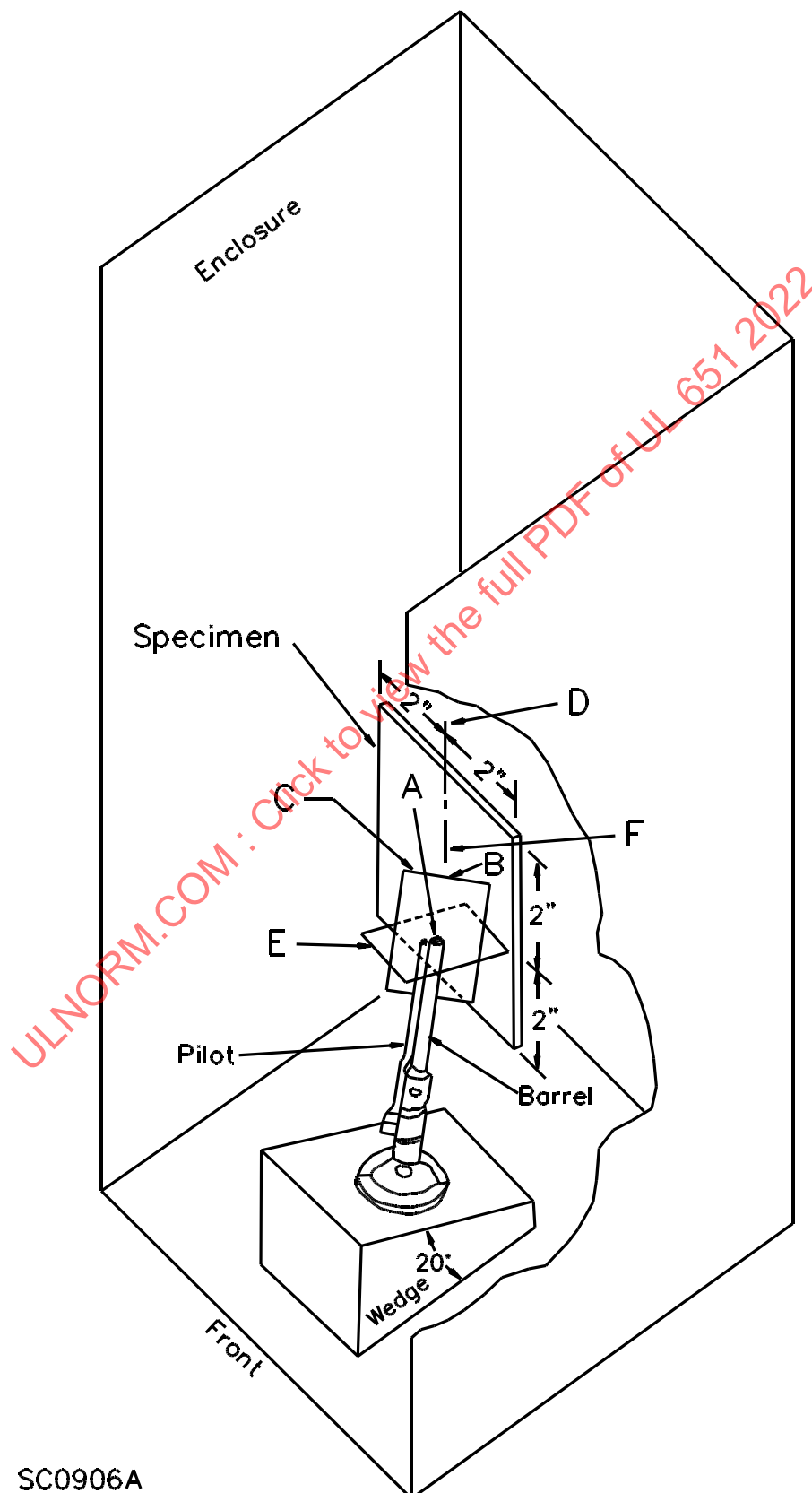
- a) A fitting shall not continue to flame for more than 5 seconds after the third application of the test flame;
- b) Flaming particles or drops shall not fall from the fitting during or after any application of the test flame; and
- c) The fitting shall not be entirely consumed during or after any application of the test flame.

7.2.2.2 The test is to be conducted in a three-sided enclosure that is 12 inches (305 mm) wide, 14 inches (356 mm) deep, and 24 inches (610 mm) high. The top and front of the enclosure are to be open. The room or hood in which the enclosure is located for the test is to be ventilated, but drafts are not to affect the test flame.

7.2.2.3 A Tirrill gas burner to which a gas pilot light is attached is to supply the test flame. The barrel of the burner is to extend 4 inches (102 mm) above the air inlets and its inside diameter is to be 3/8 inch (9.5 mm). While the barrel is vertical, the overall height of the flame is to be adjusted to 5 inches (127 mm). The blue inner cone is to be 1-1/2 inches (38 mm) high. Without disturbing the adjustments for the height of the flame, the valves supplying gas to the burner and pilot flames are to be closed.

7.2.2.4 A wedge to which the base of the burner can be secured is to be provided for tilting the barrel 20 degrees from the vertical while the longitudinal axis of the barrel remains in a vertical plane. The burner is to be secured to the wedge and the assembly is to be placed in an adjustable jig that is attached to the floor of the enclosure. The jig is to be adjusted laterally (see [Figure 7.1](#)) to place the longitudinal axis of the barrel in the same vertical plane as the vertical axis of the specimen. The plane is to be parallel to the sides of the enclosure.

Figure 7.1
Flammability test apparatus and specimen dimensions



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7.2.2.5 The jig is also to be adjusted toward the rear or front of the enclosure (see [Figure 7.1](#)) to position point A 1-1/2 inches (38.1 mm) from point B at which the extended longitudinal axis of the barrel meets the front surface of the specimen. Point A is the intersection of the longitudinal axis of the barrel with the plane of the tip of the barrel. Point B is the point at which the tip of the inner blue cone will touch the plaque or finished sample. The plaque or finished sample is to be adjusted vertically to place point B at the center of the plaque or finished sample.

7.2.2.6 The valve supplying gas to the pilot is to be opened and the pilot flame lit. The valve supplying gas to the burner is to be opened to apply the flame to the specimen automatically. This valve is to be held open for 1 minute and closed for 30 seconds for each of three applications of the test flame. The test sample is to be located so that the test flame is directed at the center of the largest surface.

7.2.2.7 If the fitting is too large to be tested in the chamber described in [7.2.2.2](#), it is acceptable to test the fitting in a chamber that is constructed as described in [7.2.2.2](#) with proportionately larger dimensions.

7.2.3 Heat-distortion test

7.2.3.1 There shall not be a change in any dimension greater than 15 percent for a fitting, cracks or openings in a fitting, or openings wider than 1/16 inch (1.6 mm) between a fitting and its cover as a result of the test described in [7.2.3.2](#)

7.2.3.2 Samples are to be heated for 1 hour at a temperature of $92 \pm 1^{\circ}\text{C}$ ($198 \pm 2^{\circ}\text{F}$) in an air-circulating oven. Samples are to be supported in the oven so that they cannot touch each other or the sides of the oven.

7.2.4 Extrusion/molding-process test

7.2.4.1 The surface of a fitting shall not exhibit any evidence of incomplete fusion after immersion of the finished product in reagent grade anhydrous acetone.

7.2.4.2 Because acetone [dimethyl ketone, $(\text{CH}_3)_2\text{CO}$] is an extremely volatile liquid, the vapors of which form explosive mixtures with air, it is imperative that open flames, glowing cigarettes, and other sources of ignition be kept away. Acetone and acetone-PVC products are toxic, damaging to clothing, and rapidly absorb moisture from air and the skin. These toxins should not be allowed to touch the skin, nor should the vapors of these substances be inhaled. Because acetone with moisture is not effective for this test, the test is to be conducted with each specimen in its own covered container. Acetone can be dehydrated by filtering it through anhydrous calcium sulphate, CaSO_4 .

7.2.4.3 With appropriate attention to the health and fire risks involved (see [7.2.4.2](#)), a sample of the fitting is to be immersed in reagent grade anhydrous acetone for 5 minutes at a temperature of $23 \pm 2^{\circ}\text{C}$ ($73 \pm 4^{\circ}\text{F}$) and then examined.

7.2.4.4 A fitting is not acceptable if there is flaking or peeling over most of the interior or exterior surfaces (see Note 2 of [Figure 6.3](#)) or if it splits. The presence of a weld (bond) line that is not uniform in width and depth or that is positively recessed below adjacent surfaces – for example, shows a definite crack or separation in the material – is not acceptable (see Note 4 of [Figure 6.3](#)).

7.2.5 Identification tests

7.2.5.1 A fitting shall comply with the requirements for the Identification of Compound Test, [6.7](#).

7.2.6 Resistance to crushing test

7.2.6.1 For resistance to crushing, when all sizes of rigid PVC conduit fittings are tested as described in [7.2.6.2](#) – [7.2.6.5](#), the minor axis shall retain at least 70 percent of its original inside diameter. There shall not be evidence of buckling and there shall not be a reduction in performance as a result of the conditioning.

Exception: A nipple and the threaded section of an externally threaded adapter need not be tested.

7.2.6.2 Specimens for the test are to consist of circular sections cut from the socket end of six samples of molded fittings, three of which have been conditioned as described in [7.2.6.3](#) and three of which are unaged.

7.2.6.3 The specimens are to be supported in a full-draft, air-circulating oven that has been preheated at full draft to $113 \pm 1^\circ\text{C}$ ($235 \pm 2^\circ\text{F}$). The specimens are to be supported so that they do not touch each other or the sides of the oven. The specimens are to be conditioned for 168 hours at full draft and then allowed to cool gradually for 16 to 96 hours in still air before being handled.

7.2.6.4 Prior to application of the load, measurements are to be made of the internal diameters of the test specimens. Each specimen is to be placed with its longitudinal axis horizontal between two rigid, flat, parallel, steel plates that are at least as long as the specimen. The internal measurement is to be at a point perpendicular to the steel plates. The load is to be applied to the center of the upper plate by means of a machine, the jaws of which close at the rate of 1/2 inch (12.7 mm) per minute.

7.2.6.5 The load is to be increased until the load value specified in [Table 7.1](#) is attained. Measurement of the minor axis of the inside dimension is to be made at the instant the load is attained. Observations for buckling are to be made at the points at which the specimen is in contact with the test plates. Buckling is considered to have occurred if a surface of the specimen in contact with a test plate starts to pull away from the plate. The load is then to be released immediately.

Table 7.1
Load for crushing test on fittings

Trade size of conduit socket (metric designator)		Load, lbf per linear in ^a
1/2	(16)	166.7
3/4	(21)	166.7
1	(27)	166.7
1-1/4	(35)	166.7
1-1/2	(41)	125.0
2	(53)	116.7
2-1/2	(63)	166.7
3	(78)	166.7
3-1/2	(91)	166.7
4	(103)	150.0
5	(129)	141.7
6	(155)	141.7
^a SI equivalents of dimensions in this table are:		
Pounds per linear in		Newtons per linear mm

Table 7.1 Continued on Next Page

Table 7.1 Continued

Trade size of conduit socket	(metric designator)	Load, lbf per linear in ^a
	116.7	20.4
	125.0	21.9
	141.7	24.8
	150.0	26.3
	166.7	29.2

7.2.7 Low-temperature handling test

7.2.7.1 Deleted

7.2.7.2 Deleted

7.2.7.3 Deleted

7.2.8 Bending test

7.2.8.1 A fitting shall not be damaged or separated from the rigid PVC conduit when subjected to the bending test described in [7.2.8.2](#) – [7.2.8.5](#).

7.2.8.2 If breakage of the rigid PVC conduit occurs prior to separation at the joint, performance is considered to be acceptable.

7.2.8.3 Samples secured by cement welded in the intended manner to 18-inch (457-mm) lengths of schedule 80 rigid PVC conduit of the appropriate trade size are to be tested as described in [7.2.8.4](#). The test is to be performed no sooner than 24 hours after assembly.

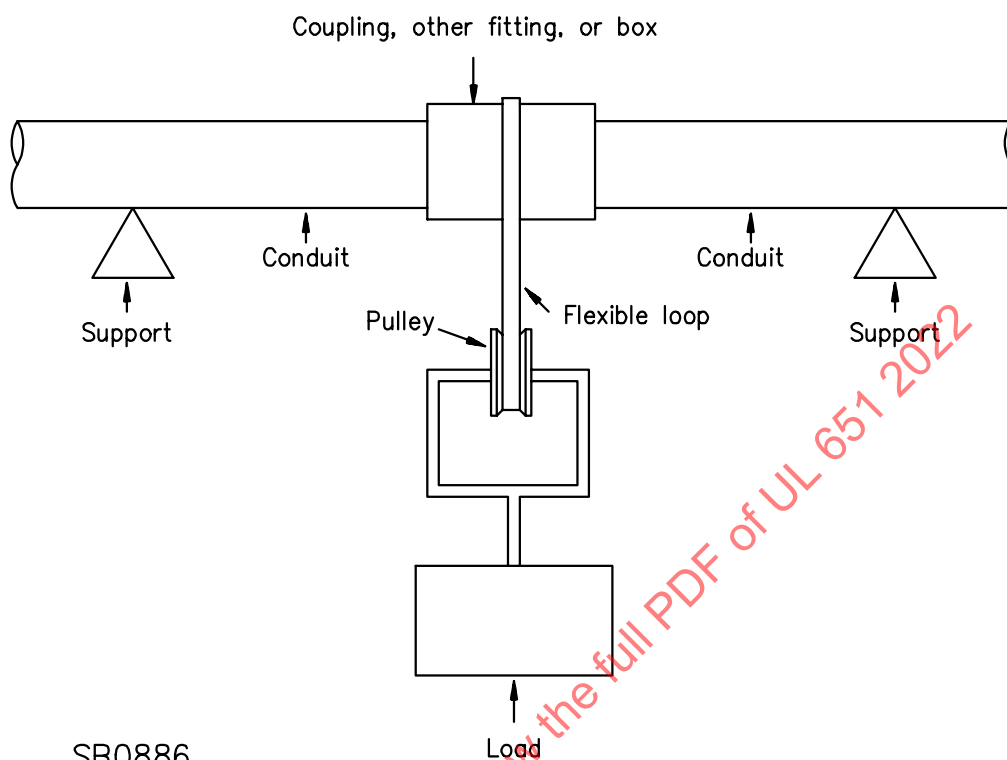
7.2.8.4 The following conditions are specified for this test:

a) For an assembly with a coupling, the center of the coupling is to be placed on supports 30 inches (760 mm) apart as illustrated in [Figure 7.2](#)

b) For an assembly without a coupling, the supports are to be separated by an additional distance, to be added to the 30 inches (760 mm) specified in (a). This distance is to be equal to the distance between the center of the assembly and the end of the rigid PVC conduit in the box or assembly in order to provide the required bending moment on the tested sample.

7.2.8.5 The load specified in [Table 7.2](#) for the size of conduit used is to be suspended from the center of the coupling (or alternative construction) for 60 seconds, during which time the coupling and the lengths of conduit are to be rotated through 1 complete revolution about the major axis of the assembly.

Figure 7.2
Bending test arrangement



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Table 7.2
Bending load and pull force

Trade size of fitting	(metric designator)	Bending load,		Pull force,	
		lb	(kg)	lbf	(N)
1/2	(16)	20	(9.07)	300	(1334)
3/4	(21)	35	(15.88)	450	(2002)
1	(27)	50	(22.68)	600	(2669)
1-1/4	(35)	75	(34.02)	700	(3114)
1-1/2	(41)	85	(38.56)	800	(3559)
2	(53)	110	(49.89)	1000	(4448)
2-1/2	(63)	110	(49.89)	1000	(4448)
3	(78)	110	(49.89)	1000	(4448)
3-1/2	(91)	110	(49.89)	1000	(4448)
4	(103)	110	(49.89)	1000	(4448)
5	(129)	110	(49.89)	1000	(4448)
6	(155)	110	(49.89)	1000	(4448)

7.2.9 Pull test

7.2.9.1 Following the bending test described in [7.2.8.1](#), a polyvinyl chloride (PVC) fitting shall withstand a direct pull of the value specified in [Table 7.2](#) for 1 minute without damage and without pulling loose from the rigid PVC conduit. See [7.2.8.2](#).

7.2.10 Resistance to specific reagents test

7.2.10.1 General

7.2.10.1.1 Usually, a reagent is understood to be a substance used to produce a characteristic reaction in chemical analysis. For the purpose of this standard, however, it is convenient to consider the word in the less restrictive sense of any chemical, oil, or other substance that has a corrosive or degrading influence on rigid polyvinyl chloride (PVC) conduit. The tests in [7.2.10.2](#) and [7.2.10.3](#) apply to fittings intended for use where wet by or immersed in a specific reagent. The 1 (27) or smaller trade size of fitting is to be considered representative of the larger trade sizes of fittings.

7.2.10.2 Reagent absorption

7.2.10.2.1 Specimens of the finished fitting, each 2 inches (50 mm) in length, are to be immersed for 60 and 120 days in the specified reagent at the intended concentration and temperature. The fitting shall exhibit a 2.50 percent or smaller gain or loss in weight. If there is weight gain after 120 days exceeding 1.00 percent, that gain shall not be more than 1.65 times the gain after 60 days.

7.2.10.3 Crushing strength

7.2.10.3.1 Specimens of the finished fitting, each 2 inches (50 mm) in length are to be immersed for 60 and 120 days in the specified reagent at the intended concentration and temperature. The fitting shall have at least 85 percent of the crushing strength of similar unaged specimens. The tests are to be done as indicated in [6.13.3.3](#) – [6.13.3.11](#).

7.2.10.3.2 The results of tests on the 1 (27) or smaller trade size of fitting are to be considered representative of the results that would be obtained from tests on the larger trade sizes of rigid PVC conduit.

7.3 Nonmetallic service-entrance heads

7.3.1 General

7.3.1.1 Nonmetallic service-entrance heads shall comply with the following:

- a) Water absorption test, [7.2.1](#);
- b) Flammability test, [7.2.2](#);
- c) Extrusion/molding-process test, [7.2.4](#);
- d) Identification test, [7.2.5](#);
- e) Wet-locations test, [7.3.2](#);
- f) Ultraviolet-light and water test, [7.3.3A](#);
- g) Aging test, [7.3.4](#);
- h) Impact test, [7.3.5](#);
- i) Impact test after cold conditioning, [7.3.6A](#);
- j) Heat distortion test, [7.3.7](#);
- k) Pull test, [7.3.8](#);

7.3.2 Wet-locations test

7.3.2.1 A fitting intended for use in a wet location shall not allow more than 0.1 mL (0.1g) of water into the fitting when tested as described in [7.3.2.3](#) and [7.3.2.4](#). Also see [9.3](#), Carton Markings, and [Table 9.1](#).

7.3.2.2 Before assembly, dry absorbent paper is to be placed in a container that can be sealed and resealed. The paper and the sealed container are to be weighed. The paper is then to be removed from the container and placed in the interior of the fitting at the point where the fitting interfaces with the rigid PVC conduit.

7.3.2.3 The product is to be assembled in the intended manner. The assembly is to be vented to atmosphere to equalize the pressure during the test. The assembly is to be mounted under the apparatus described in [7.3.2.4](#) and illustrated in [Figure 7.3](#). The water spray is to be applied for 1 hour.

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