

MIL-S-13281E(MR)
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 SUPERSEDING
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MILITARY SPECIFICATION

STEEL, CARBON, ALLOY, AND HIGH STRENGTH LOW ALLOY FOR WELDED STRUCTURES (STRESS RELIEVED)

This specification is approved for use by the Army Materials and Mechanics Research Center, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers hot rolled and cold finished carbon, alloy, and high strength low alloy steels in the form of bar, shapes, plate, sheet, and strip intended primarily for use in welded structures which are to be stress relieved after welding (see 6.1).

1.2 Classification. The steel shall be furnished in the form, class, and grade, condition and finish, as specified.

1.2.1 Form. The steel shall be furnished in the following forms, as specified: Bar, including round, square, hexagonal, flat, or bar size shapes, standard structural shapes; plate; sheet; and strip. (see 6.2).

1.2.2 Class and grade. The steel shall be furnished in the following classes and grades, as specified (see 6.2):

Class A	- Carbon Steel
Class B, Grade 1	- Carbon Steel or High Strength Low Alloy Steel
Class B, Grade 2	- High Strength Low Alloy Steel
Class C	- Alloy Steel

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 Materials and Mechanics Research Center, ATTN: AMXMR-SMS, 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.

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1.2.3 Condition. The steel shall be furnished in one of the following conditions, as specified (see 6.2):

Hot rolled
Cold Finished
Annealed
Normalized

1.2.4 Finish. The steel shall be furnished in one of the following conditions as specified (see 6.2):

As hot rolled
Descaled
Descaled and oiled
As cold finished (cold rolled, cold drawn, machined or polished)

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.

STANDARDS

FEDERAL

FED-STD-48 - Tolerances for Steel Wrought Products, and for Centrifugally Cast Steel
FED-STD-66 - Steel: Chemical Composition and Hardenability
FED-STD-151 - Metals: Test Methods

MILITARY

MIL-STD-129 - Marking for Shipment and Storage
MIL-STD-163 - Steel Mill products Preparation for Shipment and Storage

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

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM D 3951 - Practice for Commercial Packaging
- ASTM E 8 - Tension Testing of Metallic Materials
- ASTM E 290 - Semi-Guided Bend Test for Ductility of Metallic Materials

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

(Technical society and technical 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 references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Chemical composition. Unless otherwise specified in the contract or order, the selection of the chemical composition of the steel necessary to meet the requirements of this specification shall be the responsibility of the supplier. To obtain certain combinations of mechanical properties and welding characteristics or compatibility, the purchaser may specify the chemical composition (see 6.2).

3.1.1 Cast or heat analysis. A cast or heat analysis of each heat of steel shall be furnished by the supplier showing the percentage of elements specified by the purchaser or declared by the supplier.

3.1.2 Product analysis. When chemical composition is specified (see 3.1), product analysis by the purchaser may be made on the finished material from each heat of steel subject to the product analysis tolerances of FED-STD-66.

3.2 Mechanical properties.

3.2.1 Tensile. Test specimens representing the steel shall conform to the properties shown in table I, after being stress relieved at the temperatures shown in table I for each class and grade for at least 4 hours followed by furnace cooling to 600°F. (316°C.) or lower.

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Table I. Tensile requirements (properties after stress relieving)

Class and grade	Minimum temperature for stress relief, deg. F. (deg. C.)	Tensile strength max., ksi (MPa)	Yield strength, ^{a/} min., ksi (MPa)	Bars ^{b/} and flat sections over 0.250 in. (6.35 mm) thick	Elongation in 2 inches ^{c/} , minimum, percent	
					Flat sections over 0.1250 in. (3.18 mm) thick or less	Flat sections over 0.1250 to 0.250 in. (3.18 to 6.35 mm) thick
A - --	1115 (602)	60 (414)	25 (172)	25	20	17
B - Grade 1	1115 (602)	80 (552)	40 (276)	25	20	17
B - Grade 2, less than 1/2 in. (12.7 mm) thick	1115 (602)	100 (689)	50 (345) 45 (310) ^{d/}	20	18	15
B - Grade 2, 1/2 to less than 1-1/2 in. (12.7 to less than 38.1 mm) thick	1115 (602)	100 (689)	45 (310)	20	--	--
B - Grade 2, 1-1/2 to 4 in. (38.1 to 101.6 mm) thick, incl.	1115 (602)	100 (689)	40 (276)	20	--	--
C - Less than 1/2 in. (12.7 mm) thick	1050 (566)	140 (965)	70 (483)	18	15	12
C - 1/2 to 3/4 in. (12.7 to 19.1 mm) thick, incl.	1050 (566)	140 (965)	65 (448)	18	--	--
C - Over 3/4 in. (19.1 mm) thick	1050 (566)	140 (965)	60 (414)	18	--	--

^{a/}Yield strength determined by either the off-set or the extension-under-load method (see 4.5.2.2.1.1).

^{b/}When round specimens other than the standard round specimen of ASTM E 8 are used for testing bars, elongation shall be determined on a gage length 4 times the diameter of specimen.

^{c/}Elongation in 8 inches and for shapes are not required.

^{d/}Yield strength applicable to cold rolled sheet and strip.

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3.2.2 Cold bending. When specified (see 6.2), longitudinal test specimens representing plate, sheet and strip shall be bent at room temperature through an angle of 180° to an inside diameter as shown in table II without evidence of readily visible cracks on the outside of the bent portion.

TABLE II. Bending properties.

Thickness of specimens, inches (mm)	Ratio of bend diameter to thickness of specimen
To 1/2 (12.7), incl.	2T
Over 1/2 (12.7)	2-1/2T

3.2.3 Heat treatment. When heat treatment is necessary to meet the mechanical property requirements of this specification, the detailed procedures may be determined by the contractor. The contractor shall submit a statement indicating the heat treated condition of each lot.

3.3 Weldability. All steel furnished under this specification shall be capable of being welded without preheating, at normal room temperatures of 60°F. (15.6°C.) or higher, without developing cracks in the bare metal adjacent to the welds. When specified (see 6.2), the contractor shall demonstrate the suitability of the chemical composition of the steel for welding under conditions as stated by the contract or order.

3.4 Dimensions & tolerances. Dimensional tolerances shall be in accordance with the applicable portions of FED-STD-48.

3.5 Identification marking. Identification marking shall be as specified in the contract or order. (see 6.2).

3.6 Conditioning of plates and structural shapes. At the option of the contractor or as specified (see 6.2), plates and shapes may be conditioned by the removal of minor surface imperfections on either surface by grinding or chipping, provided the ground area is well flared and the grinding does not reduce the as-rolled thickness of the steel to a greater extent than indicated below. Requirements that limit or qualify these customary procedures shall be negotiated between purchaser and contractor.

(a) For plates, no more than 7 percent of the nominal thickness for plates ordered to weight per square foot (square meter), but in no case more than 1/8 inch (3.18mm); or below the permissible minimum thickness for plates ordered to thickness in inches (mm).

(b) For shapes less than 3/8 inch (9.53mm) in nominal thickness, no more than 1/32 inch (0.79mm).

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(c) For shapes over 3/8 inch (9.53mm) in nominal thickness, no more than 1/16 inch (1.59mm). When the imperfections are more than 1/16 inch (1.59mm) deep, they can be removed, provided: The cross-sectional area of the piece at any location is not reduced by more than 1.5 percent; nor the total area of the chipped surface of the piece exceed 2 percent of the total surface area; and after any imperfection has been removed, the maximum depth of depression should not exceed 20 percent of the nominal thickness of the section.

(d) The toes of angles, beams, channels and zees and the stems and toes of tees may be conditioned by grinding or chipping and welding. Prior to welding, the depth of depression, measured from the toe inward, shall be limited to the thickness of the material at the base of the depression, with a maximum depth limit of 1/2 inch (12.7mm).

(e) When repair is performed, the welds must be sound and the weld metal thoroughly fused on all surfaces and edges without undercut or overlap. The weld metal should project at least 1/16 inch (1.59mm) above the rolled surface, and the projecting metal should be removed by grinding or chipping and grinding to make it flush with the rolled surface.

3.7 Workmanship. The steel shall be clean and free of imperfections such as laminations, segregation and surface defects as is consistent with good commercial practice.

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 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.

4.2 Lot. Unless otherwise specified in the contract or order (see 6.2), a lot shall consist of all steel submitted for inspection at one time, of the same heat and same form, and if heat treated, subjected to the same heat treatment procedure.

4.3 Sampling.

4.3.1 Product analysis. When chemical composition is specified (see 3.1), at least one sample shall be taken for chemical analysis. Sampling procedures shall be in accordance with FED-STD-66. When requested, the contractor shall furnish chips or drillings from the test specimens of the tensile test.

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4.3.2 Tensile test. Two test samples shall be taken from each lot, unless the lot is less than 30 tons (27.2 metric tons) then one sample shall be taken. If one lot of steel is processed into more than one thickness of a particular form, and the thickness differs by 3/8 in. (9.5 mm) or more, one tensile test sample shall be taken from the thickest and thinnest material in the lot. Test specimens for material wider than 24 inches (600mm) shall be taken transversely. Test specimens for all other material shall be taken longitudinally. Location of sample shall be in accordance with table III.

TABLE III. Location of tensile test specimens

Product	Product diameter or thickness	Location of test specimen axis
Round bars	Under 1-1/2 inches (38.1mm)	Coincidence with central longitudinal axis of piece
Flat sections	Under 1-1/2 inches (38.1mm)	Midway between the flat surfaces (full thickness of material)
Flat sections	Over twice the greatest diameter or width of test specimen used	Midway between the center and the edge of the section
All	Over 1-1/2 inches (38.1mm)	One-fourth the diameter or thickness from the surface of the piece

4.3.3 Bend test. When cold bending properties are specified (see 6.2), the test samples shall be taken longitudinally and the number of samples shall be the same as for tensile testing (see 4.3.2).

4.3.4 Weldability tests. Sampling for weldability test and the number of samples shall be as agreed upon between the contractor and procuring activity (see 6.2).

4.4 Examination.

4.4.1 Visual and dimensional. A representative sampling of the steel shall be examined for compliance with the requirements for finish (1.2.4) identification marking (3.5), and workmanship (3.7), and shall be measured for compliance with the requirements for dimensions (3.4) and conditioning (3.6).

4.4.2 Packaging. Prior to shipment, examination shall be made to determine compliance with the requirements of section 5.

4.5 Tests.

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4.5.1 Test specimens.

4.5.1.1 Chemical composition. Specimens for chemical analysis shall be prepared in accordance with method 111 or 112 of FED-STD-151 for the applicable procedure.

4.5.1.2 Mechanical properties.

4.5.1.2.1 Tensile properties. Specimens shall be prepared in accordance with ASTM E 8 and stress relieved as specified in 3.2.1 before testing.

4.5.1.2.2 Cold bending. When specified (see 6.2), specimens for cold bending shall be taken from a location midway between the center and the edge of the section being tested.

4.5.1.3 Weldability. Specimens for the weldability test shall be prepared as specified in the contract or order (see 6.2).

4.5.2 Test methods.

4.5.2.1 Chemical composition. Chemical composition shall be conducted in accordance with method 111 or 112 of FED-STD-151.

4.5.2.2 Mechanical properties.

4.5.2.2.1 Tensile tests. Tensile tests shall be conducted in accordance with ASTM E 8.

4.5.2.2.1.1 Yield strength. The yield strength shall be determined by either the offset method or the extension-under-load method as described in ASTM E 8. For the offset method, the set shall be 0.2 percent 0.002 in./in. (0.051/25.4 mm) of gage length). The limiting extension for the extension-under-load method is shown in table IV.

TABLE IV. Extension-under-load testing

Yield strength, ksi (MPa)	Limiting extension under load - in./in. (mm/mm) of gage
25 (172)	0.0028 (0.0711)
40 (276)	.0033 (.0838)
45 (310)	.0035 (.0889)
50 (345)	.0037 (.0940)
70 (483)	.0043 (.1092)

4.5.2.2.2 Bend test. When specified (see 6.2), cold bend test shall be performed in accordance with ASTM E 290. The steel shall be bent slowly, at room temperature, in a vise or press through an angle of 180 degrees over the pin diameter specified in 3.2.2.

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4.5.2.3 Weldability test. Weldability test shall be conducted as specified by the procuring activity (see 6.2).

4.6 Rejection.

4.6.1 Examination. If representative sampling for visual, dimensional or packaging fails to meet with the requirements of this specification when examined in accordance with 4.4, the lot shall be rejected.

4.6.2 Tests. If a test specimen fails to meet any of the requirements of this specification, the lot represented by the specimen shall be rejected when tested in accordance with 4.5.

4.6.3 Retests. Retests shall be permitted in accordance with FED-STD-151.

5. PACKAGING

5.1 Preservation-packaging. Preservation-packaging shall be level A or C, as specified (see 6.2).

5.1.1 Level A. Material shall be packed in accordance with the requirements of MIL-STD-163.

5.1.2 Level C. Material shall be packed in accordance with ASTM D 3951.

5.2 Packing. Unless otherwise specified in the contract or order, packing shall be level C (see 6.2).

5.2.1 Level C. Material shall be packed for shipment in such a manner as to insure acceptance and safe delivery in accordance with ASTM D 3951.

5.3 Marking for shipment. In addition to any special marking specified in the contract or order (see 6.2), marking for shipment shall be in accordance with the requirements of MIL-STD-129 or ASTM D 3951, as applicable.

6. NOTES

6.1 Intended use. The hot rolled carbon, alloy, and high strength low alloy steels purchased under this specification are intended primarily for use in welded structures which are to be stress-relieved after welding. The classes and grades are limited to those shown in 1.2.2 with the mechanical properties and welding characteristics indicated in 3.2 and 3.3, respectively. The steel may be furnished in the forms listed in 1.2.1 Class A steels are especially intended for resistance welding applications, while Class B steels are intended primarily for other than resistance welding and for nonwelding applications. When the intended use of the material necessitates special or optional requirements, the purchaser should state in adequate detail the purpose for which the material is intended.

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6.2 Ordering data. Purchasers should select the preferred options permitted herein and include the following information in procurement documents:

- (a) Title, number, and date of this specification.
- (b) Form, class, grade, condition, and finish (see 1.2.1, 1.2.2, 1.2.3, and 1.2.4).
- (c) Chemical composition (see (3.1)).
- (d) When cold bending properties are required (see 3.2.2, 4.3.3, 4.5.1.2.2, and 4.5.2.2.2).
- (e) Weldability requirements, if required (see 3.3, 4.3.4, 4.5.1.3, and 4.5.2.3).
- (f) Identification marking (see 3.5).
- (g) When conditioning of plate and structural shapes is required by the procuring activity (see 3.6)
- (h) Lot size, if other than as specified in 4.2.
- (i) Packaging required if different than specified in section 5.

6.3 Heat treatment. The steels furnished under this specification are not intended for quenching and tempering. The user should not subject them to such treatment without assuming responsibility for the ensuing mechanical properties.

Custodian:

Army -- MR

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Army -- MI
DLA -- IS

User activities:

Army -- AT, AV

Preparing activity:

Army -- MR

Project No. 9520-A006

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER MIL-S-13281E		2. DOCUMENT TITLE STEEL CARBON, ALLOY, AND HIGH STRENGTH LOW ALLOY FOR WELDED STRUCT.	
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one)	
b. ADDRESS (Street, City, State, ZIP Code)		<input type="checkbox"/> VENDOR	
		<input type="checkbox"/> USER	
		<input type="checkbox"/> MANUFACTURER	
		<input type="checkbox"/> 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)	