

QQ-S-777a

November 10, 1966

SUPERSEDING

Fed. Spec. QQ-S-777

December 6, 1961

FEDERAL SPECIFICATION**STEEL, CARBON, STRIP, COLD-ROLLED,
UNTEMPERED SPRING QUALITY**

*This specification was approved by the Commissioner, Federal Supply Service,
General Services Administration, for the use of all Federal agencies.*

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers cold-rolled carbon steel strip of untempered spring steel quality.

1.2 Classification.

1.2.1 Types. The cold-rolled spring steel is furnished in the following types, as specified (see 6.1).

1.2.1.1 Soft type annealed-dead soft. Soft type annealed cold-rolled carbon spring steel is the type designation of the product when the final annealing is performed as the last operation at finish size. This type is commonly produced to a maximum Rockwell hardness (see 3.3.1.1).

1.2.1.2 Soft type intermediate. Soft type intermediate hardness cold-rolled carbon spring steel is the type designation of the product when it is produced to various Rockwell hardness ranges (see 3.3.1.2) the maxima being higher than customarily obtained by annealing at finish size. It is commonly produced by rolling the spring steel after final annealing, by varying the annealing treatment, or both.

1.2.1.3 Spheroidize annealed type. Spheroidize annealed type carbon spring steel is produced to give the lowest maximum Rockwell hardness for applications requiring maximum formability (see 3.3.1.3).

2. APPLICABLE DOCUMENTS

2.1 The following specifications and standards, of the issues in effect on date of invitation for bids, or request for proposal,

form a part of this specification to the extent specified herein.

Federal Standards:

Fed. Std. No. 66 — Steel: Chemical Composition and Hardenability.

Fed. Std. No. 123 — Marking for Domestic Shipment (Civilian Agencies).

Fed. Test Method Std. No. 151 — Metals; Test Methods.

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

(Single copies of this specification and other product specifications required by activities outside the Federal Government for bidding purposes are available without charge at the General Services Administration Regional Offices in Boston, New York, Washington, D.C., Atlanta, Chicago, Kansas City, Mo., Dallas, Denver, San Francisco, Los Angeles, and Seattle, Wash.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Standard:

**MIL-STD-163—Steel Mill Products
Preparation for Shipment and
Storage.**

(Copies of Military Specifications and Standards required by contractors in connection with specific

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procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Type of steel. Steel shall be fully silicon killed. Aluminum may be added to control grain size.

3.2 Chemical composition. Chemical composition of cold-rolled carbon spring steel may be ordered to identification numbers (see 6.2), applicable ranges, maximum, or minimum limit. A ladle analysis of each heat of steel shall be furnished by the supplier.

3.2.1 Check analysis. The chemical composition, as determined by check analysis, shall meet the requirements for the specified composition provided that in a heat of steel, the individual tolerances do not vary both above and below the ranges shown for check analysis tolerances in Fed. Std. No. 66.

3.3 Mechanical properties.

3.3.1 Hardness. Cold-rolled carbon spring steel shall meet the requirements for hardness specified in the invitation for bids, contract, or order.

3.3.1.1 Soft type annealed. The lowest maximum specified hardnesses shall be as shown in table I.

3.3.1.2 Soft type intermediate. The maximum of the specified hardness and the hardness ranges shall be as shown in tables II, III, and IV.

3.3.1.3 Spheroidized type. The lowest maximum specified hardness shall be as shown in table V.

3.3.1.4 Cold bending. Unless otherwise specified in the invitation for bids, contract, or order, cold-rolled carbon spring steel shall withstand bending without cracking, as shown in table VI. Cold bending will not be required in the parallel direction on spring steel when the width to thickness ratio makes such bending impracticable. Cold bending of soft type intermediate tempers is not recommended, and requirements are subject to

negotiation between the supplier and procuring agency.

3.4 Decarburization. The cold-rolled carbon spring steel shall have a maximum permissible depth of total plus partial decarburization of 0.001 inch or 1.5 percent of the thickness of the steel, whichever is greater, except that steel less than 0.011 inch thick shall show no decarburization.

3.5 Grain size. The cold-rolled carbon spring steel shall have an average austenitic grain size of 5 or finer.

3.6 Spheroidization. Cold-rolled carbon spring steel specified spheroidize annealed shall be free of lamellar pearlite unless otherwise specified in the contract or order (see 6.1).

3.7 Finish. Unless otherwise specified in the invitation for bids, contract, or order, cold-rolled carbon spring steel shall be furnished with a No. 2 (regular bright) finish (see 6.1 and 6.3).

3.8 Edge. Unless otherwise specified in the invitation for bids, contract, or order, cold-rolled carbon spring steel shall be furnished with a No. 3 slit edge free from waves, cracks, and excessive burrs (see 6.4).

3.9 Dimensions. Cold-rolled carbon spring steel shall be furnished to the sizes as shown in the invitation for bids, contract, or order. Tolerances from specified dimensions shall be as shown in tables VII, VIII, IX, X, XI, and XII. Flatness tolerances shall be as negotiated between the supplier and the procuring agency.

3.10 Identification marking. Unless otherwise specified, strip in coils or bundles shall have the manufacturer's name or trademark, the specification number, and type legibly imprinted on oilproof, waterproof tags. Two tags shall be attached to each coil or bundle.

3.11 Workmanship. The cold-rolled carbon spring steel shall be clean and free from 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 supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to 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.

4.2 Lot. Unless otherwise specified, a lot shall consist of cold-rolled carbon spring steel submitted for inspection at one time of the same heat, the same type and finish, and the same thickness.

4.3 Sampling.

4.3.1 Chemical composition. A sample for check analysis of chemical composition shall be taken from three different coils in each lot. Each sample shall be analyzed separately and tested in accordance with 4.5.1.1.

4.3.2 Mechanical properties.

4.3.2.1 Hardness. A sample for hardness tests shall be taken from 2 different coils representing each 5,000 pounds of steel in the lot and tested in accordance with 4.5.2.2.1.

4.3.2.2. Cold bending. A sample for cold bending shall be taken from 2 different coils from each 5,000 pounds in the lot. Each sample shall be of sufficient size to obtain therefrom 1 longitudinal and 1 transverse test specimen. Upon approval of the procuring agency, when it has been demonstrated that the cold-rolled carbon spring steel uniformly meets the cold bending requirement, the number of samples may be reduced to that taken from 1 coil for each 5,000 pounds in the lot.

4.3.3 Microexamination for spheroidization, decarburization, and grain size. A sample shall be taken from two different coils in each lot.

4.4 Examination.

4.4.1 Visual and dimensional. Examination shall be made of portions of each coil in accordance with the inspection methods of the supplier for compliance with the requirements for finish (see 3.7), edge (see 3.8), workmanship (see 3.11), and dimensions (see 3.9). The equipment and techniques employed for examination shall be discriminatory and capable of detecting variations of magnitude outside the acceptable range for the steel quality.

4.4.2 Preparation for delivery. Prior to shipment, examination shall be made to determine compliance with the requirements of section 5, and 3.10.

4.5 Tests.

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. Test Method Std. No. 151 for the applicable procedure.

4.5.1.2 Mechanical properties.

4.5.1.2.1 Hardness. Specimens shall be prepared in accordance with method 248 of Fed. Test Method Std. No. 151.

4.5.1.2.2 Cold bending. One longitudinal and one transverse test specimen shall be prepared from each sample in accordance with method 231 of Fed. Test Method Std. No. 151.

4.5.1.3 Microexamination.

4.5.1.3.1 Decarburization and spheroidization. Two specimens shall be prepared from each sample. The prepared surface of the specimen shall be not less than 1 inch in length representing the full thickness and shall be perpendicular to the direction of rolling. Specimens shall be prepared using precautions to insure freedom from disturbed metal.

4.5.1.3.2 Grain size. Unless otherwise specified, specimens shall be prepared in accordance with procedure F, method 811 of Fed. Test Method Std. No. 151.

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4.5.2 Test methods.

4.5.2.1 Chemical composition. Chemical analysis shall be conducted in accordance with method 111 or 112 of Fed. Test Method Std. No. 151.

4.5.2.2 Mechanical properties.

4.5.2.2.1 Hardness tests. Hardness tests shall be conducted in accordance with method 248 of Fed. Test Method Std. No. 151.

4.5.2.2.2 Cold bending. Cold bending tests shall be conducted in accordance with method 281 of Fed. Test Method Std. No. 151.

4.5.2.3 Microexamination.

4.5.2.3.1 Spheroidization and decarburization. Microexamination of specimens for spheroidization and decarburization shall be made at a magnification of 100 diameters.

4.5.2.3.2 Grain size. Unless otherwise specified, grain size tests shall be conducted in accordance with procedure F, method 311 of Fed. Test Method Std. No. 151.

4.6 Rejection.

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

4.6.2 Tests. A lot shall be rejected for failure to comply with any of the specified test requirements when tested in accordance with 4.5.

4.6.3 Retests. Retests shall be permitted in accordance with Fed. Test Method Std. No. 151.

5. PREPARATION FOR DELIVERY

5.1 Preservation (military). Cold-rolled carbon spring steel shall be prepared for shipment in accordance with level A or C, as specified (see 6.1).

5.1.1 Level A. Preservation for shipment shall be in accordance with MIL-STD-163.

5.1.2 Level C. Steel shall be protected in accordance with general industry practice, with a suitable antirust oil.

5.2 Packing (military). Cold-rolled carbon spring steel shall be packed for shipment in accordance with level A or C, as specified (see 6.1).

5.2.1 Level A. Packing for shipment shall be in accordance with MIL-STD-163.

5.2.2 Level C. Packing for shipment shall be in accordance with commercial practice adequate to ensure carrier acceptance and safe delivery at the lowest rate.

5.3 Marking for delivery.

5.3.1 Civil agencies. Marking for shipment shall be in accordance with Fed. Std. No. 123.

5.3.2 Military agencies. In addition to marking specified in the contract or order, marking for shipment shall be in accordance with MIL-STD-163.

6. NOTES

6.1 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) Type (see 1.2).
- (c) Chemical composition (see 3.2).
- (d) Hardness ranges or maximum (see 3.3.1).
- (e) Standards for spheroidize annealed type (see 3.6).
- (f) If finish other than No. 2 is required (see 3.7).
- (g) If edge other than No. 3 is required (see 3.8).
- (h) Size required (see 3.9).
- (i) Selection of applicable levels of preservation, and packing required (see 5.1 and 5.2).

6.2 Selection of chemical composition.

6.2.1 Steel grade designation numbers. While it is not common practice to specify to numerical designations indicating chemical composition, designations covering composition (ladle analysis) commonly produced to this specification are shown in table XIII and may be used as a guide in procurement.

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6.2.2 *Minimum and maximum limits and ranges.* When carbon steel in sheet or strip form is specified to chemical composition, the compositions are commonly prepared using the ladle ranges and limits shown in table XIV. For steel manufactured by any process, the elements comprising the desired chemical composition are specified in one of three ways.

- (a) By a maximum limit.
- (b) By a minimum limit.
- (c) By minimum and maximum limits, termed the range; by common usage, the range is the arithmetical difference between the two limits (e.g., 0.60 to 0.72 is a 0.12 range).

6.3 *Finishes.* Standard commercial finishes available for cold-rolled carbon spring steel are as follows:

- (a) No. 2 (regular bright finish) is a finish produced by rolls having a moderately smooth finish.
- (b) No. 3 (best bright finish) is the highest quality finish produced. It is of high luster due to selective rolling practice on specially prepared rolls and is suited for electroplating.

6.4 *Edges.* Cold-rolled carbon spring steel is furnished to numerical designations for edges as follows:

- (a) No. 1, round, beveled, or square smooth edge as specified.

- (b) No. 2, mill edge, natural rounded edge resulting from rolling.
- (c) No. 3, slit edge, approximate square edge produced by slitting, not filed.
- (d) No. 4, round edge, rolled.
- (e) No. 5, square edge, approximate square edge produced by slitting, then flat rolled or filed.
- (f) No. 6, square edge, edge rolled.

6.5 *Supersession data.* This specification supersedes Federal Specification QQ-S-00640 (Army-Ord) in part.

Table I. *Soft type annealed cold-rolled carbon spring steel maximum Rockwell hardness*

Percent carbon maximum of range	Thickness		
	0.040 in. and over	Under 0.040 to 0.025 in., incl.	Under 0.025
	Rockwell	hardness	
0.30	B 74	30T 67	15T 84
.35	B 76	30T 68	15T 84
.40	B 78	30T 70	15T 85
.45	B 80	30T 71	15T 85
.50	B 82	30T 72	15T 86
.55	B 84	30T 73	15T 87
.60	B 85	30T 74	15T 87
.65	B 87	30T 75	15T 88
.70	B 88	30T 76	15T 88
.75	B 89	30T 76	15T 88
.80	B 90	30T 77	15T 89
.85	B 91	30T 77	15T 89
.90	B 92	30T 78	15T 89
.95 and over	B 92	30T 78	15T 90

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Table II. Soft type intermediate hardness cold-rolled carbon spring steel
Rockwell hardness ranges
thicknesses 0.040 inch and over

Maximum of carbon range, percent	For maximum of specified Rockwell hardness range, B scale														
	74	76	78	80	82	83.5	85	86.5	88	89	90	91	92	93/ 97	Over 97
	Rockwell hardness ranges														
0.26 to 0.30	*An	12	12	10	10	10	10	10	10	8	8	8	8	6	---
.31 to .35		*An	12	10	10	10	10	10	10	8	8	8	8	6	---
.36 to .40			*An	10	10	10	10	10	10	8	8	8	8	6	---
.41 to .45				*An	10	10	10	10	10	8	8	8	8	6	---
.46 to .50					*An	10	10	10	10	8	8	8	8	6	---
.51 to .55						*An	10	10	10	8	8	8	8	6	---
.56 to .60							*An	10	10	8	8	8	8	6	---
.61 to .65								*An	10	8	8	8	8	6	5
.66 to .70									*An	8	8	8	8	6	5
.71 to .75										*An	8	8	8	6	5
.76 to .80											*An	8	8	6	5
.81 to .90												*An	8	6	5
.91 to 1.35													*An	6	5

*An represents the lowest expected maximum Rockwell hardness value for the indicated carbon content in the annealed condition as shown in table I.

Rockwell B scale is not recommended for values over B 100.

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Table III. Soft type intermediate hardness cold-rolled carbon spring steel
Rockwell hardness ranges
thicknesses under 0.040 to 0.025 inch, inclusive

Maximum of carbon range percent	For maximum of specified Rockwell hardness range 30T scale														
	66.5	68	69.5	70.5	71.5	72.5	73.5	74.5	75.5	76	76.5	77.5	78	78.5/80.5	Over 80.5
	Rockwell hardness ranges														
0.26 to 0.30	*An	8	8	8	6	6	6	6	6	5	5	5	5	4	--
.31 to .35		*An	8	6	6	6	6	6	6	5	5	5	5	4	--
.36 to .40			*An	6	6	6	6	6	6	5	5	5	5	4	--
.41 to .45				*An	6	6	6	6	6	5	5	5	5	4	--
.46 to .50					*An	6	6	6	6	5	5	5	5	4	4
.51 to .55						*An	6	6	6	5	5	5	5	4	4
.56 to .60							*An	6	6	5	5	5	5	4	4
.61 to .65								*An	6	5	5	5	5	4	4
.66 to .70									*An	5	5	5	5	4	4
.71 to .75										*An	5	5	5	4	4
.76 to .80	*An represents the lowest expected maximum Rockwell hardness value for the indicated carbon content in the annealed condition as shown in table I.										*An	5	5	4	4
.81 to .90												*An	5	4	4
.91 to 1.35													*An	4	4

Rockwell 30T scale is not recommended for values over 30T 83.

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Table IV. Soft type intermediate hardness cold-rolled carbon spring steel
Rockwell hardness ranges
thicknesses under 0.025 to 0.010, inclusive

Maximum of carbon range, percent	For maximum of specified Rockwell hardness range, 15T scale														
	83.5	84.5	85	85.5	86	86.5	87	87.5	88	88.5	88.5	89	89.5	90/ 92	Over 92
	Rockwell hardness ranges														
0.26 to 0.30	*An	5	5	5	5	5	4	4	4	4	4	4	4	3	---
.31 to .35		*An	5	5	5	5	4	4	4	4	4	4	4	3	---
.36 to .40			*An	5	5	5	4	4	4	4	4	4	4	3	---
.41 to .45				*An	5	5	4	4	4	4	4	4	4	3	---
.46 to .50					*An	5	4	4	4	4	4	4	4	3	3
.51 to .55						*An	4	4	4	4	4	4	4	3	3
.56 to .60							*An	4	4	4	4	4	4	3	3
.61 to .65								*An	4	4	4	4	4	3	3
.66 to .70									*An	4	4	4	4	3	3
.71 to .75										*An	4	4	4	3	3
.76 to .80	*An represents the lowest expected maximum Rockwell hardness value for the indicated carbon content in the annealed condition as shown in table I.										*An	4	4	3	3
.81 to .90												*An	4	3	3
.91 to 1.35													*An	3	3

Rockwell 15T scale is not recommended for values over 15T 93.

Note: For hardness values other than those shown in tables IV, V, and VI, the producer should be consulted.

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Table V. Spheroidize annealed cold-rolled carbon spring steel maximum Rockwell hardness

Percent carbon maximum of range	Thickness		
	0.040 in. and over	Under 0.040 to 0.025 in., incl.	Under 0.025
	Rockwell hardness		
0.30	B 68	30T 63	15T 84
.35	B 70	30T 65	15T 84
.40	B 72	30T 66	15T 85
.45	B 74	30T 67	15T 85
.50	B 76	30T 68	15T 86
.55	B 78	30T 69	15T 87
.60	B 80	30T 71	15T 87
.65	B 82	30T 72	15T 88
.70	B 83	30T 73	15T 88
.75	B 84	30T 73	15T 88
.80	B 86	30T 74	15T 89
.85	B 87	30T 74	15T 89
.90	B 87	30T 75	15T 89
.95 and over	B 88	30T 75	15T 90

Table VI. Cold bending requirements

Type	Degree of bend	Inside radius to thickness	Relation of bend to rolling direction
Soft type annealed	180°	2t	Perpendicular, longitudinal
Soft type annealed	180°	3t ¹	Parallel, transverse
Spheroidize annealed	180°	t	Perpendicular, longitudinal
Spheroidize annealed	180°	2t ¹	Parallel, transverse

¹Up to 0.100 inch thickness maximum. Radius for thickness over 0.100 inch shall be negotiated between the supplier and the procuring agency.

Table VII. Thickness tolerances—cold-rolled carbon spring steel tolerances for specified thickness, plus and minus, inch ¹

Specified thickness inch					Widths, inches				
Under	To and incl.	Under 1 to 1/2, excl.	Under 3 to 1, incl.	3 to 6, incl.	Over 6 to 9, incl.	Over 9 to 12, incl.	Over 12 to 16, incl.	Over 16 to 20, incl.	Over 20 to 23-15/16, incl.
0.250	0.200	0.0020	0.0035	0.004	0.0045	0.005	0.0055	0.0055	0.0055
.200	.161	.002	.0035	.004	.004	.0045	.0045	.005	.005
.161	.100	.002	.002	.003	.003	.003	.0035	.0045	.005
.100	.069	.002	.002	.0025	.003	.003	.0035	.0035	.0035
.069	.050	.002	.002	.0025	.0025	.0025	.003	.003	.003
.050	.040	.002	.002	.0025	.0025	.0025	.0025	.0025	.0025
.040	.035	.002	.002	.002	.002	.002	.002	.002	.002
.035	.032	.0015	.0015	.002	.002	.002	.002	.002	.002
.032	.029	.0015	.0015	.0015	.002	.002	.002	.002	.002
.029	.026	.001	.0015	.0015	.002	.002	.002	.002	.002
.026	.023	.001	.001	.001	.0015	.0015	.002	.002	.002
.023	.020	.001	.001	.001	.0015	.0015	.0015	.0015	.0015
.020	.013	.00075	.00075	.00075	.001	.001	.0015	.0015	.0015
.013	.009	.00075	.00075	.00075	.001	.001	.001	.001	.001
.009	.007	.00075	.00075	.00075	—	—	—	—	—
.007		.00050	.00050	.00050	—	—	—	—	—

¹Measured 3/8 inch or more from edge on 1 inch or wider, and at any place between the edges on narrower than 1 inch.

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Table VIII. *Width tolerances for special edges*

Edge No.	Width, inch	Thickness, inch	Tolerance for specified width, plus and minus, inch
1	Over 1/2 to 3/4, incl.	3/32 and thinner	0.005
1	Over 3/4 to 5, incl.	1/8 and thinner	.005
4	Over 1/2 to 1, incl.	3/16 to 0.025, incl.	.015
4	Over 1 to 2, incl.	0.2499 to 0.025, incl.	.025
4	Over 2 to 4, incl.	0.2499 to 0.035, incl.	.047
4	Over 4 to 6, incl.	0.2499 to 0.047, incl.	.047
5	Over 1/2 to 3/4, incl.	3/32 and thinner	.005
5	Over 3/4 to 5, incl.	1/8 and thinner	.005
5	Over 5 to 9, incl.	1/8 to 0.008, incl.	.010
5	Over 9 to 20, incl.	0.105 to 0.015	.010
5	Over 20 to 23-15/16, incl.	0.080 to 0.023	.015
6	Over 1/2 to 1, incl.	3/16 to 0.025, incl.	.015
6	Over 1 to 2, incl.	0.2499 to 0.025, incl.	.025
6	Over 2 to 4, incl.	0.2499 to 0.035, incl.	.047
6	Over 4 to 6, incl.	0.2499 to 0.047, incl.	.047

Table IX. *Width tolerances for No. 2 (mill edge)*

Specified width, in.		Tolerance for specified width, plus and minus, in.
Over	Up to and including	
1/2	2	1/32
2	5	3/64
5	10	5/64
10	15	3/32
15	20	1/8
20	23-15/16	5/32

Table X. *Width tolerances for No. 3 edge (slit edge)*

Specified thickness, in.		Width, inches				
Over	To and incl.	Over 1/2 to 6 incl.	Over 6 to 9 incl.	Over 9 to 12 incl.	Over 12 to 20 incl.	Over 20 to 23-15/16 incl.
Tolerance for specified width, plus and minus, inch						
0.160	0.2499	0.016	0.020	0.020	0.031	0.031
.099	.160	.010	.016	.016	.020	.020
.068	.099	.008	.010	.010	.016	.020
.016	.068	.005	.005	.010	.016	.020
Up to	.016	.005	.005	.010	.016	.020

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Table XI. *Length tolerances*

Specified width, in.	Tolerance over specified length, inch; no tolerance under		
	24 to 60 in. incl.	Over 60 to 120 in. incl.	Over 120 to 240 in. incl.
Over 1/2 to 12, incl.	1/4	1/2	3/4
Over 12 to 23-15/16, incl.	1/2	3/4	1

Table XII. *Camber tolerances*

Width, in.	Tolerance in any 3 feet, in.
Over 1/2 to 1-1/2, incl.	1/2
Over 1-1/2	1/4

Table XIII. *Chemical composition—ladle analysis*

Number	Carbon percent	Manganese percent	Phosphorus percent (max.)	Sulphur percent (max.)	Silicon percent
1045	0.41 to 0.49	0.60 to 0.90	0.040	0.050	0.15 to 0.30
1045, modified	.41 to .49	.45 to .75	.040	.050	.15 to .30
1050	.47 to .55	.60 to .90	.040	.050	.15 to .30
1050, modified	.47 to .55	.45 to .75	.040	.050	.15 to .30
1055	.51 to .59	.60 to .90	.040	.050	.15 to .30
1055, modified	.51 to .59	.45 to .75	.040	.050	.15 to .30
1065	.59 to .70	.60 to .90	.040	.050	.15 to .30
1075	.70 to .84	.60 to .90	.040	.050	.15 to .30
1085	.80 to .94	.80 to .50	.040	.050	.15 to .30
1095	.90 to 1.04	.80 to .50	.040	.050	.15 to .30

Table XIV. *Ladle chemical ranges and limits*

Standard chemical ranges and limits, percent			
Element	When maximum of specified element is	Range	Lowest maximum
Carbon (See note)	Over 0.25 to 0.30, incl.	0.06	0.40
	Over .30 to 0.40, incl.	.07	
	Over .40 to 0.60, incl.	.08	
	Over .60 to 0.80, incl.	.11	
	Over .80 to 1.35, incl.	.14	
Manganese	To 0.50, incl.	.20	.04
	Over 0.50 to 1.15, incl.	.30	
	Over 1.15 to 1.65, incl.	.35	
Phosphorus			.05
Sulphur			.10
Silicon	To 0.15, incl.	.08	
	Over 0.15 to 0.30	.15	
	Over 0.30 to 0.60, incl.	.30	

Note. Carbon: The carbon ranges shown in the column headed "Range" apply when the specified

maximum limit for manganese does not exceed 1.00 percent. When the maximum manganese limit exceeds 1.00 percent, add 0.01 to the carbon ranges shown above.

CUSTODIAN:

Army—MR

Navy—WP

Air Force—(11)

Review interest:

Army—MR, MI, MU

Navy—WP

Air Force—11, 69

User interest:

Army—WC, MO, GL

Navy—SH

CIVIL AGENCIES INTEREST:

PO

Int

Agr

HEW

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Jus

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QQ-S-777a

Preparing activity:

Army—MR

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