

MIL-T-13915E(MR)
5 June 1987
SUPERSEDING
MIL-T-13915D(MR)
27 April 1976

MILITARY SPECIFICATION

TUBES, STEEL, SEAMLESS: FOR CANNONS AND RECOILLESS RIFLES

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

1. SCOPE

1.1 This specification covers seamless, thin-wall, steel tubes in the quenched and tempered condition for use in the manufacture of cannons and recoilless rifles.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedure and tables for Inspection by Attributes
MIL-STD-109 - Quality Assurance Terms and Definitions

(Copies of specifications, standards, handbooks, drawings, publications, and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, US Army Laboratory Command, Materials Technology Laboratory, ATTN: SLCMT-MSE, Watertown, MA 02172-0001 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC NO. A4087

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2.2 Other publications. The following document(s) form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the non-government documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM A751 - Chemical Analysis of Steel Products, Standard Methods, Practices, and Definitions for
- ASTM D3951 - Commercial Packaging
- ASTM E8 - Tension Testing of Metallic Materials
- ASTM E10 - Brinell Hardness of Metallic Materials, Test for
- ASTM E23 - Notched Bar Impact Testing of Metallic Materials
- ASTM E381 - Rating Macroetched Steel, Procedure for

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

AEROSPACE MATERIAL SPECIFICATIONS (SAE)

- AMS 2301 - Aircraft Quality Steel Cleanliness (Magnetic Particle Inspection Procedure)

(Copies should be obtained from the procuring activity or as directed by the contracting officer.)

(Non-government standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Chemical composition. Unless otherwise agreed to by the contractor and the Procuring Contracting Officer, the chemical composition of the steel shall be within the limits proposed by the contractor.

3.2 Processing controls.

3.2.1 Orientation of tube to ingot. The tube shall be made so that its longitudinal axis shall be essentially coincident with the longitudinal axis of the ingot.

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3.2.2 Straightening. Tubes may be cold straightened. After cold straightening, tubes shall be stress relieved at a temperature within 100°F below the tempering temperature but no lower than 900°F.

3.2.3 Welding. Tubes shall not be welded except on prolongations. All welds shall be in such a position so as not to affect the finished tube or test metal.

3.3 Heat treatment. Heat treatment shall be performed on the whole tube, never on a portion only, and shall at least consist of normalizing, austenitizing, agitated liquid quenching and tempering. Unless otherwise allowed, the tubes shall be quenched without any obstruction in the bore to permit free passage of the coolant through the bore. Tempering shall follow quenching and shall consist of heating the entire tube at a temperature not less than 1000°F for yield strength ranges up to 159,999 p.s.i., nor less than 900°F for yield strength ranges above 159,999 p.s.i. and holding at the temperature for a time appropriate to the thickness. A zone controlled tempering treatment employing different temperatures at opposite ends of the tube (differential tempering) may be used at the option of the contractor. Whenever differential tempering is employed, or whenever tubes are retempered only (see 4.6.7.5), temperatures of 1000°F or 900°F minimum are required, as noted above, unless otherwise allowed by the procuring contracting officer.

3.4 Mechanical properties.

3.4.1 Yield strength. Yield strength shall be as specified on the applicable drawings, or in the contract or order.

3.4.2 Reduction of area. The minimum percent reduction of area for individual specimens shall be as specified in table I.

3.4.3 Charpy V-notch impact resistance. The minimum value for individual Charpy V-notch impact resistance specimens shall be as specified in table I for the average yield strength.

3.4.4 Hardness. The range of hardness of each tube end not tested for yield strength shall be within ± 25 points Brinell of the average hardness of the corresponding ends of all tubes of the same lot that are tested for yield strength.

3.5 Dimensions. Dimensions and dimensional tolerances shall be as specified on the applicable tube drawing.

3.6 Identification marking. Each tube shall carry positive identification through the various processes, so that it is possible to determine the original source of the finished part. Each tube shall be marked on either end, by metal-die stamping, with the heat and drawing numbers, and the manufacturer's identification (supply code, name or registered trademark).

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TABLE I. Mechanical properties.

Yield strength (0.10 percent offset) psi.	Minimum percent reduction of area		Minimum foot-pounds Charpy V-notch impact resistance at -40°F + 20°F	
	Transv.	Long	Transv.	Long
60,000 - 69,999	40	50	55	85
70,000 - 79,999	40	50	50	80
80,000 - 89,999	40	50	45	70
90,000 - 99,000	40	50	40	60
100,000 - 109,999	40	50	35	50
110,000 - 119,999	40	50	35	50
120,000 - 129,999	40	50	35	45
130,000 - 139,999	35	45	30	40
140,000 - 159,999	30	40	20	30
160,000 - 180,000	25	35	15	20

3.7 Soundness. When specified, the soundness of steel to be used in the tubes shall be determined by a macrostructure equal to or better than the following conditions designated by ASTM E 381.

36 sq. in. and Less

S-3, R-2, C-2

over 36 sq. in.

S-3, R-3, C-3

3.8 Records. The contractor shall maintain records of the chemical and mechanical properties of each lot of tubes.

3.9 Cleanliness. The steel material to be used in fabrication of tubes shall meet the requirements of AMS 2301.

3.10 Workmanship. The finish-machined, heat-treated tube shall be free from seams, cracks, flakes, injurious segregation and other defects detrimental to the application of the tube.

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

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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 that supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.2 Quality Assurance terms and definitions. Quality Assurance terms and definitions used in this specification are in accordance with MIL-STD-109.

4.2.1 Lot. A lot shall consist of all the tubes of the same size, from the same heat (see 4.2.3) of steel that are heat treated at the same time in the same batch furnace and quenched at the same time in the same tank or that pass consecutively through a continuous type of heat treating process.

4.2.2 Tube. A tube for purposes of inspection and test is defined as the tube, the length of which is shown on the applicable tubing drawing, plus any prolongations as defined in 6.4.3 which are integral parts of the piece as heat treated.

4.2.3 Heat. The heat shall be the original melt from which the ingots are poured. For remelt processes (electro-slag remelt and vacuum arc remelt) the heat shall be this original heat, and not any of the smaller remelts.

4.3 Quality conformance inspection. Sample sizes for quality conformance inspection shall be as specified in table II.

4.3.1 Check tests. Unless otherwise specified, from any lot of tubes found acceptable under prescribed inspection, the Government may designate any tube as a check tube. Such a tube becomes the property of the Government, and shall be tested at Government expense at a facility to be designated by the Government, and shall be subjected to any or all tests specified herein. If the tube fails to comply with the requirements, two additional tubes shall be tested at Government expense. Failure of either of these tubes shall be cause for rejection of the lot. If both tubes comply with all requirements, the lot shall be accepted. However, it shall be understood that the paragraph titled "Special Reservation for Critical Defects", of MIL-STD-105, shall apply to the check test procedure.

4.4 Sampling.

4.4.1 Chemical analysis. At least one sample shall be taken from each heat to verify chemistry. The chemical analysis shall be performed in accordance with ASTM A751. A report shall be prepared detailing the results of the chemical analysis (see 6.3).

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4.4.2 Tension and impact tests. The number of tubes selected from each lot for tests shall equal or exceed the sample sizes specified in table II.

TABLE II. - Sample size.

<u>Lot size</u>	<u>Sample size (minimum)</u>
1-15	All
16-90	16
91 and over	16 plus at least 10% of lot in excess of 90

a. If all tubes in a lot are not tested, the sample tubes shall include the extremes of the furnace charge locations and the quenching order when the continuous-type of heat treating is employed. For remelts (see 4.2.3) only, the sample size shall be one tube per remelt ingot, or in accordance with table II, whichever provides the maximum testing.

b. Two tensile specimens and two Charpy V-notch impact specimens shall be taken from each sample tube selected in accordance with 4.4.2. Specimens shall be taken from alternate tube ends so that at least 50 percent of the sample tubes shall be tested from end number 1 and 50 percent from end number 2 (see 6.4.1 and 6.4.2). At least two tensile and two Charpy V-notch impact tests shall be performed on each sample tube.

4.4.3 Hardness tests. Each tube shall be tested for hardness (see 4.6.3).

4.4.4 Macrostructure. When specified, each heat shall be examined for soundness (see 4.6.4).

4.4.5 Cleanliness. Samples shall be taken in accordance with AMS 2301.

4.5 Examinations.

4.5.1 Visual. All tubes shall be subject to examination for compliance with the Identification Marking (3.6), Workmanship (3.10) and Packaging (Section 5) provisions of this specification.

4.5.2 Dimensional. All tubes shall be subject to examination for compliance with the dimension and tolerance requirements specified on the applicable tube drawing, contract, or purchase order.

4.6 Tests.

4.6.1 Chemical composition. Tests shall be conducted in accordance with ASTM A751.

4.6.2 Tension and impact.

4.6.2.1 Location of specimens. Two tension and two impact specimens shall be taken from the locations indicated on the applicable drawing. When no location is shown on the drawing, specimens shall be taken so that the longitudinal center lines of the specimens, at midlength of the specimens, are tangent to a circle of 1/2 inch from the inside surface of the finished tube. Specimens from the same end or ends of the tube or tubes shall all be taken in the same direction.

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a. When the design of the tube precludes the use of transverse specimens, longitudinal specimens shall be used. The specimens shall be taken with their longitudinal center lines approximately parallel to the longitudinal axis of the tube.

b. Test specimens shall be taken from the 12, 6, 3, and 9 o'clock positions consecutively, as may be necessary to obtain sufficient tests. Additional specimens, if required, may be taken from any o'clock position provided that each additional specimen shall be taken from a position diametrically opposite the preceding specimen unless a specimen has previously been taken from the location.

c. All specimens from quenched and tempered, or requenched and tempered tubes shall be from prolongations of the tubes and from metal at least one wall thickness from the end of the tube. After specimens have been taken in accordance with the above requirements, additional specimens, if required, may be taken without additional discard provided additional thermal treatment is limited to retempering or other thermal treatment after cold straightening.

4.6.2.2 Type of specimens. Tensile test specimens shall be prepared in accordance with ASTM E8, and Charpy V-notch impact test specimens shall be Specimens from the same end or ends of the tube or tubes shall all be taken in the same direction.
prepared in accordance with ASTM E23.

4.6.2.3 Tension tests. Tension tests shall be conducted in accordance with ASTM E8. The rate of stress application shall not exceed 100,000 pounds per square inch per minute.

4.6.2.3.1 Yield strength. Yield strength shall be determined by the offset method in accordance with ASTM E8. The limiting offset shall be 0.10 percent (0.001 inch per inch of gage length).

4.6.2.3.2 Reduction of area. Reduction of area shall be determined in accordance with ASTM E8.

4.6.2.4 Impact tests. Charpy V-notch impact tests shall be conducted in accordance with ASTM E23. The temperature of the test specimen at the time of fracture shall be $-40^{\circ}\text{F} + 2^{\circ}\text{F}$. The error in the Charpy machine shall not exceed ± 1 ft-lb for energy values up to and including 20 ft-lbs and ± 5 percent for energy values over 20 ft-lbs when the machine is tested using standardized specimens obtained from the U.S. Army Material Technology Laboratory (see 6.2). This comparison shall have been made within 1 year prior to the time of inspection testing.

4.6.3 Hardness. Specimens for hardness tests shall be prepared and tested in accordance with ASTM E10. At least two hardness tests shall be made on each end of the tube. For tubes not tested for yield strength, the hardness range from each end shall be compared with the average of all hardness readings from the corresponding ends of tubes which were tested for yield strength.

4.6.4 Macrostructure. When specified, discs for macro-examination specimens shall be prepared and evaluated in accordance with ASTM E 361.

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4.6.5 Cleanliness. Inspection shall be performed as required by AMS 2301.

4.6.6 Interpretation of mechanical properties test results.

4.6.6.1 Yield strength.

4.6.6.1.1 Individual tubes. Each individual tube shall have met the requirements for yield strength if all values of yield strength fall within the limits prescribed by the applicable drawings and the requirements of 3.4.1.

4.6.6.1.2 Sampled lots. Each lot of tubes shall have met the requirements for yield strength if all of the following criteria are satisfied:

- a) All values of yield strength of the sample representing the lot fall within the limits prescribed by the applicable drawings and the requirements of 3.4.1.
- b) All Brinell hardness test values conform to the requirements of 3.4.4 and 4.6.3.

4.6.6.2 Reduction of area.

4.6.6.2.1 Individual tubes. Each individual tube shall have met the requirements for reduction of area if the reduction of area is equal to or greater than that shown in table I. The minimum percent reduction of area is shown opposite the applicable yield strength range (see Table I).

4.6.6.2.2 Sampled lots. Each lot of tubes shall have met the requirements for reduction of area if all values of reduction of area of the sample representing the lot is equal to or greater than that shown in table I. The minimum percent reduction of area is shown opposite the applicable yield strength range (see table I).

4.6.6.3 Charpy V-notch impact resistance.

4.6.6.3.1 Individual tubes. Each individual tube shall have met the requirements for Charpy V-notch impact resistance, if the impact resistance is equal to or greater than that shown in Table I. The minimum foot-pounds resistance is shown opposite the applicable average yield strength range (see table I).

4.6.6.3.2 Sampled lots. Each lot of tubes shall have met the requirements for Charpy V-notch impact resistance, if all values of impact resistance of the sample representing the lot is equal to or greater than that shown in table I. The minimum foot-pounds resistance is shown opposite the applicable yield strength range, into which the average yield strength of the sample falls (see table I).

4.6.7 Rejection.

4.6.7.1 Individual tubes. Any tube submitted as an individual tube for examination and testing, and tubes for which 100 percent examination and testing is required, shall be subject to rejection when the tube fails to meet any requirement of this specification and the contract.

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4.6.7.2 Sampled lots. When sampling procedures are allowed (see 4.4), any lot of tubes submitted as a lot for examination and testing, and represented by a sample shall be subject to rejection when any tube in the sample fails to meet any requirement of this specification and the contract. The remainder of the lot shall meet the hardness requirement of 3.4.4 and 4.6.3. A rejected lot shall be screened, that is, each tube in the lot shall be examined and tested to detect and remove all defects.

4.6.7.3 Local defects. If rejection of a tube can be traced to the presence of obvious defects (e.g., non-metallics) in the failed test bar or bars, the test values obtained on those bars may be disregarded subject to the approval of the Government Quality Assurance representative. One wake bar may be substituted for each defective bar. When a wake bar has been substituted, failure of the tube to meet specification requirements based on test results from the wake bar shall be cause for rejection of the tube, whether or not the wake bar also exhibits defects.

4.6.7.4 Defectively machined bars and faulty testing technique. If defectively machined test bars or faulty operation of the testing machine or recording device results in the rejection of a tube, the test values obtained on such bars may be disregarded subject to the approval of the Government Quality Assurance representative, and another specimen from the same tube end may be substituted for each such bar.

4.6.7.5 Treatment for retest. Tubes that do not meet the yield strength, reduction of area and Charpy V-notch resistance requirements of this specification, except as noted in 4.6.7.3 and 4.6.7.4, shall be reheat-treated before retesting. Reheat treatment may consist of retempering or reaustenitizing, agitated liquid quenching, and retempering. All retempering without reaustenitizing shall be at a temperature equal to or greater than the original tempering temperature for the tube.

4.6.8 Test records. The results of all final tests taken on each individual tube and on each tube comprising a sample and on each tube not comprising a sample (the remainder of a lot) shall be recorded. All final heat treatment cycles and results of all final tests taken on each individual tube and on each tube comprising a sample shall be recorded and a report shall be prepared (see 6.3).

5. PACKAGING

5.1 Preservation - packaging. Cleaning, drying, preservation and packaging shall be in accordance with ASTM D3951.

5.2 Packing. All tubes shall be packed for shipment in a manner to ensure carrier acceptance and safe delivery at destination.

5.3 Marking. Marking shall be in accordance with ASTM D3941 in addition to any special marking required in the contract or purchase order.

6. NOTES

6.1 Ordering data. Procurement documents should specify the following:

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6.1.1 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. Applicable drawing numbers.
- c. Quantity and dimensions of tubes.
- d. Yield strength (see 3.4.1).
- e. Impact requirements if other than in table I.
- f. Special identification marking not covered in 3.6.
- g. Requirements on records. (see 3.8)
- h. Sampling methods (see 4.4).
- i. Rejection and retest (see 4.6.7).
- j. Macrostructure (see 3.7).

6.2 Information regarding comparison tests in Charpy impact machine employing U.S. Army Material Technology Laboratory comparison specimens may be obtained from the Director, U.S. Army Materials Technology Laboratory, Watertown, Massachusetts 02172-0001.

6.3 Data requirements. When this specification is used in an acquisition and data are required to be delivered, the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved Contract Data Requirements List (CDRL), incorporated into the contract. When the provisions of DOD FAR Supplement, Part 27, Sub-Part 27.410-6 (DD Form 1423) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this specification are cited in the following paragraphs.

<u>Paragraph No.</u>	<u>Data Requirement Title</u>	<u>Applicable DID No.</u>
4.4.1, 4.6.8	Chemical and Physical Properties for Forging or Castings Analysis Report	DI-P-1638

6.4 Definitions.

6.4.1 End number 1. End number 1 as used herein is the heavier end of the tube. If both ends of the tube are the same size, end number 1 shall be the end of the tube first inserted in the heat treating furnace horizontally, or the bottom end of the tube if hung vertically in the heat treating furnace.

6.4.2 End number 2. End number 2 as used herein is the opposite end of the tube from end number 1 as defined in 6.4.1.

6.4.3 Prolongations. A prolongation for purposes of inspection and test is defined as an extension beyond the end of the tube length. The diameters and mass distribution of the extension shall not be less than those of the tube, at a point coincident with the end of the tube from which it extends.

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6.4.4 Average yield strength. The average yield strength of the tube under consideration is the arithmetical mean of all yield strength values obtained from the same end at the stage of heat treatment at which tests are being performed.

6.4.5 Wake bar. A wake bar is a tests specimen which is substituted for another specimen which has been discarded because of the presence of local defects.

6.4.6 Retest. A retest is defined as any tests made after the results of the original test are known.

6.5 Metric units. When metric units are required, units for degree Fahrenheit, pounds per square inch, square inch and inch may be converted to the metric equivalent by multiplying them by the following conversion factors:

<u>English</u>	<u>Multiply by</u>	<u>Equals</u>	<u>Metric SI Unit</u>
degree Fahrenheit	(F-32) X 5/9	=	degree Celcius (C)
pounds per square inch	6.894	=	Pascal (Pa)
square inch	6.452	=	(Cm) ²
inch	2.54	=	Centimeter (cm)

Note: Conversion factors can be associated with ASTM E380 entitled "Metric Practice Guide."

6.6 Subject term (key word) listing.

Tubes, steel, seamless

Thin-wall tubes, for cannons and recoilless rifles

6.7 International standardization agreements. Certain provisions (3.4.3 and 4.6.2.4) of this specification are the subject of international standardization agreement ABC-ARMY-STD-129 and STANAG No. 4020. When amendment, revision, or cancellation of this specification is proposed, the departmental custodians will inform their respective Departmental Standardization Officer so that appropriate action may be taken respecting the international agreement concerned.

6.8 Changes from previous issue. Asterisks (or vertical lines) are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

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Army - MR

Review activity:
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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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		<input type="checkbox"/> USER	
		<input type="checkbox"/> MANUFACTURER	
		<input type="checkbox"/> OTHER (Specify): _____	
5. PROBLEM AREAS			
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b. Recommended Wording:			
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