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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE STANDARD

SAE J2043

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Nonmetallic Fuel System Tubing

1. ***Scope***—This SAE Standard covers the minimum requirements for nonmetallic tubing as manufactured for use in gasoline or diesel fuel systems. It is not intended to cover tubing for any portion of the system which operates below –40 °C, above 115 °C, or above a maximum working gage pressure of 690 kPa.

2. ***References***

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

2.1.1 SAE PUBLICATIONS—Available From SAE, 400 Commonwealth Drive, Warrendale, Pa 15096-0001.

SAE J30—Fuel and Oil Hoses
SAE J1681—Gasoline/Methanol Mixtures for Material Testing
SAE J2044—SAE Quick Connector Specifications for Liquid Fuel Systems

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

ASTM D 412—Test Methods for Rubber Properties in Tension
ASTM D 4000—Classification System for Specifying Plastic Materials
ASTM D 4066—Specification for Nylon Injection and Extrusion Materials

3. ***Installation, Assembly, Handling Recommendation***

3.1 End Fittings—End fittings are to be assembled to the tubing with a procedure which does not permit mechanical damage to the tubing. Assemblies manufactured with such end fittings must meet all of the requirements of the SAE J2044 specification.

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

a. Prevent 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.
d. Be protected where temperatures exceed the limits –40 to 115 °C by the addition of insulation.

3.3 Handling—Tubing ends should be protected during handling and storage to prevent internal contamination.

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4. ***Color and Identification***—Fuel system tubing shall be black. Fuel system tubing shall be labeled in a contrasting color with the legend repeated every 380 mm 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. Fuel
   b. SAE J2043-NNNN ('NNNN' = Tubing Nominal OD, from Table 1.)

5. ***Construction***—Fuel system tubing shall consist of a single wall extrusion of virgin nylon 11 or 12 (polyamide) containing additives which provide heat and light resistance.

   Plasticizers, colorants, and impact modifiers only may also be added to the nylon raw material. No regrind is permitted. The material shall meet the specified ASTM D 4000/D 4066 requirements.

6. ***Dimensions and Tolerances***—The tubing shall conform to the dimensions shown in Table 1 under all conditions of moisture.

TABLE 1—DIMENSIONS AND TOLERANCES

Nominal Outside Diameter mm	Inside Diameter mm	Wall Thickness mm	Minimum Bend Diameter mm
6.35	3.89–4.14	0.98–1.14	76.2
7.93	6.20–6.50	0.90–1.15	101.6
9.53	7.90–8.20	0.90–1.15	152.4

7. ***Performance Requirements***—The tubing shall meet the following performance tests with a ±3 sigma capability.

   Tubing shall be tested for conformance to the requirements after a minimum of 24 h after tubing manufacturer.

   All test temperatures specified may vary by ±2 °C, unless otherwise specified. All times are minimum unless otherwise specified.

7.1 **Room Temperature Burst Test**—Tubing shall be stabilized (for 1/2 to 3 h at 23 °C) and tested by increasing pressure at a constant rate to reach a pressure of 3500 kPa within a time period of 3 to 15 s. Continue at that rate until tubing bursts. The lower 3 sigma burst pressure shall be 3500 kPa.

7.2 **Cold Temperature Flexibility**—Expose sample of tubing for 24 h in circulating air oven at 110 °C. Remove from oven and within 30 min expose for 4 h at –40 °C using a mandrel with a diameter equal to 12 times the nominal outside 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. Permit tubing to return to 23 °C, subject tubing to Room Temperature Burst Test per 7.1. Tubing must meet the requirements of the Room Temperature Burst Test.

7.3 **Resistance to Zinc Chloride**—Bend tubing to form a coil with the minimum bend diameter shown in Table 1. Secure the coil with copper wire to maintain this diameter (ties made of Nylon 11 or Nylon 12 can also be used.) While in this position, immerse in a 50% (by weight) aqueous solution of zinc chloride for 200 h at 23 °C. Remove from solution. Tubing shall show no evidence of cracking on the outside diameter. Subject tubing to the requirements of the Room Temperature Burst 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 at 15.6 °C.)

7.4 **Burst Test-Kinked Tubing**—Tubing shall be stabilized for 1/2 to 3 h at 23 °C. Bend tubing so tubing is kinked and two lengths of tubing on either side of kink touch along entire length. Straighten tubing completely. Repeat so tubing is kinked a total of five times at same position of tubing. Conduct Room Temperature Burst Test per 7.1. Tubing must meet the requirements of the Room Temperature Burst Test.

7.5 **Resistance to Kinking**—Use test sample length and test ball diameter as indicated in Table 2. Tubing to be tested shall be a minimum wall thickness as indicated in Table 1. Install the tube onto the test fixture as described in Figure 1. When installing the tube, it shall be bent in the same plane and direction as its free state curvature. Place the tube, installed on the fixture into an oven at 121 °C and soak for 1 h. Remove the fixture from the oven. Within 5 min, pass the specified steel ball through the tube on the fixture.

Restriction to the passage of the ball constitutes a failure.

TABLE 2—TEST DIMENSIONS FOR 7.5

Nominal Outside Diameter mm	Sample Length mm	Ball Diameter mm
6.35	240 ± 5	2.13 ± 0.50
7.93	460 ± 5	2.95 ± 0.50
9.53	715 ± 5	3.75 ± 0.50

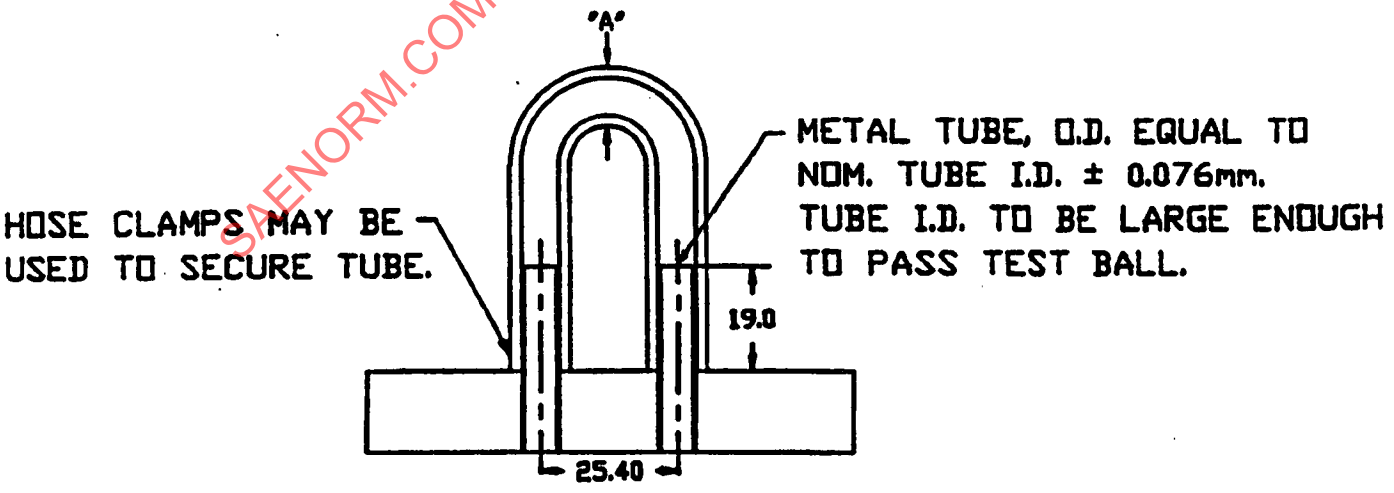


Figure 1—KINKING RESISTANCE TEST FIXTURE

7.6 **Tensile Strength, Elongation**—The minimum tensile strength and elongation at break of the tubing at 23 degrees shall be as follows:

a. Tensile Strength, minimum = 30 MPa
b. Elongation, minimum = 200%

The fixturing shall be as described in Figure 2. The procedure to be followed shall be as described in 7.6.1 through 7.6.3.

7.6.1 TEST METHODS SUMMARY—This test method covers tension testing of plastic fuel tubing. This test method follows the general practices of ASTM D 412. Method "A" of ASTM D 412 for dumbbell and straight specimens is the method of choice with the following modifications listed in 7.6.2.1. See also ITT Standard, Method for Measuring Elongation at Break and Tensile Strength at Break.

7.6.2 MODIFICATIONS TO ASTM D 412

7.6.2.1 *Grips and Fixtures*—For gripping plastic tubing, metal pins for the dimensions shown for applicable tubing bore (Figure 3) are inserted into the ends of the tubing. The ends of the tubing are inserted into grips fitted with a collet as shown in Figure 3. Hydraulic pressure of 17.2 MPa is applied to the grips to prevent specimen slippage. This method of gripping provides a more even distribution of pressure on the tubing in the grips. This reduces the chance of the tubing failing in the gripping fixture.

7.6.2.2 *Gage Length and Distance Between Grips*—The gage length between benchmarks shall be 25 mm ± 2 mm. The distance between grips shall be not less than 150 mm.

7.6.2.3 *Crosshead Travel Speed*—The crosshead travel speed shall be set at 50 mm/min ± 5 mm/min.

7.6.3 SUMMARY—The method of gripping tubing when testing in tension is critical to optimizing repeatability. The previous modifications to ASTM D 412 listed in 7.6.2, enhance this repeatability.

7.7 **Cold Temperature Impact**—Expose the tubing to –40 °C for 4 h, and expose the Impact Test Apparatus pictured in Figure 3 for 1 h at –40 °C. A chest type cold chamber is required for the cold soaking of the tubing and the fixture. The impact head of the fixture must have a mass of 0.912 kg ± 0.003 kg, a diameter of 31.75 mm, and a spherical radius of 15.88 mm. The sample is inserted into the test apparatus, and impacted by allowing the head to fall 305 mm ± 3 mm. If the test cannot be done inside the cold chamber, the impact should occur immediately after the removal of the apparatus and the tube sample to be tested. Allow tubing to return to 23 °C within 30 min ± 5 min, and then subject tubing to the Room Temperature Burst Test per 7.1.

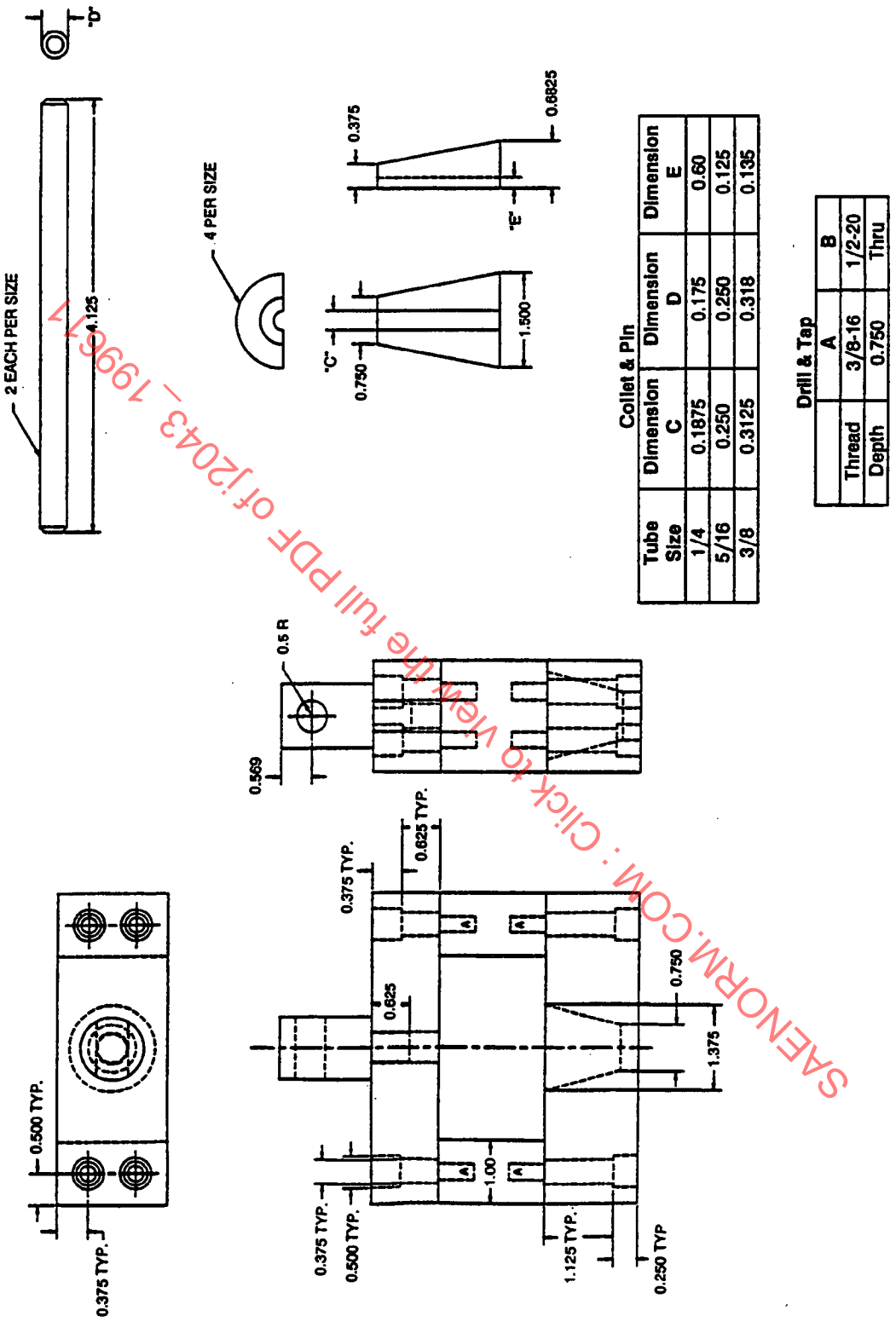
The mass must be free to impact the tubing throughout the length of the impact without hindrance by any portion of the fixture. The maximum radius of curvature of the edge of the supporting platform of the tubing at the circumference of the impact area = 1.3 mm.

The temperature of the fixture and the tubing must be held to –40 °C.

The 305 mm ± 3 mm impact distance is measured to the center of the tube specimen being impacted.

The tubing must meet the Room Temperature Burst Test Requirements.

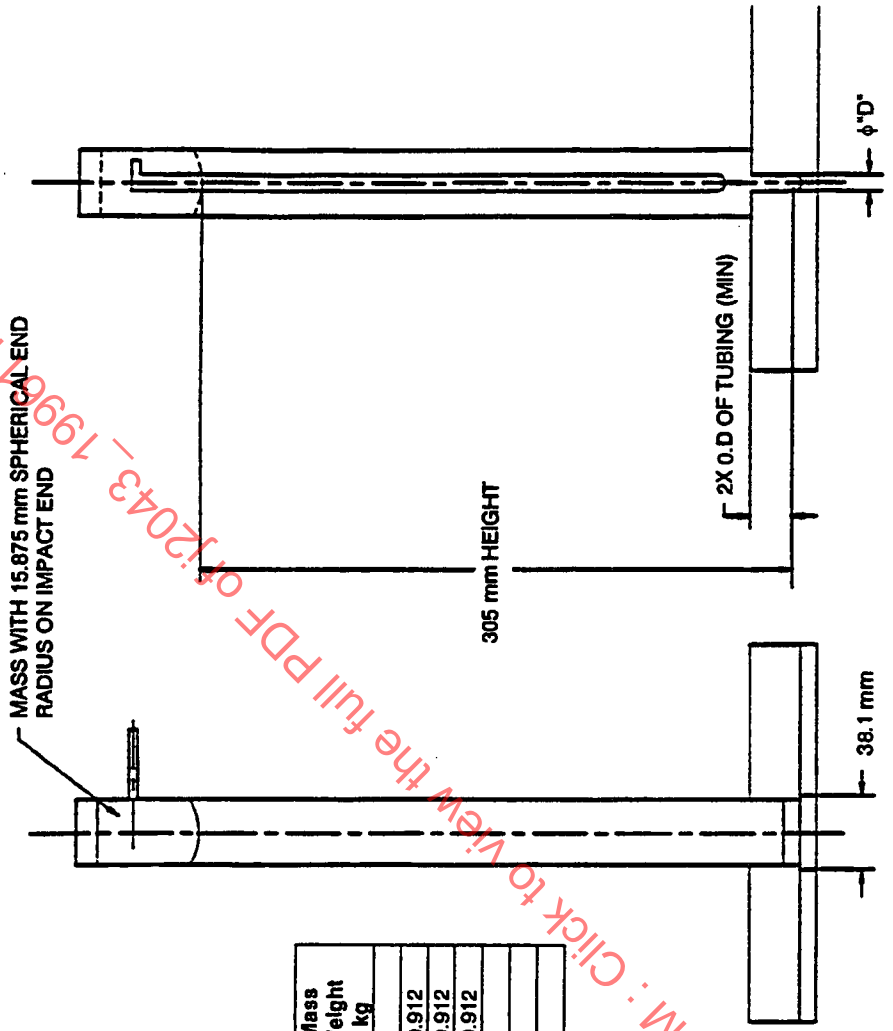
7.8 **Fuel Resistance**—Immerse tubing in ASTM Reference Fuel C for 45 days at 23 °C. The Fuel C test fuel must be replaced with fresh test fuel every 7 days. After 45 days, the tubing is to be removed and tested for tensile strength and elongation per 7.6. The tubing must retain 75% of the tensile strength and elongation values recorded for the non-fuel exposed tubing as measured per 7.6.



Collet & Pin			
Tube Size	Dimension C	Dimension D	Dimension E
1/4	0.1875	0.175	0.60
5/16	0.250	0.250	0.125
3/8	0.3125	0.318	0.135

Drill & Tap		
	A	B
Thread	3/8-16	1/2-20
Depth	0.750	Thru

Figure 2—FIXTURE FOR GRIPPING OF TUBING DURING TENSILE STRENGTH/ELONGATION TESTING (from 7.6)



Nominal Tube O.D	Hole "D" mm	Hole "D" In	Mass Weight kg
6.35 mm	3.96	0.156	0.912
7.93 mm	7.14	0.281	0.912
9.53 mm	6.71	0.343	0.912
	10.31	0.406	0.912
	13.49	0.531	
	16.66	0.656	
	20.32	0.800	

Figure 3—COLD IMPACT TEST FIXTURE