TABLE 6A—DIMENSIONS AND TOLERANCES OF PIPE FOR AIR BRAKE USE, MM

Nominal Pipe Size	Outside Diameter Specified mm	Outside Diameter Tolerance min	Outside Diameter Tolerance max	Inside Diameter (Ref)	Wall Thickness Specified	Wall Thickness min	Threads per in	Nominal Weight Plain Ends kg/m±5%
1/8	10.29	9.50	10.67	6.83	1.73	1.52	27	0.36
1/4	13.72	12.93	14.10	9.25	2.24	1.96	18	0.63
3/8	17.14	16.36	17.53	12.53	2.31	2.03	18	0.85
1/2	21.34	20.55	21.72	15.80	2.77	2.41	14	1.27
3/4	26.67	25.88	27.05	20.93	2.87	2.51	14	1.68
1	33.40	32.61	33.78	26.64	3.38	2.95	11.5	2.50

TABLE 6B—DIMENSIONS AND TOLERANCES OF PIPE FOR AIR BRAKE USE, IN

Nominal Pipe Size	Outside Diameter Specified	Outside Diameter Tolerance Plus	Outside Diameter Tolerance Minus	Inside Diameter (Ref)	Wall Thickness Specified	Wall Thickness min	Threads per in	Weight Per ft,[1] lb ±5%
1/8	0.405	0.016	0.031	0.269	0.068	0.060	27	0.24
1/4	0.540	0.016	0.031	0.364	0.088	0.077	18	0.42
3/8	0.675	0.016	0.031	0.493	0.091	0.080	18	0.57
1/2	0.840	0.016	0.031	0.622	0.109	0.095	14	0.85
3/4	1.050	0.016	0.031	0.824	0.113	0.099	14	1.13
1	1.315	0.016	0.031	1.049	0.133	0.116	11.5	1.68

[1] Nominal Weight Plain Ends.

TABLE 7—MECHANICAL PROPERTIES, GALVANIZED STEEL PIPE

Yield Strength, MPa (psi), min	Elongation in 50 mm (2 in), %
170 (25 000)	14-40

NONMETALLIC AIR BRAKE SYSTEM TUBING—SAE J844 JUN98

SAE Standard

Report of the Tube, Pipe, Hose, and Lubrication Fittings Committe approved June 1963. Completely revised by the Fluid Conductors and Connectors Technical Committee October 1988 and June 1990. Revised by the SAE Fluid Conductors and Connectors Technical Committee SC4—Air Brake Tubing and Fitting October 1994, May 1997, and June 1998.

1. Scope[1]— This SAE Standard covers the minimum requirements for nonmetallic tubing as manufactured for use in air brake systems. Nonreinforced products are designated type A and reinforced products type B. It is not intended to cover tubing for any portion of the system which operates below –40 °C (–40 °F), above +93 °C (+200 °F), above a maximum working gage pressure of 1030 kPa (150 psi), or in an area subject to attack by battery acid. This tubing is intended for use in the brake system for connections which maintain a basically fixed relationship between components during vehicle operation. Coiled tube assemblies required for those installations where flexing occurs are covered by this document and SAE J1131 to the extent of setting minimum requirements on the essentially straight tube and tube fitting connections which are used in the construction of such assemblies[2].

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J246—Spherical and Flanged Sleeve (Compression) Tube Fittings

SAE J1131—Performance Requirements for SAE J844 Nonmetallic Tubing and Fitting Assemblies Used in Automotive Air Brake Systems

SAE J1149—Metallic Air Brake System Tubing and Pipe

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 4329—Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Plastics

ASTM G 53—Recommended Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent U-Condensation Type) for Exposure of Nonmetallic Materials

2.1.3 FEDERAL REGULATIONS—Available from The Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

49CFR393.45—Brake Tubing and Hose Adequacy

49CFR571.106—Brake Hoses

3. Installation and Assembly Recommendations

3.1 End Fittings—End fittings are to be assembled to the tubing in accordance with the fitting manufacturer's recommendations. The fitting may be of the design shown in SAE J246, or any other design suitable for use with nonmetallic air brake tubing. Performance test requirements for nonmetallic air brake assemblies are covered in SAE J1131.

3.2 Noncoiled Tubing—Noncoiled tubing should not be used in flexing applications such as frame to axle.

3.3 Support and Routing—When installed in a vehicle this tubing shall be routed and supported so as to:

a. Eliminate chafing, abrasion, kinking, or other mechanical damage
b. Minimize fatigue conditions
c. Be protected against road hazards by installation in a protected location or by providing adequate shielding at vulnerable areas

1. See SAE J1149 for Metallic Air Brake System Tubing and Pipe.
2. Federal regulations covering designed requirements and accepted applications for coiled tube assemblies are set forth in 49CFR393.45. Conformance to SAE J844 does not imply compliance with Federal regulations for air brake tubing. Sizes 3.97 mm (5/32 in) and below may not meet 49CFR571.106 requirements for air brake systems.

d. Not to be exposed to temperatures, internal or external, over +93 °C (+200 °F) or below –40 °C (–40 °F)
e. Not to be exposed to attack by battery acid
f. Avoid excessive sag

4. Identification—Air brake tubing shall be labeled in a contrasting color with the legend repeated every 380 mm (15 in) or less along the entire length of tubing in legible block capital letters.

The following minimum information, in the order listed, is required. Additional information and/or another lay line may be added, if necessary.

a. Air brake
b. SAE J844
c. Type, A or B
d. Nominal, tubing OD in fractions of 6.4, 9.5, 12.7 mm (1/4, 3/8, 1/2 in), etc.
e. Tubing manufacturer's identification

5. Manufacture—The tubing shall be manufactured to comply with the requirements outlined in this document.

6. Construction—Type A tubing shall consist of a single wall extrusion of 100% virgin nylon (polyamide) containing additives which provide heat and light resistance. Type B tubing shall consist of a core extrusion of 100% virgin nylon (polyamide) containing additives which provide heat resistance. This core shall be reinforced with polyester braid or equivalent, and covered with a protective jacket of 100% virgin nylon (polyamide) containing additives which provide heat and light resistance. The protective covering shall be bonded to the core through the interstices of the braid. The inner core and outer jacket shall be of contrasting colors.

7. Dimensions and Tolerances—The tubing shall conform to dimensions shown in Table 1 under all conditions of moisture. Conformance with this requirement shall be determined on samples which have been subjected to 110 °C (230 °F)[1] for 4 h[2] in a circulating air oven, and on separate samples which have been immersed in boiling water for 2 h. Dimensional tests shall be made after samples have been returned to room temperature for 1/2 to 3 h.

8. Mechanical Properties—The tubing shall conform to the mechanical properties shown in Table 2, when tested according to the methods outlined in this document.

9. Performance Requirements—The tubing shall satisfactorily meet the following performance tests (see footnotes 3, 4, 5, 6, 7, and 8).

9.1 Leak Test[3]—The tubing manufacturer shall subject each continuous length of tubing to test at a gage pressure of 200 psi +50, –0 (1380 kPa +350, -0) with an appropriate gas for a period of time (minimum 30 s) sufficient to determine the presence of any leaks. Defective sections shall be cut off and scrapped. The remaining tubing shall be recoupled at the points where defective sections were removed and again subjected to the 200 psi +50, –0 (1380 kPa +350, -0) pressure test. The procedure shall be repeated until all sections of tubing designated for distribution to users have successfully withstood the test.

9.2 Moisture Absorption[4]—Expose sample of tubing for 24 h in a circulating air oven at 110 °C (230 °F). Remove from oven, weigh immediately and expose for 100 h at 100% relative humidity and 24 °C (75 °F). Within 5 min from humidity conditioning, wipe surface moisture from both the interior and exterior surfaces of the tubing and reweigh. Moisture absorption shall not exceed 2% by weight.

9.3 Ultraviolet Resistance[6]—Place samples of tubing in the sample racks of a Q-Panel QUV test apparatus* equipped with Phillips bulbs, type UVA-340. Expose for 300 h minimum. If the test apparatus is equipped with a "Solar Eye," the bulbs need not be rotated and the irradiance should be set at 0.85, however all bulbs should be discarded after 4800 h maximum, or if they fall below the 0.85 irradiance level, whichever occurs first. If the test apparatus is not equipped with a "Solar Eye," the bulbs must be rotated every 400 h maximum, as recommended by the manufacturer and ASTM G 53, this procedure will result in discarding lamps after 1600 h of use. Control the temperature of the appartus to 45 °C ± 3 °C. The distance from the plate upon which the specimens are mounted and the light bulbs will be 51 mm (2 in) maximum. The automatic humidity cycling must be turned off. Rotate the specimens according to ASTM D 4329 except the time interval should be each 96 hours maximum instead of weekly. Maintain and operate the QUV tester in accordance with the manufacturers instructions. Immediately following this exposure, subject the tubing to the impact test shown in Figure 1. Subject tubing to room temperature burst as specified in 9.10. Tubing shall withstand no less than 80% of the burst pressure shown in Table 2.

* The Q-Panel QUV Accelerated Weathering Tester is available from:
The Q-Panel Company
26200 First Street
Cleveland, OH 44145
(216) 835-8700

1. All test temperatures specified may vary by ±3 °C (±5 °F).
2. All times are minimum unless otherwise specified.
3. Normally an Inspection Test conducted on each lot of tubing, and where a lot is defined as "the output of one production shift of one size and color of tubing."
4. A Qualification Test.

TABLE 1—DIMENSIONS AND TOLERANCES

Type of Tubing	Nominal Tubing OD	Outside Diameter max mm	Outside Diameter max in	Outside Diameter min mm	Outside Diameter min in	Inside Diameter Basic mm	Inside Diameter Basic in	Wall Thickness Basic mm	Wall Thickness Basic in	Wall Thickness Tolerances mm	Wall Thickness Tolerances in
A	1/8	3.25	0.128	3.10	0.122	2.01	0.079	0.58	0.023	±0.08	±0.003
A	5/32	4.04	0.159	3.89	0.153	2.34	0.092	0.81	0.032	±0.08	±0.003
A	3/16	4.83	0.190	4.67	0.184	2.97	0.117	0.89	0.035	±0.08	±0.003
A	1/4	6.43	0.253	6.27	0.247	4.32	0.170	1.02	0.040	±0,08	±0.003
A	5/16	8.03	0.316	7.82	0.308	5.89	0.232	1.02	0.040	±0.10	±0.004
B	3/8	9.63	0.379	9.42	0.371	6.38	0.251	1.57	0.062	±0.10	±0.004
B	1/2	12.83	0.505	12.57	0.495	9.55	0.376	1.57	0.062	±0.10	±0.004
B	5/8	16.00	0.630	15.75	0.620	11.20	0.441	2.34	0.092	±0.13	±0.005
B	3/4	19.18	0.755	18.92	0.745	14.38	0.566	2.34	0.092	±0.13	±0.005

TABLE 2—MECHANICAL PROPERTIES

Type of Tubing	Nominal Tubing OD	Minimum Burst Pressure at 24 °C (75 °F)(1) kPa	Minimum Burst Pressure at 24 °C (75 °F)(1) psi	Test Bend Radius(2) mm	Test Bend Radius(2) in	Maximum Stiffness N	Maximum Stiffness lbf
A	1/8	6900	1000	9.4	0.37	4.4	1
A	5/32	8300	1200	12.7	0.50	4.4	1
A	3/16	8300	1200	19.1	0.75	4.4	1
A	1/4	8300	1200	25.4	1.00	8.9	2
A	5/16	6900	1000	31.8	1.25	27.0	6
B	3/8	9700	1400	38.1	1.50	36.0	8
B	1/2	6600	950	50.8	2.00	89.0	20
B	5/8	6200	900	63.5	2.50	222.0	50
B	3/4	5500	800	76.2	3.00	356.0	80

1. With moisture content of tubing 0.06% maximum.
2. For test purpose only.

NOMINAL TUBE O.D.	HOLE DIA D mm	HOLE DIA D in
1/8	3.96	0.156
5/32	4.75	0.187
3/16	5.54	0.218
1/4	7.14	0.281
5/16	8.71	0.343
3/8	10.31	0.406
1/2	13.49	0.531
5/8	16.66	0.656
3/4	20.32	0.800

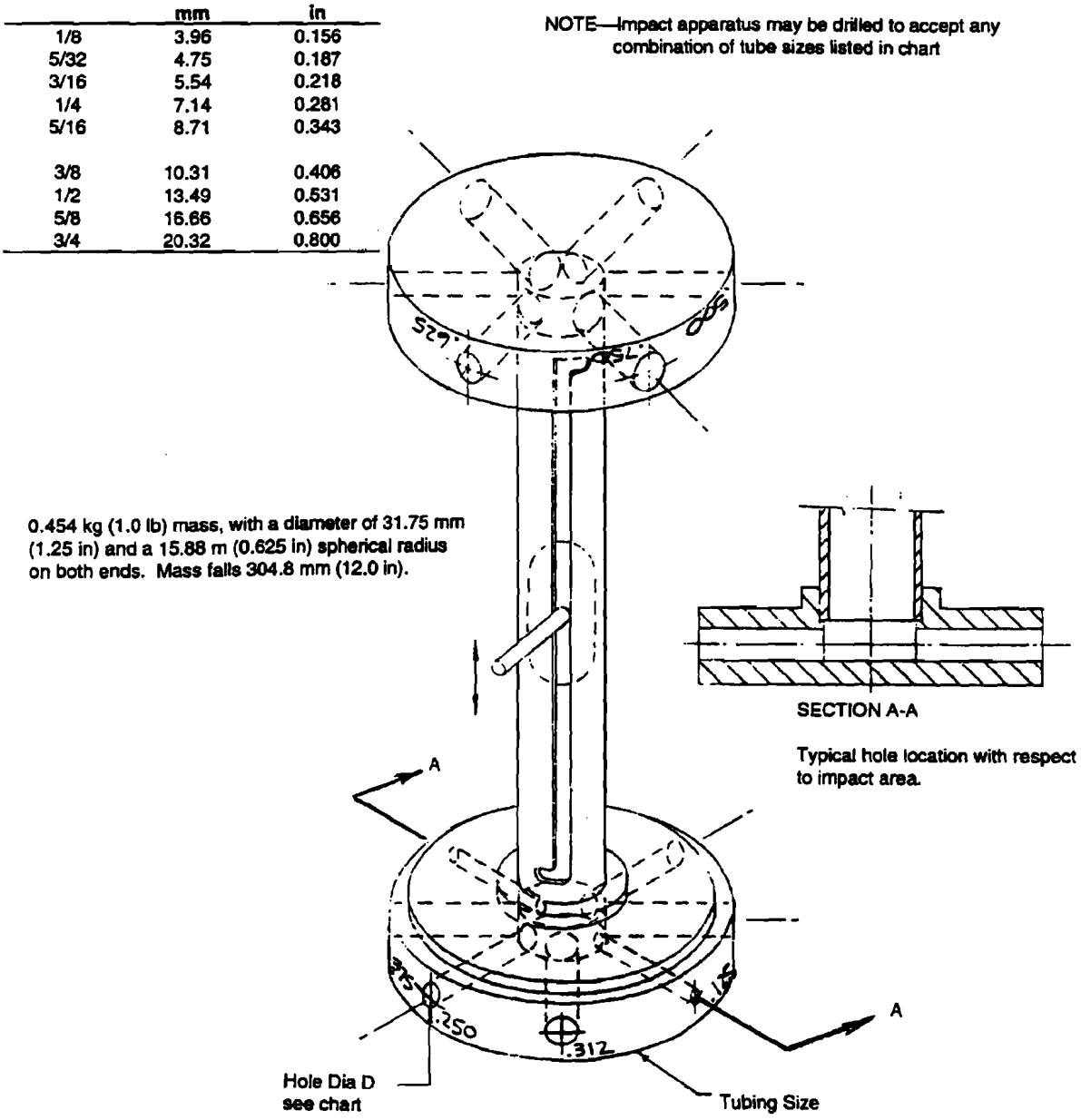

FIGURE 1—TYPICAL NYLON TUBING IMPACT APPARATUS

9.4 Cold Temperature Flexibility[6]—Expose sample of tubing for 24 h in a circulating air oven at 110 °C (230 °F). Remove from oven and within 30 min expose for 4 h at -40 °C (-40 °F). Also expose a mandrel at -40 °C (-40 °F) having a diameter equal to 12 times the nominal diameter of the tubing. (In order to obtain uniform temperatures, the tubing and mandrel may be supported by a nonmetallic surface during the entire period of test.) Immediately following this exposure, bend tubing 180 degrees over the mandrel, accomplishing the bending motion within a period of 4 to 8 s. The tubing shall show no evidence of fracture.

9.5 Heat Aging[1]—Three separate heat aging tests shall be conducted; each phase shall be run on separate tubing samples. Subject tubing to room temperature burst test as specified in 9.10. Tubing shall withstand 80% of the burst pressure shown in Table 2.

a. Phase 1—Bend samples of tubing 180 degrees around a mandrel having a diameter equivalent to twice the test bend radius specified in Table 2. While in this position, expose tubing and mandrel for 72 h in a circulating air oven at 110 °C (230 °F). Remove from oven and permit tubing to return to 24 °C (75 °F) while still on the mandrel. Within 30 min after stabilization at 24 °C (75 °F), return the tubing to a straight position in a minimum of 4 s, then rebend (against the set) 180 degrees around the mandrel, accomplishing the bending motion within a period of 4 to 8 s.

b. Phase 2—Expose samples of tubing for 72 h in a circulating air oven at 110 °C (230 °F). Remove from oven and permit tubing to return to 24 °C (75 °F). Within 30 min after stabilization at 24 °C (75 °F), subject tubing to the impact test shown in Figure 1.

c. Phase 3—Immerse samples of tubing in boiling water for 2 h. Remove from water and permit to return to 24 °C (75 °F). Within 30 min after stabilization at 24 °C (75 °F), subject tubing to the impact test shown in Figure 1.

9.6 Resistance to Zinc Chloride[7]—Bend tubing to the test bend radius shown in Table 2. While in this position, immerse in a 50% (by weight) aqueous solution of zinc chloride for 200 h at 24 °C (75 °F). Remove from solution. Tubing shall show no evidence of cracking on the outside diameter.

1. A Qualification Test.

NOTE—Fresh, anhydrous zinc chloride should be used to make up a concentration of 50% (by weight) aqueous solution (specific gravity of 1.576 or a Baume rating of 53 degrees at 16 °C (61 °F)).

9.7 Resistance to Methyl Alcohol[7]—Bend tubing to the test bend radius shown in Table 2. While in this position, immerse in 95% methyl alcohol for 200 h at 24 °C (75 °F). Remove from solution. Tubing shall show no evidence of cracking.

9.8 Stiffness[7]—Use samples 280 mm (11 in) long. Insert a rod of suitable size into the tubing to maintain a straight position within 3.2 mm (±0.125 in). Expose tubing and rod for 24 h in a circulating air oven at 110 °C (230 °F). Remove from oven and permit tubing and rod to return to 24 °C (75 °F). Within 30 min after stabilization at 24 °C (75 °F), remove rod and subject tubing to stiffness test shown in Figure 2. Tubing shall require no more force than specified in Table 2 to deflect 51 mm (2 in).

9.9 Boiling Water Stabilization and Burst Test[7]—Immerse tubing in boiling water for 2 h. Remove from water and subject to the room temperature burst test as specified in 9.10. Tubing shall withstand no less than 80% of the burst pressure shown in Table 2.

9.10 Room Temperature Burst Test[1]—Tubing shall be stabilized for 0.5 to 3.0 h at 24 °C (75 °F) and tested by increasing pressure at a constant rate to reach the specified minimum burst pressure in Table 2 within a time period of 3 to 15 s. Tubing that bursts below the pressure specified in Table 2 shall be rejected.

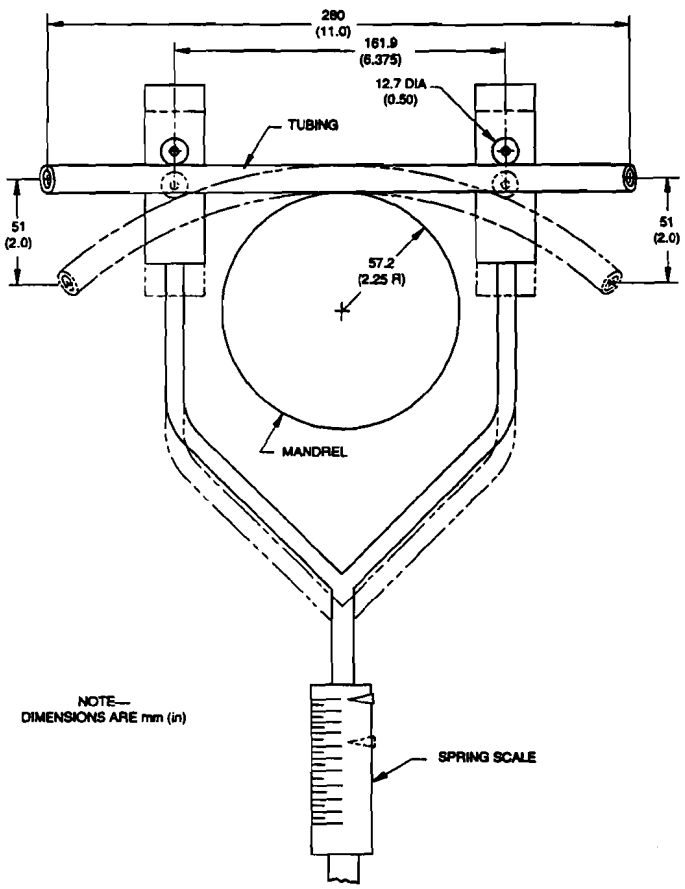

FIGURE 2—STIFFNESS TEST APPARATUS

9.11 Cold Temperature Impact[2]—Condition tubing by exposing one half the samples for 24 h at 110 °C (230 °F) in a circulating air oven, and one half the samples in boiling water for 2 h; then expose all the samples to –40 °C (–40 °F) for 4 h. Also, expose impact test apparatus, shown in Figure 1, to –40 °C (–40 °F). While tubing and apparatus are at this cold temperature (approximately –40 °C (–40 °F), subject tubing to impact as specified. The tubing shall show no evidence of cracks. After impact testing, permit tubing to return to 24 °C (75 °F). Within 30 min after stabilization at 24 °C (75 °F), subject tubing to room temperature burst test as specified in 9.10. Tubing shall withstand at least 80% of the burst pressure shown in Table 2. Sample size shall be 10 specimens per lot. In the event of any failures, a second sample from the same lot consisting of 20 specimens shall be tested. If another failure occurs, the lot shall be rejected.

9.12 Adhesion Test[9]

9.12.1 This test applies only to the reinforced products, Type B.

9.12.2 CONDITION—This test shall be conducted at 24 °C (75 °F) ambient temperature.

9.12.3 PROCEDURE AND REQUIREMENTS—Cut a strip of tubing into a 6.0 mm (0.25 in) wide helical coil equal in length to five times the circumference of the tubing. Bend the helical coil in reverse of coiling so as to expose the braid gap between the outer jacket and core tube section. Start by working a sharp knife blade into the braid gap to initiate separation, and then attempt to separate the outer jacket from the core tube at the braid interstices. The bonded surface (excluding the braided area) between the outer jacket and core section shall be inseparable for the entire test sample length.

9.13 Heat Aging Adhesion Test[3]

9.13.1 PROCEDURE—Subject samples to Phase 1 of the heat aging test procedure per 9.5.

9.13.2 REQUIREMENTS—After completion of the Phase 1 procedure, the tubing shall meet the requirements of 9.12.

9.14 Collapse Resistance Test Procedure[10]

9.14.1 GENERAL—All tests are to be conducted at room temperature 93 °C (75 °F)[4] unless otherwise specified.

9.14.2 PREPARATION OF TEST SAMPLES—Three samples shall be prepared for testing. The free tube length of the samples shall be as follows:

3.14 x (min kink radius) + 10 x (tube OD) + 2 x (length of supporting pin)

9.14.3 TEST PROCEDURE—Place a reference mark at the middle of each sample and measure the cross section diameter (Minor Diameter [unbent]) at this point and record.

NOTE—See Figures 4 and 3 for location of minor diameters.

9.14.4 Carefully install the samples on a bend test fixture (as shown in Figure 5) in a 180-degree bend condition. The tube shall be bent in the direction of the natural curvature of the tube. Samples prepared per 9.14.2 shall be bent to a radius equal to the minimum kink radius called out in Table 3.

9.14.5 Age samples on test fixture at 93 °C (200 °F)[5] for 24 h[6]. Allow the samples to cool to room temperature. While the samples are on the test fixture, measure the minor diameter (bent). Collapse of greater than 20% is considered a failure (see Equation 1).

$$\text{Percent Collapse} = \frac{\text{Minor OD [unbent]} - \text{Minor OD [bent]}}{\text{Minor OD [unbent]}} \times 100 \qquad \text{(Eq. 1)}$$

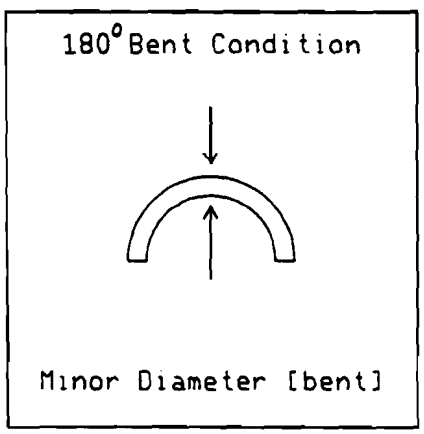

FIGURE 3—MINOR DIAMETER (BENT)

1. Normally an Inspection Test conducted on each lot of tubing, and where a lot is defined as "the output of one production shift of one size and color of tubing."
2. Normally an Inspection Test conducted on each lot of tubing, and where a lot is defined as "the output of one production shift of one size and color of tubing."
3. A Qualification Test.
4. All test temperatures specified may vary by ±3 °C (±5 °F).
5. All test temperatures specified may vary by ±3 °C (±5 °F).
6. All times are minimum unless otherwise specified.

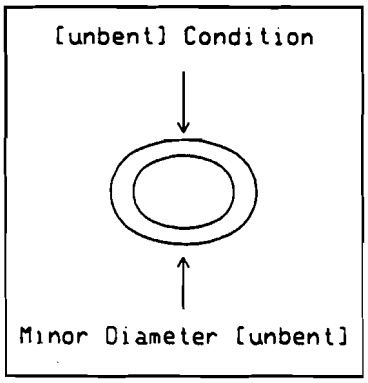

FIGURE 4—MINOR DIAMETER (UNBENT)

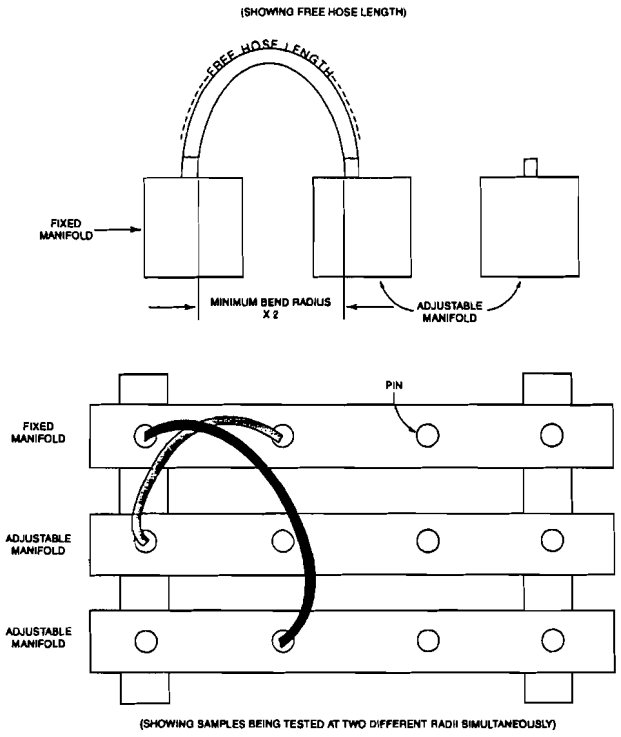

FIGURE 5—BEND TEST FIXTURE

TABLE 3—MINIMUM KINK RADIUS[1]

Tubing Size	Minimum Kink Radii (mm)	Minimum Kink Radii (In)
1/8 A	9.4	0.37
5/32 A	12.7	0.50
3/16A	19.1	0.75
1/4 A	25.4	1.00
5/16 A	38.1	1.50
3/8 B	38.1	1.50
1/2 B	63.5	2.50
5/8 B	76.2	3.00
3/4 B	88.9	3.50

1. It should be noted that these values represent unsupported kink radii which can be used for installation purposes.