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400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1047

CAN-CELLED NOV1998

Issued 1974-10
Cancelled 1998-11

Superseding J1047 JUN90

Tubing—Motor Vehicle Brake System Hydraulic

Foreword—This is a performance requirement qualification specification intended to give reasonable flexibility in the initial engineering selection of materials when fabricated by currently accepted manufacturing processes. It is not intended to be used for quality control purposes.

1. Scope—This SAE Recommended Practice covers the tubing intended primarily for use as hydraulic brake lines on motor vehicles. It covers materials, manufacturing processes, and general properties required to meet the wide range of service encountered in automotive applications. To meet this need, it must be formed, assembled, handled, and installed in accordance with sound engineering and manufacturing practices. This specification covers only the basic tubing and does not include attachments such as protective armor or end fittings. This document is not intended to be used for quality control purposes. Design guidelines are shown in Appendix A.

2. References

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

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

SAE J533—Flares for Tubing
SAE J1703—Motor Vehicle Brake Fluid

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

ASTM B 117—Method of Salt Spray (Fog) Testing
ASTM Bulletin #187 of January 1953

3. Materials—The material(s) must be metallic and compatible with the type of tube construction.

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4. Construction—The construction must be limited to either of the following types:

4.1 Multiple Ply Tubing—Wherein the plies are continuously bonded by a metallurgical bond, and if made from separate strips, the joints in adjacent plies, which occur as a result of the forming operation, are separated by at least 120 degrees (2.1 rad).

4.2 Seamless Tubing

5. Requirements—The tubing must meet the following requirements:

5.1 Bursting Strength—When tested with hydraulic pressure, sections of tubing - with a minimum expanded length of 18 in (45.7 cm) - must be capable of withstanding an internal pressure of 8000 psi (5.52 MN/m^2).

5.2 Bending Properties

5.2.1 Using suitable bending fixtures, an adequate length of tubing must withstand bending around a mandrel whose diameter is equal to five times the nominal diameter of the tubing, through 360 degrees (6.28 rad) without kinking, cracking, or developing other flaws.

5.2.2 The reduction in tubing outside diameter must not exceed 20%.

5.2.3 After the bending test, the tubing must be capable of meeting the corrosion resistance requirements (see 5.6).

5.3 Flaring Test

5.3.1 The tubing must be capable of being expanded over a tapered mandrel, having a slope (based on radius) of one in ten, until the outside diameter at the expanded end is increased 20% without cracking or developing other flaws. Prior to the expansion test, the tubing must be cut off square, edge crowned, and deburred. It must be held firmly and squarely in the die, and the punch must be guided on the axis of the tubing.

5.3.2 The tubing must be capable of being flared with double 45 degree (0.79 rad) flares in accordance with SAE J533. There must not be cracks on the sealing surface nor other imperfections which would prevent sealing.

5.4 Fatigue Resistance—Straight lengths of new tubing, when tested as outlined in 6.1, must have a minimum fatigue limit of 24 000 psi (16.55 MN/m^2) at 10^7 cycles for steel, or an equivalent degree of fatigue resistance if made of other materials.

5.5 Heat Resistance

5.5.1 After soaking at a temperature of 425 °F ± 25 (218 °C ± 14) for 30 min ± 5, the tubing must be capable of meeting the bursting strength requirements (see 5.1).

5.5.2 After being subjected to a temperature of 425 °F ± 25 (218 °C ± 14) for 30 min ± 5, the tubing must be capable of the corrosion resistance requirements (see 5.6).

5.6 Corrosion Resistance—Either of the following tests, both of which are described in 6.2, are satisfactory to assure compliance.

5.6.1 SALT SPRAY TEST—After 60 days of exposure as described in 6.2.1, the tubing must be capable of meeting the bursting strength requirements (see 5.1) at a reduced internal pressure of 2000 psi (1.38 MN/m^2).

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5.6.2 CYCLIC HUMIDITY TEST—After 170 cycles of exposure as described in 6.2.2, the tubing must be capable of meeting the bursting strength requirements (see 5.1) at a reduced internal pressure of 2000 psi (1.38 MN/m^2).

5.7 Impact Resistance—The tubing must withstand an impact load of 1.5 ft-lb (0.21 kg-m) in the transverse plane by a 60 degree (1 rad) included angle hardened steel knife edge. After impact, the tubing must be capable of meeting the burst strength requirements (see 5.1).

5.8 Brake Fluid Compatibility—The tubing and SAE J1703 RM-1 compatibility fluid shall, when tested in accordance with the procedures outlined in 6.3, meet the following requirements.

5.8.1 WEIGHT LOSS—The tubing must not experience a weight loss greater than 0.000007 oz per in^2 (0.02 mg/cm^2) of internal area.

5.8.2 SEDIMENT—The test brake fluid must not contain more than 0.010 percent sediment by volume.

5.8.3 PH—The pH value of the fluid must not be less than 7 nor more than 11.5.

5.8.4 BOILING POINT—The boiling point of the fluid must not have changed by more than 5 °F (3 °C) plus 0.09 °F (0.050 °C) for each 1.8 °F (1 °C) that the boiling point exceeds 437 °F (235 °C).

6. Test Procedure

6.1 Fatigue Resistance—A standard rotating beam fatigue testing machine (for wire or tubing) should be used for testing tubing specimens by loading them as bent, pin-ended columns.

A series of identical samples of a given kind of tubing shall be tested in air at room temperature at various calculated levels of maximum bending stress until failure by fracture occurs or until an acceptably large number of cycles for the material tested has been reached without failure of the specimen. For each sample tested, the value of applied stress shall be plotted versus the number of cycles of stress applications to produce a typical S-N diagram for the kind of tubing tested. The fatigue limit, the maximum stress that a tube will withstand for the minimum specified number of cycles, is determined by inspection of the S-N diagram obtained.

6.2 Corrosion Resistance—Prepare the specimen by installing tube nuts, flaring both ends with double 45 degree (0.79 rad) flares per SAE J533 and sealing both ends with appropriate fittings. Clean the assemblies by simple immersion in trisodium phosphate at 160 to 180 °F (71 to 82 °C). Coat both ends for a distance of 2 in (5.08 cm) with wax or equivalent to protect fittings against corrosion.

6.2.1 SALT SPRAY (FOG) TEST—Run this test as outlined in ASTM B 117.

6.2.2 CYCLIC HUMIDITY TEST—Run this test as outlined in ASTM Bulletin #187 of January 1953 (except as noted below). (See Appendix B for condensation of this bulletin.)

a. The dipping solution no longer contains 0.1% sulphuric acid by weight.
b. The test sample must be electrically insulated from the cabinet and from each other.

6.3 Brake Fluid Compatibility—Form each piece of tubing (that is, eight for 3/16 OD - 4.75 mm - or smaller or four if the diameter is larger) into a "U" shape about a 2 in ± 1/8 (50.8 mm ± 3.2) mandrel. Each piece of tubing is to be 36 in ± 1 (91 cm ± 2.5) long before bending. Measure and record the length and internal diameter of each tube. Weigh the tubes to the nearest 0.0000035 oz (0.1 mg). Support the formed tubes in an appropriate fixture so that the straight sections of the tubes are vertical. Fill the tubes to within 2 in (5.1 cm) of the open ends of the tubes with brake fluid conforming to SAE J1703 RM-1. Place the fluid tubes in an oven maintained at 212 °F ± 3.6 (100 °C ± 2) for 120 h ± 2.

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After the test, collect the test brake fluid in a clean beaker. Remove loose adhering sediment from the interior of the tubes by flushing with water. Dry the tubes in an oven at 212 °F ± 3.6 (100 °C ± 2) for 30 min. Weigh the tubes to the nearest 0.0000035 oz (0.1 mg) and calculate the weight loss per in^2 (cm^2) of internal area.

Determine the percent sediment by volume, the pH value and the boiling point of the test brake fluid per procedures specified in SAE J1703.

PREPARED BY THE SAE HYDRAULIC BRAKE
COMPONENTS STANDARDS COMMITTEE

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APPENDIX A

A.1 Design Guidelines—The best tubing will be unsatisfactory unless it is used properly. The following should be considered:

a. Since tubing may suffer damage and/or loss of corrosion resistance as a result of gravel impact, it should be adequately protected in areas of potential damage.
b. Tubing should be adequately protected against hoist or towing fixture damage.
c. Tubing should be routed or otherwise protected so that under no condition can the tubing or its protective conduit come in contact with any vibrating or moving component (that is, if the tubing is attached to the frame, the underbody is one item considered to be a "vibrating component"). The tubing should never cross under (or over) an exhaust pipe, muffler, or catalytic converter unless it is adequately protected against excessive movement of the pipe, muffler, or catalytic converter such as may occur if a hanger failed.
d. Tubing should be so routed that its stress limits will not be exceeded during flexing.
e. Tubing should be so routed that it will not be in, or form, a pocket which will trap salt or other de-icing chemicals.
f. Tubing should avoid, or be protected from, exhaust systems or other areas of extreme heat.
g. The design engineer should take into account possible electrolytic corrosion resulting from contact between dissimilar metals (that is, brake pipes and protective conduit, clips, fittings, and mounting surfaces).
h. The design engineer should determine the minimum tubing inside diameter based on brake system actuation time. Other factors affecting actuation time are:

1. Brake fluid viscosity
2. Operating temperature
3. Pipe length
4. Fluid flow rate as determined by brake system displacement requirements

A.2 Cyclic Humidity Test—Figure A1 shows four of the five main parts of the apparatus: the humidifying tower, the heating cabinet, the corrosion chest, and the dip mechanism. Not shown is a drying train which is used on part of the cycle.

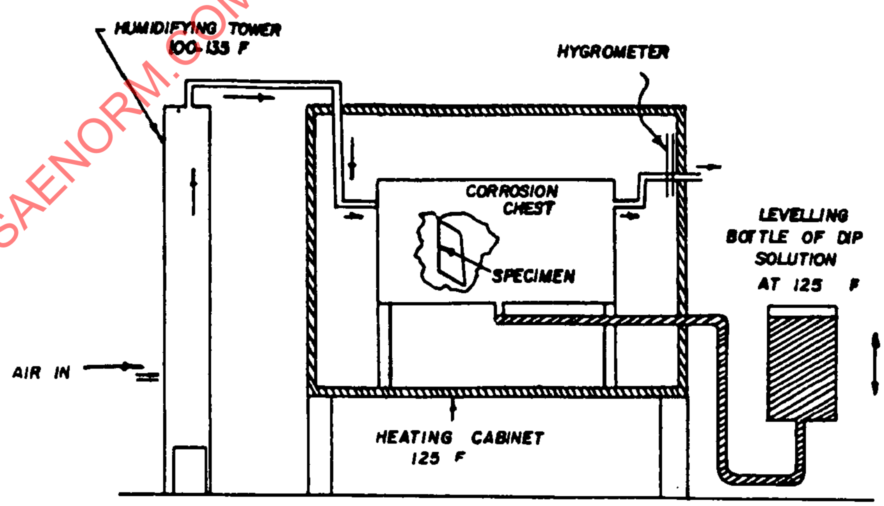

FIGURE A1—

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A cyclic variation of humidity is obtained basically by the variation of the temperature of the water in the humidifying tower. The temperature of the water is cycled thermostatically between limits such that the relative humidity of air bubbling through the water will vary between about 50 and 100% when the air is brought to 125 °F (52 °C). Extension of the range of relative humidity is accomplished by adding a drying period to the basic humidity cycle described above. The relay circuit is so arranged that the drying period is switched on when the relative humidity has descended to about 50%. The length of the drying period has been 3 h; the entire cycle takes about 8 h. The lowest relative humidity regularly obtained is 8 to 10% and the highest is 100%. Figure A2 portrays the cycle schematically.

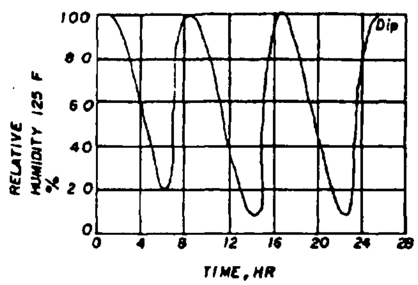

FIGURE A2—

The drying train, through which the air is switched during the drying period, has a concentrated sulfuric acid bubbler for primary dehumidification. The secondary stage is a desiccating tower containing anhydrous calcium sulfate.

The block diagram of air distribution is shown in Figure A3. The humidifying tower and the drying train are in parallel, with the solenoid valves switching the air flow through one or the other.

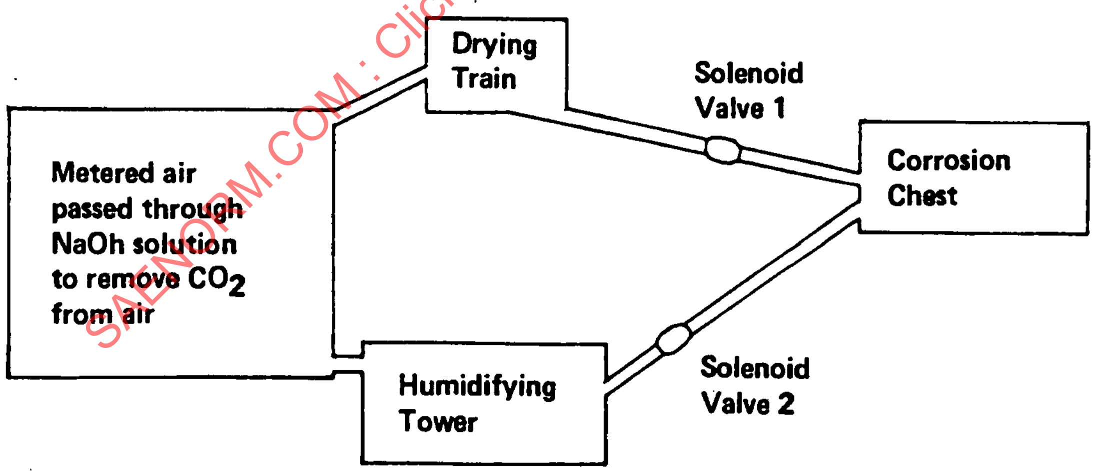

FIGURE A3—

The corrosion chest is a coated stainless-steel box within which the specimens are exposed. It is surrounded by a heating cabinet which is thermostatically maintained at 125 °F ± 2 (52 °C ± 1). This 125 °F (52 °C) temperature is an accentuated variable leading to the acceleration of the test; it has been held constant during the test procedure. The air leaving the chest passes through a wet and dry bulb hygrometer used to show gross variations in the relative humidity.

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