MIL-T-3520C
10 April 1984
SUPERSEDING
MIL-T-3520B
6 February 1975

MILITARY SPECIFICATION

TUBING, STEEL (LOW-CARBON) MECHANICAL ROUND

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers round, low-carbon steel tubing for use on automotive and mechanical equipment.

1.2 Classification. Tubing shall be the following types, classes, sizes, and conditions, as specified (see 6.2).

Type I - Electric-resistance-welded.
- Class 1 - As welded.
- Class 2 - Welded-annealed.
- Class 3 - Cold-drawn, unannealed.
- Class 4 - Cold-drawn, annealed.
- Class 5 - Heat treated.
  - Condition A - Annealed.
  - Condition B - Normalized.
  - Condition C - Quenched and tempered.

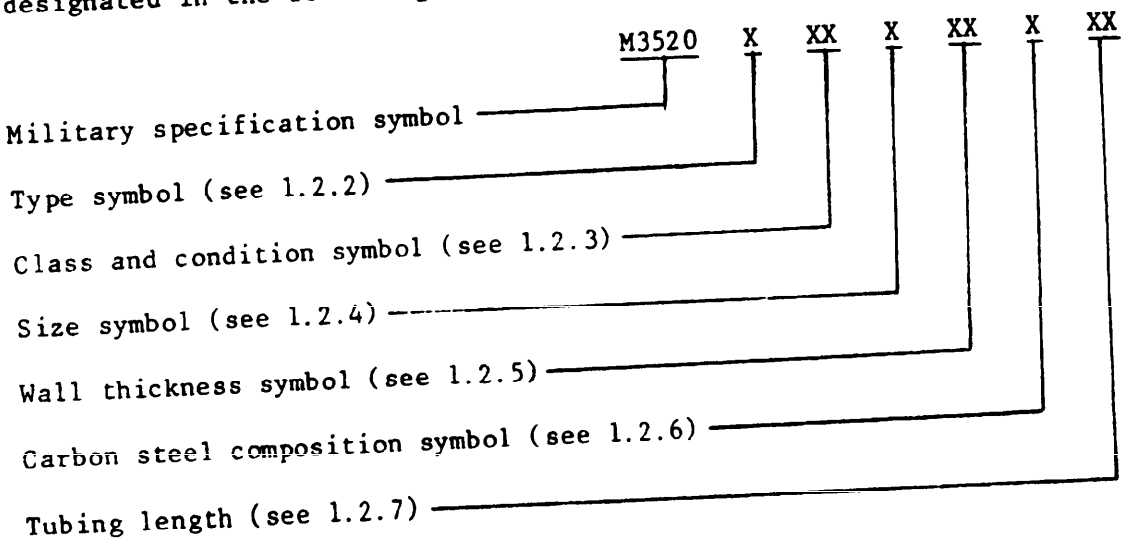
Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: USA Belvoir Research and Development Center, ATTN: STRBE-DS, Fort Belvoir, VA 22060 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 4710

Type III - Double wall, copper-brazed.
Class 6 - Cold-drawn, unannealed.
Class 7 - Cold-drawn, annealed.
Class 8 - As brazed.

Sizes (outside diameter) - 1/8 inch through 1/2 inch inclusive in increments of 1/16 inch, and 5/8 inch (1/8-inch and 3/16-inch sizes not available in type I).

1.2.1 Part number. The tubing covered by this specification shall be designated in the following form (see 6.2 and 6.7).



1.2.2 Types. The tubing type is identified by the symbols shown in Table I.

TABLE I. Tubing type symbols.

Symbol	Type
A	Type I, Electric-resistance-welded
B	Type III, Double wall, copper brazed

1.2.3 Class and condition. The tubing class and condition is identified by the symbols shown in table II.

TABLE II. Tubing class and condition symbols. 1/

Symbol	Class and condition
	Type I
10	Class 1, as welded
20	Class 2, welded annealed
30	Class 3, cold-drawn, unannealed
40	Class 4, cold-drawn, annealed
5A	Class 5, heat treated, condition A, annealed
5B	Class 5, heat treated, condition B, normalized
5C	Class 5, heat treated, condition C, quenched and tempered
	Type III
60	Class 6, cold drawn, unannealed
70	Class 7, cold drawn, annealed
80	Class 8, as brazed

1/ Condition applies to Class 5 only.

1.2.4 Size. The tubing size (outside diameter) is identified by the symbols shown in table III.

TABLE III. Tubing size.

Symbol	Size (inch)	Symbol	Size (inch)
A	1/8 1/	E	3/8
B	3/16 1/	F	7/16
C	1/4	G	1/2
D	5/16	H	5/8

1/ Not available in type I.

1.2.5 Wall thickness. The tubing wall thickness is identified by the symbols shown in table IV.

TABLE IV. Wall thickness.

Symbol	Wall thickness (inch)
	Size 1/8-inch
00	0.025
	Size 3/16-inch
01	0.028
	Sizes 1/4-, 5/16-, and 3/8-inch
02	0.028
03	0.032
04	0.035
05	0.042
06	0.060
	Sizes 7/16-, 1/2-, and 5/8-inch
07	0.030
08	0.035
09	0.049

1.2.6 Carbon steel composition. The composition number of the carbon steel used in the manufacture of the tubing is identified by the symbols shown in table V.

TABLE V. Carbon steel composition number.

Symbol.	Composition number
	Class 1 through 4
A	1008
B	1010
C	1015
D	1020
E	1025
	Class 5
F	1025
	Classes 6 through 8
G	1010

1.2.7 Tubing length. The tubing length is identified by a two digit number. The number shall be the number of whole feet in the required length.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. Unless otherwise specified (see 6.2), the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation, form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-L-13762	- Lead Alloy Coating, Hot Dip (for Iron and Steel Parts).
MIL-G-20241	- Gasket Material, Wool Felt, Impregnated, Adhesive, Pressure-Sensitive.
MIL-S-81733	- Sealing and Coating Compound, Corrosion Inhibitive.

STANDARDS

MILITARY

MIL-STD-105	- Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-163	- Steel Mill Products Preparation for Shipment and Storage.
MIL-STD-889	- Dissimilar Metals.

(Copies of specifications and standards required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extend specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 254	- Copper Brazed Steel Tubing.
ASTM A 450	- General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes.

ASTM A 513 - Electric Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J403 - Chemical Compositions of SAE Carbon Steels.

(Application for copies should be addressed to the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15086.)

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the reference cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Description. The tubing shall be round steel tubing fabricated by electric-resistance welding for type I and copper brazing for type III.

3.2 Material. A chemical analysis of the steel used in fabricating the tubing shall be furnished by the contractor. When approved by the contracting officer, certification that the material in the tubing conforms to the chemical requirements specified herein may be furnished in lieu of the chemical analysis (see 6.2 and 6.6).

3.2.1 Material deterioration and control. The tubing shall be fabricated from compatible materials, inherently corrosion and deterioration resistant or treated to provide protection against the various forms of corrosion and deterioration that may be encountered in any of the applicable storage and operating environment to which the item may be exposed.

3.2.1.1 Dissimilar metals. Dissimilar metals, as defined in MIL-STD-889, shall be electrically insulated from one another to minimize or prevent galvanic corrosion. Insulation may be provided by an insulating barrier such as a corrosion inhibiting sealant conforming to MIL-S-81733 or chromate tape conforming to MIL-G-20241. Protection against any galvanic corrosion could also be obtained by exclusion of the electrolyte if feasible.

3.2.1.2 Identification of materials and finishes. The contractor shall identify the specific material, material finish or treatment for use with components and sub-components, and shall make information available, upon request, to the contracting officer or designated representative.

3.3 Protective coating. Unless otherwise specified (see 6.2), the outside surface of the tubing shall be coated with lead-tin alloy by the hot-dip process in accordance with MIL-L-13762.

3.3.1 Optional protective coating. At the contractor's option, in lieu of the coating specified in 3.3, a lead-tin alloy coating shall be applied by hot-dip method with a composition of 85 percent lead minimum, 12 percent tin minimum, and 2 percent other elements maximum. The minimum weight of the coating shall be 0.06 oz/sq. ft. for type I, and 0.16 oz/sq. ft. for type III.

3.4 Dimensions.

3.4.1 Lengths. Unless otherwise specified (see 6.2), tubing shall be furnished in random lengths of 5 to 24 feet, and not more than 10 percent of any order shall be furnished in lengths shorter than 12 feet.

3.4.2 Outside diameter and wall thickness. Tubing shall be furnished with a wall thickness in accordance with table VI. The wall thickness for sizes of tubing from 1/4- through 5/8-inch outside diameter shall be selected from table VI, as specified (see 6.2). Variations in outside diameter and wall thickness shall not exceed the tolerances shown in table VI.

TABLE VI. Permissible variations in outside diameter and wall thickness.

Size of tubing, OD	Tolerance, OD	Wall thickness	Tolerance, wall thickness
Inch	Inch	Inch	Inch
1/8 (0.125)	±0.002	0.025	±0.005
3/16 (0.188)	±0.003	0.028	±0.005
1/4 (0.250), 5/16 (0.312), and 3/8 (0.375)	±0.003	0.028, 0.032, 0.035, 0.042, or 0.060	±0.0035
7/16 (0.437), 1/2 (0.500), and 5/8 (0.625)	±0.004	0.030, 0.035, or 0.049	±0.0035

3.5 Straightness. The straightness tolerance for unannealed tubing shall not exceed 1 part in 600 parts total length. Annealed tubing shall conform to standard commercial straightness requirements.

3.6 Hydrostatic test pressure resistance. Tubing shall withstand a hydrostatic pressure without leakage, deformation, rupture, or evidence of any other failure. The pressure shall be calculated in accordance with the formula

$$P = \frac{2St}{d}$$

where P = internal pressure (psi),
S = allowable fiber stress (16,000 psi),
t = wall thickness in inches,
d = outside diameter in inches.

In no case, however, shall the maximum test pressure exceed the values specified in table VII.

TABLE VII. Hydrostatic pressure requirements.

Ordered outside diameter	Hydrostatic pressure
Inch	psi
1/8, 3/16, 1/4, 5/16	5000
3/8	4000
7/16, 1/2, 5/8	3000

3.7 Identification marking. Tubing 0.500 inch and over in outside diameter shall be marked with constantly recurring symbols which shall provide the following information, repeated at 3-foot intervals:

a. Specification number.
b. Type, class, size, and conditions.
c. Manufacturer's name or trademark.

In lieu of continuous marking, tubing less than 0.500 inch outside diameter may be bundled. Each bundle shall be identified by metal tags, securely attached near each end of the bundle, inpression stamped with the information specified above.

3.8 Flare requirements.

3.8.1 Type I. Type I, classes 2 and 4 and class 5, condition A, tubing shall be subject to the flaring test in accordance with ASTM A 513, and shall not crack or develop flaws or irregularities.

3.8.2 Type III. Type III, classes 7 and 8 tubing shall be subject to the flaring test in accordance with ASTM A 254, and shall not crack or develop flaws or irregularities.

3.9 Flattening requirements. Type I tubing, when flattened (cold) in accordance with ASTM A 513, and type III tubing, when flattened (cold) in accordance with ASTM A 254, shall show no evidence of cracking, lamination, unsound material, or other flaws.

3.10 Type I tubing. Type I tubing shall be manufactured by the electric-resistance-welding method in accordance with ASTM A 513. The tubing shall have no welds other than the one longitudinal weld necessary in the manufacturing process. The tubing for classes 1 through 4 shall be of carbon steel conforming to SAE J403, composition number 1008, 1010, 1015, 1020, or 1025, as specified (see 6.2). Class 5 tubing shall be of SAE J403, composition number 1025 steel.

3.11 Type III tubing. Type III tubing shall be made by the double-wall copper-brazed process conforming to ASTM A 254, class I. No brazes shall be made except those necessary for manufacture. The tubing shall be brazed in a controlled atmosphere. The edges of the strip stock used shall be beveled so that, after manufacture, the tubing shall have a true circular cross section. Material shall be in accordance with SAE J403, composition number 1010, or ASTM A 254.

3.11.1 Bend requirements. Finished type III tubing shall withstand being bent on a centerline radius equal to three times the tubing outside diameter without kinking, cracking, or developing other flaws.

3.11.2 Expansion requirements. Type III tubing shall withstand an expansion test as described in ASTM A 254 without developing cracks or other flaws.

3.12 Workmanship. Finished tubing shall be clean, uniform in temper and quality, round in cross section, and shall be free from burrs, cracks, rust, scale, damaged ends, and other injurious defects.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any

other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Material inspection. The contractor is responsible for insuring that materials used are manufactured, examined, and tested in accordance with referenced specifications and standards.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Quality conformance inspection (see 4.3).

b. Inspection of packaging (see 4.5).

4.3 Quality conformance inspection.

4.3.1 Sample unit. The sample unit for examination, straightness test and hydrostatic test shall be one complete tube. The sample unit for destructive tests shall be cut from the accepted sample used for the hydrostatic test and shall be the length and quantity specified for the applicable test.

4.3.2 Sampling. Sampling for examination and tests shall be in accordance with MIL-STD-105.

4.3.3 Examination. Samples selected in accordance with 4.3.2 shall be examined for the major and minor defects specified in 4.4.1. AQL shall be 2.5 percent defective for major defects and 4.0 percent defective for minor defects.

4.3.4 Tests. Samples selected in accordance with 4.3.2 shall be tested as specified in 4.4.2. AQL shall be 2.5 percent defective.

4.4 Inspection procedure.

4.4.1 Examination. The tubing shall be examined as specified herein for the following defects:

Major

101. Tubing not as specified.
102. Materials not as specified.
103. Materials are not resistant to corrosion and deterioration or treated to be resistant to corrosion and deterioration for the applicable storage and operating environments.

104. Dissimilar metals as defined in MIL-STD-889 are not effectively insulated from each other.
105. Contractor does not have documentation available for identification of material, material finishes or treatment.
106. Chemical composition not as specified.
107. Coating not as specified.
108. Dimensions and tolerances not as specified.

Minor

201. Identification marking not as specified.
202. Workmanship not as specified.

4.4.2 Tests.

4.4.2.1 Hydrostatic pressure test. Sample tubing shall be subjected, at room temperature, to a minimum internal hydrostatic pressure in accordance with 3.6. Nonconformance to 3.6 shall constitute failure of this test.

4.4.2.1.1 Optional nondestructive electric test. At the contractor's option in lieu of a hydrostatic pressure test (see 4.4.2.1), all tubing shall be 100 percent tested at the contractor's fabrication plant by a nondestructive electric test. Type III tubing shall be tested as specified in ASTM A 450. Type I tubing shall be tested as specified in ASTM A 513. Tubes containing defects producing signals equal to or greater than calibration defects as specified in ASTM A 513 and ASTM A 450, as applicable, shall be rejected.

4.4.2.2 Flattening test. From each sample unit, one section of tubing 4 to 6 inches in length shall be cut from each of a finished tube and shall withstand a flattening test in accordance with ASTM A 254 and ASTM A 513. Cracks or flaws in the tubing shall constitute failure of this test.

4.4.2.3 Bend test for type III tubing. Two specimens of type III tubing of sufficient length shall withstand being bent cold on a centerline radius equal to three times the tubing outside diameter. Kinking, cracking, or developing other flaws shall constitute failure of this test.

4.4.2.4 Flare tests. Type I, class 5, condition A, and classes 2 and 4, tubing shall be flare-tested in accordance with ASTM A 513, type III, classes 7 and 8 tubing shall be flare-tested in accordance with ASTM A 254. Two specimens 4 inches in length shall be used for this test. Development of cracks, flaws or other irregularities shall constitute failure of this test.

4.4.2.5 Expansion test for type III tubing. Two specimens of type III tubing shall withstand the expansion test described in ASTM A 254. Cracking or showing other flaws shall constitute failure of this test.

4.4.2.6 Straightness test (unannealed tubing only). Straightness of unannealed tubing shall be determined by rolling the tubing on a flat level surface and measuring the greatest departure of the tubing from the surface by means of a steel scale and straightedge or calipers. Departure of any 3-foot section from a straight line by more than 0.060 inch shall constitute failure of this test.

4.5 Inspection of packaging. The preservation, packing, and marking shall be examined to determine compliance with the requirements specified herein.

5. PACKAGING

5.1 Preservation, packing and marking. The tubing shall be preserved, packed and marked in accordance with MIL-STD-163. Tubing sizes not specifically covered in MIL-STD-163 shall be packed as specified for the next larger size. The degree of preservation and packing shall be level A or commercial as specified (see 6.2).

6. NOTES

6.1 Intended use. The tubing covered by this specification is intended for various engineering and mechanical uses including automotive, refrigeration and heating applications.

6.2 Ordering data. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. Military specification part number required (see 1.2, 3.4.1, 3.4.2, 3.10 and 3.11).

c. When a certification of compliance is acceptable in lieu of chemical analysis (see 3.2 and 6.5).

d. When coating is to be other than that specified (see 3.3).

e. Level of preservation and degree of packing required (see 5.1).

6.3 Cold-drawn tubing. Finish-annealed, cold-drawn tubing is the usual cold-drawn product available from both warehouse stocks and mills. This material provides fair machineability and can be formed to a moderate degree. Unannealed, cold-drawn tubing is generally available only in mill quantities. Maximum machineability for the composition of steel is provided by this tubing but it cannot be readily formed. Heat-treated, cold-drawn tubing covers fully annealed, normalized, and quenched-and-tempered tubing. It is necessary to indicate which of those properties is desired when heat-treated tubing is specified.

6.4 Copper brazed tubing. Type III (copper-brazed) tubing should not be specified when conditions likely to result in electrolytic action exist, because the tubing is brazed with a nonferrous alloy having a different electric potential.

6.5 Certification. In lieu of chemical analysis as specified in 3.2, a certification of compliance may be accepted from the contractor.

6.6 Recycled material. It is encouraged that recycled material be used, when practical, as long as it meets the requirements of this specification (see 3.2).

6.7 Definitive military specification part number. The military specification part number corresponds to the type, class, and condition of the tubing covered by this specification and defines the requirements of the options presented under this specification. The military specification is a definitive part number which is formed by combining the military specification symbol (M3520 for MIL-T-3520) with a dash after it; the type symbol; the class and condition symbol; the size symbol; the wall thickness symbol; the carbon steel composition symbol; and the tubing length in whole feet combination as shown in 1.2.

Custodians:
Army - ME
Air Force - 99

Review activities:
Army - MI, AT, AR
DLA - CS

User activity:
Army - AV

Preparing activity:
Army - ME

Project 4710-0652

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NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document*(s)* or to amend contractual requirements.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-T-3520C	Tubing, Stell (Low-Carbon) Mechanical Round

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
	☐ USER
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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