

Submitted for recognition as an American National Standard

## TESTS AND PROCEDURES FOR SAE LOW-CARBON STEEL AND COPPER NICKEL TUBING

1. **Scope**—This SAE Standard is intended to establish uniform methods for the testing and performance evaluation of certain types of steel and copper nickel tubing. The specific test and performance criteria applicable to each variety of tubing are set forth in the respective SAE J-Specifications.
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 PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.  
SAE J533—Flares for Tubing
    - 2.1.2 ASTM PUBLICATION—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.  
ASTM A 370—Methods and Definitions for Mechanical Testing of Steel Products
  - 2.2 **Related Publications**—The following publications are provided for information purposes only and are not a required part of this document.
    - 2.2.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.  
SAE J356—Welded Flash Controlled Low-Carbon Steel Tubing Normalized for Bending, Double Flaring and Beading  
SAE J524—Seamless Low-Carbon Steel Tubing Annealed for Bending and Flaring  
SAE J525—Welded and Cold-Drawn Low-Carbon Steel Tubing Annealed for Bending and Flaring  
SAE J526—Welded Low-Carbon Steel Tubing  
SAE J527—Brazed Double Wall Low-Carbon Steel Tubing  
SAE J1650—Seamless Copper Nickel 90-10 Tubing
3. **Test Procedures**—The test procedures described in the current issue of ASTM D 370 shall be followed. However, in cases of conflict between the ASTM specifications and those described herein, the latter shall take precedence.

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**3.1 Test Frequency**—There are many factors which can effect the required frequency of these tests, including:

- a. Tube size
- b. Production run quantity
- c. Type of production equipment
- d. Production methods
- e. End use
- f. Material

Therefore, it shall be the responsibility of the manufacturer and user to establish a test frequency that will produce tubing which conforms to the SAE Standards as well as the needs and requirements of the user.

**4. Test Specimens**—Test specimens for mechanical tests shall be smooth on the ends and free from flaws. If any test specimen exhibits burrs, flaws, or defective machining before testing, it may be discarded and another specimen may be selected. Test specimens shall be taken from tubing which has not been subjected to cold working after the anneal of the finished sized tubing. All tests shall be conducted at room temperature using finished tubing.

**5. Performance Tests**—Test specimens shall be taken from tubing which has not been subjected to cold working after the final processing of the finished sized tubing.

**5.1 Flattening Test**—Test specimens approximately 75 mm in length shall not crack or show any flaws when flattened between parallel plates to a distance equal to three times the wall thickness of the section under test. For welded tubing, the weld shall be placed at 90 degrees from the direction of applied force. Superficial ruptures resulting from minor surface imperfections shall not be considered cause for rejection.

**5.2 Reverse Flattening Test**—Test specimens shall be split longitudinally 90 degrees on each side of the weld. The section containing the weld shall be opened and flattened with the weld at the point of maximum bend. There shall be no evidence of cracks or metal flaking, or lack of weld penetration or overlaps resulting from flash control or flash removal in the weld.

**5.3 Bending Test**—If a bend test is required, the customer shall specify a suitable test method at time of purchase.

**5.4 Expansion Test**—Test specimens shall be subjected to expansion over a hardened tapered plug having a slope of 0.1:1.0, until the outside diameter has been expanded 25% without evidence of cracking or flaws.

**5.5 Flaring Test**

**5.5.1 DOUBLE FLARE—METHOD A**—Test sections having squared and deburred ends shall withstand being double flared at one end to the dimensions shown in SAE J533. The test section shall be held firmly and squarely in the die and the punch, while being forced down, shall be guided parallel to the axis of the tubing. The flare shall exhibit no evidence of splitting or flaws in area A (Figure 1).

- a. Area B—The flare seat, defined as the surface within the included angle. Conical surface shall be smooth and free from cracks or other irregularities which could cause leaks after assembly.
- b. Area C—The surface beyond the length of the double thickness created by the flare.

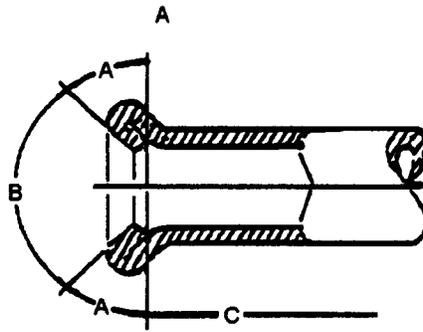


FIGURE 1—DOUBLE FLARED TUBING

5.5.2 DOUBLE FLARE—METHOD B—Test sections having squared and deburred ends shall withstand being double flared at one end to the dimensions shown in SAE J533. The test section shall be held firmly and squarely in the die and the punch, while being forced down, shall be guided parallel to the axis of the tubing. The flare shall exhibit no evidence of splitting or flaws except that a separation of the outer lap joint with area A (Figure 2) shall be permissible providing it does not exceed 3.1 mm in length and is confined to the outer thickness only. Seam separation shall not be permissible in the following areas:

- a. Area B—The flare seat, defined as the surface within the included angle. Conical surface shall be smooth and free from cracks or other irregularities which could cause leaks after assembly.
- b. Area C—The surface beyond the length of the double thickness created by the flare.

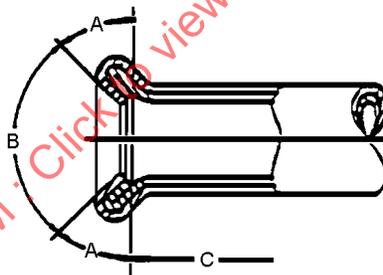


FIGURE 2—DOUBLE FLARED, DOUBLE WALL TUBING

5.5.3 SINGLE FLARE—Test sections having squared and deburred ends shall withstand being single flared at one end to the dimensions shown in SAE J533. The test section shall be held firmly and squarely in the die and the punch, while being forced down, shall be guided parallel to the axis of the tubing. The flare shall exhibit no evidence of splitting or flaws in area A (Figure 3).

- a. Area B—The flare seat, defined as the surface within the included angle. Conical surface shall be smooth and free from cracks or other irregularities which could cause leaks after assembly.

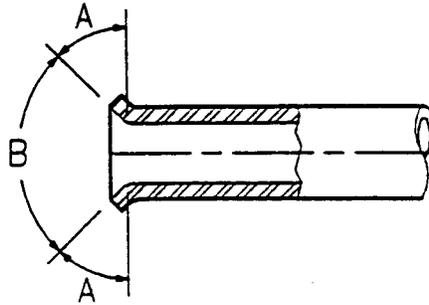


FIGURE 3—SINGLE FLARED TUBING

- 5.6 Hardness Test**—Hardness tests shall be made on the inside surfaces of test specimens. This test is not required on tubing with a nominal wall thickness less than 1.7 mm. Such tubing shall meet all other mechanical properties and performance requirements.
- 5.7 Tensile Test**—If the percentage of elongation of the test specimen is less than that specified and/or any part of the fracture is more than 19 mm from the center of the gage length, as indicated by scribe marks on the specimen before testing, a retest shall be allowed.
- 5.8 Proof Pressure Test**—Tubing shall be tested hydrostatically, with no evidence of failure, at a pressure which will subject the material to the appropriate fiber stress. Test pressures shall be as determined by Barlow's formula for thin hollow cylinders under pressure:

$$P = \frac{2TS}{D} \quad (\text{Eq. 1})$$

where:

D = outside diameter of tubing, mm

P = hydrostatic pressure, MPa

S = allowable unit stress of material from applicable tubing specification, MPa

T = minimum wall thickness of tubing, mm

No tube shall be tested beyond a hydrostatic pressure of 35 MPa unless so specified and mutually agreed upon by supplier and customer.

- 5.9 Nondestructive Electronic Test**—In lieu of the hydrostatic test, where mutually agreed upon by the purchaser and manufacturer, all tubing shall be tested by passing it through a nondestructive electronic test (such as eddy current, flux leakage, or ultrasonic) which is capable of detecting defects that would prevent the tubing from passing the hydrostatic pressure proof test.