The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE STANDARD

SAE J1958

REAF. JUN95

Issued 1989-04
Reaffirmed 1995-06

Superseding J1958 APR89

Submitted for recognition as an American National Standard

DIESEL ENGINES—STEEL TUBES FOR HIGH-PRESSURE FUEL INJECTION PIPES (TUBING)

***Foreword*—**This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

***1. Scope*—**This SAE Standard specifies dimensions and requirements for single-wall steel tubing intended for use as high-pressure fuel injection pipes on a wide range of engines (Class A), and for fuel injection pump testing (Class B, Reference SAE J1418). Tubing shall be cold drawn, annealed or normalized, seamless tubing suitable for cold swaging, cold upsetting, and cold bending.

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

SAE J1418—Fuel Injection Pumps—High Pressure Pipes (Tubing) for Testing

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

ASTM A 370—Test Methods and Definitions for Mechanical Testing of Steel Products

3. Dimensions and Tolerances

3.1 Sizes—The recommended outside diameter and inside diameter tubing sizes are shown on Figure 1. Other sizes may be available by agreement.

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-8512 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER; (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS http://www.sae.org

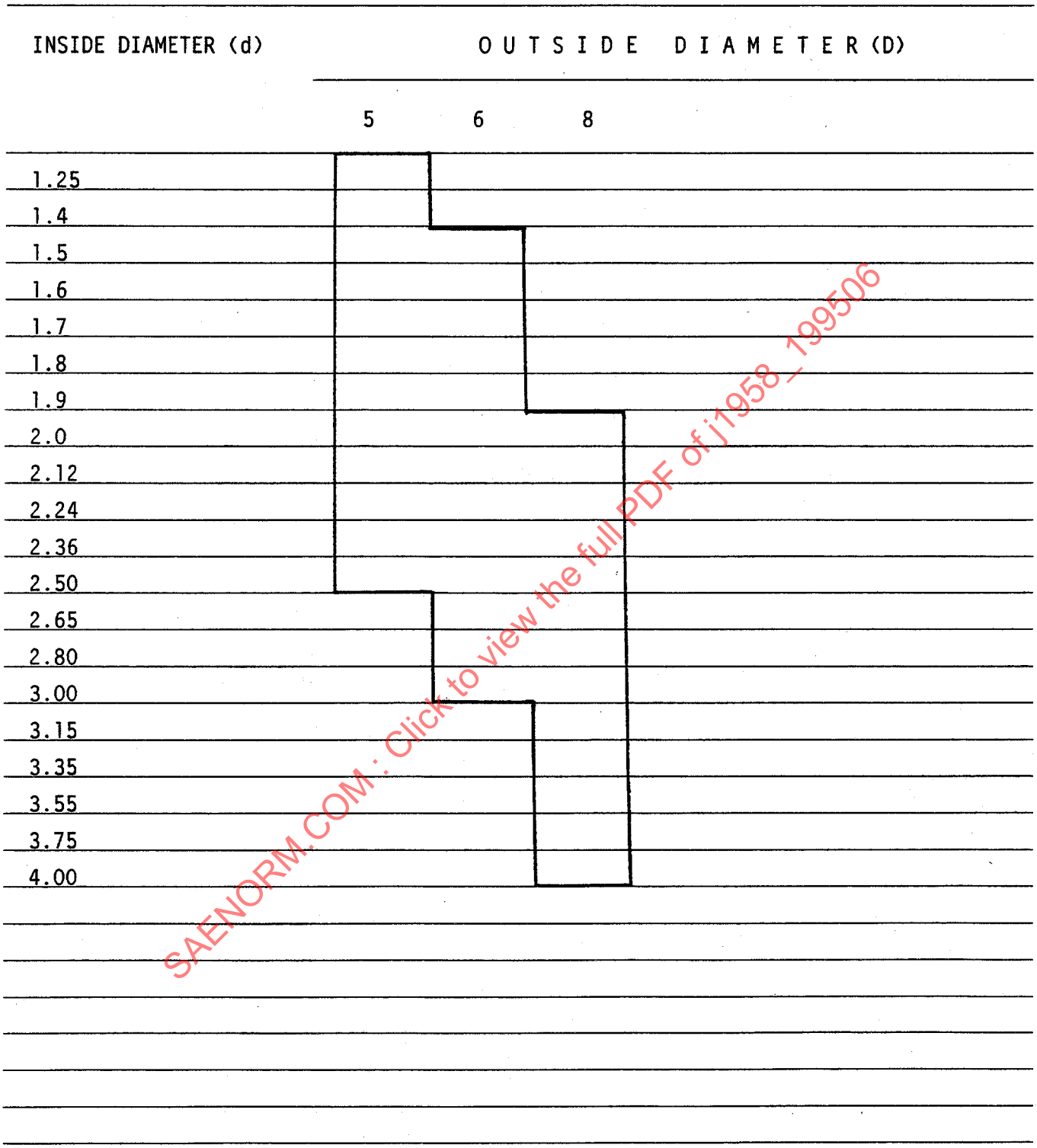

FIGURE 1—RECOMMENDED INSIDE AND OUTSIDE DIAMETERS IN MM

3.2 Tolerances

3.2.1 INSIDE DIAMETER[1]—Standard $\frac{mm}{\pm 0.06}$

3.2.2 OUTSIDE DIAMETER—Standard $\frac{mm}{\pm 0.06}$

3.2.3 DEGREE OF ECCENTRICITY—The degree of eccentricity of the outside diameter of the tube relative to the inside diameter is proportioned to the wall thickness as shown in Figure 2.

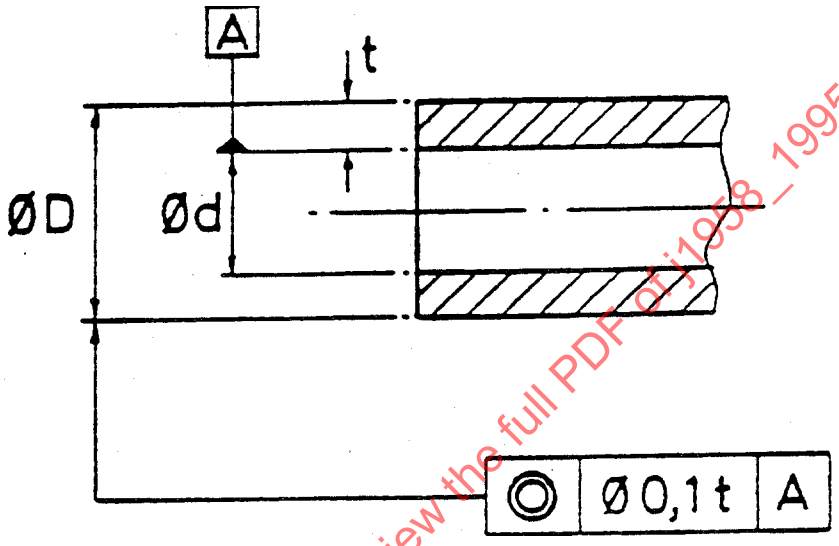

FIGURE 2—

3.2.4 LENGTH—Length and tolerance on length shall be by agreement between purchaser and supplier.

3.3 Straightness—Unless otherwise specified, the tubes shall be straight within a maximum error of 1 in 400 without any localized deformation.

4. Material Processing

4.1 Material—Tubing shall be manufactured from an unalloyed or low alloy steel produced by a steelmaking process providing a very homogeneous structure. Upon request, the supplier shall state the method of the steel making and deoxydation process used.

4.2 Manufacturing of Tubes—The tubing shall be cold drawn from steel hollows processed in a manner that allows the manufacturer to obtain tubes in conformance with agreed upon portions of this document. After forming, the tubing, if annealed, shall be processed in such a manner as to prevent formation of scale on the inside surface and produce a finished product which will meet all agreed to requirements of this document.

4.3 Mechanical Properties—The furnished tubing shall have mechanical properties [2] as tabulated in Table 1.

1. Refer to SAE J1418 for Class B.
2. Per ASTM A 370, Supplement II, Section T-2.

TABLE 1—MECHANICAL PROPERTIES

	Yield Strength Min	Tensile Strength	Elongation in 2 in (51 mm) % Min	Hardness Rockwell B Scale Max
Grade One	205 N/mm^2 (29 730 psi)	310–379 N/mm^2 (44 960 – 54 965 psi)	30	65
Grade Two	220 N/mm^2 (31 905 psi)	360–480 N/mm^2 (52 210–69 615 psi)	23	80
Grade Three	355 N/mm^2 (51 485 psi)	490–630 N/mm^2 (71 065–91 370 psi)	22	87

4.4 Surface Quality

4.4.1 GENERAL—The outside and inside surfaces of finished tubing shall be clean and free from scale, rust, seams, laps, laminations, deep pits, nonmetallics, or other injurious defects.

4.4.2 OD SURFACE

4.4.2.1 *Condition*—The outside surface of annealed or normalized tubes may have a slight discoloration, but shall be free from loose scale and represent a smooth cold-finished surface. Imperfections in any tube, heat treated or not, deeper than 0.13 mm will be a cause for rejection. Scratches resulting from a mechanical finishing process such as polishing or grinding are prohibited.

4.4.2.2 *Coatings*—The outside surface of the tubes may be coated utilizing a product and method agreed upon by purchaser and manufacturer. The inside surface of the tube shall remain uncoated.

4.4.3 ID SURFACE—The inside of tubing shall be clean and free from any contaminations which will impair the processing or serviceability of the tubing and shall be finished to ensure a smooth bore of accurate size and shall conform to one of the following bore designations described in Table 2.

Bore designation, as described in Table 2, shall be specified on the face of the order.

TABLE 2—BORE DESIGNATION

Bore Designation	Permitted Imperfections	Magnification
A	5 imperfections (max) between 0.08 to 0.13 mm deep in any cross section and no imperfections deeper than 0.13 mm	100 X
B	5 imperfections (max) over 0.05 mm to 0.08 mm maximum deep	200 X
C	5 imperfections (max) over 0.02 to 0.05 mm maximum deep	200 X
D	All imperfections less than 0.03 mm deep. As an alternate, an imperfection can be classified as having a depth that is at least twice the width.	200 X

4.4.3.1 *ID Bore Optional Requirement*—Inclusions occurring within 10% of the wall thickness as measured from the ID surface is to be considered as continuous to the ID.

De-carb (C.F.D. = Carbon Free Depth) of 0.050 mm maximum on the OD and 0.020 mm maximum on the ID C.F.D. shall be determined at 200 X.

4.5 Microstructure

4.5.1 The microstructure shall be essentially ferrite with pearlite permitted to the extent necessary to fulfill the mechanical requirements.

4.5.2 Grain size shall be five or finer.

5. ***Testing—***The finished tubing shall satisfactorily meet the following performance tests as well as the mechanical properties using standard sampling techniques for testing to determine compliance. Test specimens shall be taken from tubing which has not been subjected to cold working after final annealing/ normalizing of the finished tubing.

5.1 Cold Upsetting Test—The tubing shall withstand cold upsetting from a length of 12.7 to 6.4 mm (1/2 to 1/4 in) without showing other than superficial outside surface ruptures.

5.2 Bend Test—Tubing shall be capable of being formed into bends and 360 degree circles without showing evidence of cracking, kinking, or other flaws rendering it useless for its intended end use when the following minimum bend radius is used: 3 x OD.

5.3 Dimensional Testing—The dimensions of the tube shall comply with the dimensions and tolerances indicated under Section 3 of this document. All tubes in the lot shall be tested except that, by agreement, an acceptable statistical process of testing may be substituted.

5.4 Testing of Mechanical Properties—The tubes shall comply with properties stated under 4.3 of this document. Tests shall be made according to ASTM A 370, Supplement II, with the average of results obtained from three samples per heat tested being reported on a test certificate, if requested.

5.5 Surface Quality Test—A visual check of the OD shall be conducted on all tubes to assure compliance with requirements of Section 5.

5.5.1 If mutually agreed between the purchaser and supplier, the visual inspections may be replaced by a nondestructive testing procedure.

5.5.2 If a proof of a specified delect depth is required, an inspection by attributes per AQL shall be agreed upon when ordering, and the proof shall be made on the metallographic cross section of the tube utilizing the specified magnification in Table 2.

5.5.3 Surface coatings on tubes with plates or treated surfaces shall satisfy tests on the coatings as agreed between purchaser and supplier.

5.6 Pressure Proof Test—Unless otherwise specified, tubing supplied under this document shall have been tested hydrostatically, with no evidence of permanent internal deformation, at a pressure which will subject the material to a fiber stress of 75% of minimum yield strength. Test pressure shall be determined by the Lame formula as shown in Equation 1:

$$P = S\frac{(D^2 - d^2)}{D^2 + d^2} \qquad \text{(Eq. 1)}$$

where:

D = Nominal outside diameter of tubing, mm (in)
d = Nominal inside diameter of tubing, mm (in)
P = Hydrostatic pressure, MPa (psi)
S = Allowable fiber stress (75% of minimum yield strength), N/mm^2 (psi)