

**QQ-S-698**

September 11, 1961

**SUPERSEDING**

Fed. Spec. QQ-S-636

June 20, 1941

(See section 6)

**FEDERAL SPECIFICATION****STEEL, SHEET AND STRIP, LOW-CARBON**

*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 low-carbon sheet and strip steel for general fabrication application (see 6.1 and 6.7).

**1.2 Classification.**

**1.2.1 Quality, temper or condition.** The steel sheet and strip are classified as to quality or temper in the following manner (see 6.2 and 6.10):

*Sheet:***Hot rolled:**

- (a) Commercial quality (HRCQ).
- (b) Physical quality (HRPQ).
- (c) Drawing quality (HRDQ).

**Cold rolled:**

- (a) Commercial quality (CRCQ).
- (b) Physical quality (CRPQ).
- (c) Drawing quality (CRDQ).
- (d) Drawing quality special killed (CRDQSK).

*Strip:***Hot rolled:**

- (a) Commercial quality.
- (b) Physical quality.
- (c) Drawing quality.

**Cold rolled (see 6.5):**

- (a) Full-hard temper—CR full-hard No. 1 temper.

- (b) Half-hard temper—CR half-hard No. 2 temper.

- (c) Quarter-hard temper—CR quarter-hard No. 3 temper.

- (d) Skin-passed temper—CR soft No. 4 temper.

- (e) Dead-soft temper—CR dead soft No. 5 temper.

**1.2.2** The steel sheet and strip are classified as to finishes as follows (see 3.4 and 6.4).

*Sheet:***Hot rolled:**

- (a) As rolled (AR).
- (b) Pickled (P).
- (c) Pickled and oiled (PO).

**Cold rolled (see 6.4):**

- (a) No. 1 (matte).
- (b) No. 2 (luster).
- (c) No. 3 (bright).

*Strip:***Hot rolled:**

- (a) As rolled (AR).
- (b) Pickled (P).
- (c) Pickled and oiled (PO).

**(Cold rolled (see 6.4):**

- (a) No. 1 (dull).
- (b) No. 2 (bright).
- (c) No. 3 (best bright).

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**1.2.3** The steel sheet and strip are classified as to edges as follows (see 3.5 and 6.2):

*Sheet:*

Hot rolled:

- (a) Mill.
- (b) Cut.

Cold rolled:

Cut.

*Strip:*

Hot rolled:

- (a) Mill.
- (b) Slit.
- (c) Square.

Cold rolled:

- (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 filing, then flat rolled or filed.
- (f) No. 6 Square edge, edge rolled.

## **2. APPLICABLE SPECIFICATIONS, AND STANDARDS**

**2.1 Specifications and standards.** The following specifications and standards, of the issues in effect on date of invitation for bids, form a part of this specification to the extent specified herein.

*Federal Standards:*

Fed. Std. No. 48—Tolerances for Steel and Iron Wrought Products.

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

Fed. Std. No. 102—Preservation, Packaging, and Packing Levels.

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, Standards, and Handbooks, 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 25, D. C.

(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, Atlanta, Chicago, Kansas City, Mo., Dallas, Denver, San Francisco, Los Angeles, Seattle, and Washington, D. C.

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

*Military Standards:*

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

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

## **3. REQUIREMENTS**

**3.1 Type of steel.** The choice of type of steel whether rimmed, capped, semi-killed, or killed is generally the supplier's option. If killed steel is required, it should be so specified in the invitation for bids, contract or order (see 6.2).

**3.2 Chemical composition.** When chemical composition is specified (see 6.1 and 6.2), the composition shall be specified to maximum limits. However, if required it may be specified to minimum limits, ranges or to grade designation numbers (see 6.3). A ladle analysis of each heat of steel shall be furnished by the supplier.

**3.2.1 Killed steel.** When killed steel is specified, the steel shall be subject to check analysis. The chemical composition shall meet the requirements as specified provided that in a heat of steel the individual tolerances do not vary from above or below the ranges shown for check analysis tolerances in Federal Standard No. 66.

**3.2.2 Semi-killed, rimmed and capped steel.** When semi-killed, rimmed, or capped steel is furnished check analysis is not applicable unless misapplication is clearly indicated, with the exception as follows: Copper analysis is required when copper-bearing steels are specified. A ladle analysis of each heat shall be furnished by the supplier showing the percentage of elements for the limits, range or grade designation and also copper and silicon when specified.

### 3.3 Mechanical properties.

**3.3.1 Tensile or hardness, physical quality hot-rolled sheet and strip; physical quality cold-rolled sheet and strip only.** The specimens representing the steel sheet or strip shall meet the tensile or hardness requirements when these requirements are specified in the invitation for bids, contract or order (see 6.2 and 6.9).

**3.3.2 Cold bending.** Unless otherwise specified in the invitation for bids, contract or order (see 6.2), the specimens representing the steel sheet or strip shall withstand being bent at room temperature without cracking on the outside of the bent portion as indicated in table I.

### 3.4 Finishes (see 1.2.2).

**3.4.1 Hot-rolled steel.** Unless otherwise specified in the invitation for bids, contract, or order (see 6.2), hot-rolled steel sheet and strip shall be furnished in the as-hot-rolled condition.

**3.4.2 Cold rolled steel.** Unless otherwise specified in the invitation for bids, contract, or order (see 6.2), cold-rolled steel sheet and strip shall be furnished in No. 1 (matte or dull) finish (see 6.2 and 6.4).

### 3.5 Edges (see 1.2.3).

**3.5.1 Sheet.** Hot-rolled steel sheet shall be furnished in mill or cut edge as specified (see 6.2), without numerical designation. Cold-rolled sheet shall be furnished with cut edge only.

#### 3.5.2 Strip.

**3.5.2.1 Hot rolled.** Hot-rolled strip shall be furnished with mill, slit, or square edge only,

as specified (see 6.2), without numerical designation.

**3.5.2.2 Cold rolled.** Cold-rolled steel strip shall be furnished to the type of edge, as specified (see 6.2) by numerical designation (see 1.2.3).

**3.6 Spheroidization.** Steel sheet or strip specified spheroidize annealed shall be free of lamellar pearlite unless otherwise specified in the contract or order (see 6.2).

**3.7 Drawing quality.** Steel sheet and strip specified as drawing quality shall perform satisfactorily, within the given limits, in such drawing or forming operation as may be specified in the invitation for bids, contract or order (see 6.2). When this quality is ordered, a drawing or description of the part should accompany the invitation for bids. When this quality is specified, cold rolled drawing quality sheets shall be free from stretcher strains or fluting if properly roller leveled just prior to use. If the material is for general use or if sheets must be free from significant changes in mechanical properties over a period of time or if parts must be essentially free from surface disturbances such as stretcher strains or fluting without roller leveling, drawing quality special killed sheet should be specified (see 6.2).

**3.8 Size and dimensional tolerances.** Steel sheet and strip shall be furnished to the sizes specified (see 6.2) and shall meet the requirements for the applicable tolerances of Federal Standard No. 48. The applicable references are shown in table II.

**3.9 Identification marking.** Marking for identification shall be as specified in the invitation for bids, contract or order (see 6.2). Individual sheets shall be marked with the quality designated as shown in 1.2.1.

**3.10 Workmanship.** Sheet and strip shall be clean and free of injurious imperfections, such as laminations, segregation, pipe, and surface defects which are not consistent with good commercial practice.

**QQ-S-698****4. SAMPLING, INSPECTION, AND TEST PROCEDURES**

**4.1** The supplier is responsible for the performance of all inspection requirements prior to submission for Government inspection and acceptance. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. 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, a lot shall consist of all sheet or strip submitted for inspection at one time, of the same heat, the same condition and finish, the same thickness and, when heat treated, subjected to the same heat treatment.

**4.3 Sampling.**

**4.3.1 For chemical composition.** At least one sample shall be taken from each lot for check analysis, when specified, in accordance with methods 111 or 112 or Federal Test Method Standard No. 151.

**4.3.2 For mechanical properties.**

**4.3.2.1 Tension test.** When tensile properties are specified, one tension-test sample shall be taken for each 60,000 pounds or fraction thereof in a lot.

**4.3.2.2 Hardness test.** When hardness requirements are specified for cut lengths, one hardness determination shall be made for each 10,000 pounds or fraction thereof in each lot. For coils, hardness shall be taken at both the front and back end of 5 percent of the coils, but not less than 2 coils in each lot.

**4.3.2.3 Cold bending.** At least one sample shall be taken from each lot. If bend test re-

quirements are in any direction (see 3.3.2) at least one longitudinal and one transverse sample shall be taken from each lot.

**4.3.3 For spheroidization.** For material ordered spheroidized annealed, one sample shall be taken from each lot for microscopic examination.

**4.4 Examination.**

**4.4.1 Visual.** A representative sampling of sheet or strip shall be examined for compliance with the specified finish (see 3.4), edge (see 3.5), identification marking (see 3.9), and workmanship (see 3.10) requirements.

**4.4.2 Dimensions and tolerances.** A representative number of measurements of the sheet or strip shall be taken on each lot to determine compliance with the size and dimensional tolerances (see 3.8). Thickness dimensions shall be determined by micrometer measurements.

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

**4.5 Tests.****4.5.1 Specimen.**

**4.5.1.1 Chemical composition.** Specimens for chemical analysis shall be prepared in accordance with methods 111 or 112 of Federal Test Method Standard No. 151 for the procedure used.

**4.5.1.2 Mechanical properties.**

**4.5.1.2.1 Tension tests.** Specimens for tension tests shall be prepared in accordance with method 211 of Federal Test Method Standard No. 151, and shall conform to the shape and dimensions of type F1 or F2 test specimens.

**4.5.1.2.2 Hardness.** The specimens for hardness testing shall be prepared in accordance with the applicable hardness method in accordance with Federal Test Method Standard No. 151.

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**4.5.1.2.3 Cold bending.** The specimens for cold bending shall be prepared in accordance with method 231 Federal Test Method Standard No. 151.

**4.5.1.3 Spheroidization.** The specimens for micro-examination for spheroidisation shall have a prepared surface at least 1 inch long and shall represent the full thickness of the material. The specimen shall be taken perpendicular to the rolling direction and shall be obtained from a location one-quarter of the width from the edge of the material.

#### **4.5.2 Test methods.**

**4.5.2.1 Chemical composition.** Chemical analysis, when specified, shall be conducted in accordance with methods 111 or 112 of Federal Test Method Standard No. 151.

#### **4.5.2.2 Mechanical properties.**

**4.5.2.2.1 Tension tests.** Tension tests shall be conducted in accordance with method 211 of Federal Test Method Standard No. 151.

**4.5.2.2.2 Hardness tests.** Hardness tests shall be conducted in accordance with the applicable method of Federal Test Method Standard No. 151 for the specified hardness.

**4.5.2.2.3 Cold bending.** Cold bending tests shall be conducted in accordance with method 231 of Federal Test Method Standard No. 151.

**4.5.2.3 Spheroidisation.** The metallographic examination for spheroidisation shall be conducted at sufficient magnification to give reliable results.

**4.5.2.4 Drawing quality.** Drawing tests shall be conducted as negotiated between the supplier and the procuring agency.

#### **4.6 Rejection.**

**4.6.1 Examination.** If 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 requirements when tested in accordance with 4.5.

**4.6.3 Retests.** Retests shall be granted in accordance with Federal Test Method Standard No. 151.

### **5. PREPARATION FOR DELIVERY**

**5.1 Preservation, packaging, and packing, (civil agencies).** Definitions and applications of the levels of preservation, packaging, and packing shall be in accordance with Federal Standard No. 102.

**5.2 Preservation (military).** Sheet and strip shall be prepared for shipment in accordance with levels A or C as specified (see 6.1).

**5.2.1 Level A.** Preservation for shipment shall be in accordance with Military Standard MIL-STD-163.

**5.2.2 Level C.** Preservation for shipment shall be in accordance with commercial practice.

**5.3 Packing (military).** Sheet and strip shall be packed for shipment in accordance with levels A or C, as specified (see 6.1).

**5.3.1 Level A.** Packing for shipment shall be in accordance with Military Standard MIL-STD-163.

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

#### **5.4 Marking for shipment.**

**5.4.1 Civil agencies.** Marking for shipment shall be in accordance with Federal Standard No. 123.

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**5.4.2 Military agencies.** Marking for shipment shall be in accordance with Military Standard MIL-STD-163.

**6. NOTES****6.1 Intended use and definitions of quality.****6.1.1 Commercial quality.**

**6.1.1.1 Hot-rolled sheet and strip.** This quality is ordinarily produced in a low-carbon grade of steel. It is suitable for many applications where the presence of oxide and normal surface defects are not objectionable. In this quality surface is of secondary importance; hence it is not recommended for exposed parts where finish is a prime requirement. When carbon content is not specified commercial quality is furnished to a maximum carbon limit of 0.15 percent by ladle analysis.

**6.1.1.2 Cold-rolled sheet.** This quality is suitable for exposed parts requiring a good surface finish. It is produced with a matte finish for the application of various organic finishes, such as paints, enamels, or lacquers, but is not suitable for electroplating where surface smoothness or freedom from surface imperfections in the finished product is essential. When a carbon content is not specified, it is assumed that commercial quality sheets not exceeding 0.15 percent carbon by ladle analysis are desired.

**6.1.2 Physical quality.**

**6.1.2.1 Hot-rolled sheet and strip.** This quality is produced when mechanical property values are specified or required other than bend tests of commercial quality. Such values include those indicated by tension, hardness, or other commonly accepted mechanical tests. It is customary to specify only one kind of test requirement on any one item. The surface characteristics of this quality are the same as those of hot rolled commercial quality.

**6.1.2.2 Cold-rolled sheet.** This quality is produced when mechanical property values are

specified or required. Such values include those indicated by tension, hardness, or other commonly accepted mechanical tests. It is customary to specify only one kind of test requirement on any one item. The surface characteristics of cold rolled physical quality sheets are the same as for cold rolled commercial quality sheets.

**6.1.3 Drawing quality.**

**6.1.3.1 Hot-rolled sheet and strip.** This quality is produced for use in fabricating an identified part when surface finish is not of primary importance and surface disturbances are not objectionable. This product should produce an identified part within the breakage allowance negotiated between the consumer and producer.

**6.1.3.2 Cold-rolled sheet.** This quality is manufactured from specially produced or selected steels and is specially processed to have good uniform drawing properties for use in fabricating identified parts. Drawing quality steels are generally produced from specially selected rimmed steels. Sheets of this quality should produce, within the breakage allowances negotiated between the purchaser and producer, an identified part too difficult for the fabricating properties of cold rolled commercial quality sheet.

**6.1.3.3 Special killed.** This steel is generally a low carbon aluminum killed steel, although the producer sometimes uses other deoxidizers to obtain the characteristics. Special-killed steel is intended for applications where cold rolled sheets are to be essentially free from significant changes in mechanical properties over a period of time or when this type of sheet is to be essentially free from surface disturbances, such as stretcher strains or fluting without roller leveling.

**6.2 Ordering data.** Purchasers should exercise any desired options offered herein, and procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Quality or temper required (see 1.2.1).

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- (c) Whether killed steel is required (see 3.1).
- (d) Chemical composition; if required (see 3.2).
- (e) Mechanical properties, if required (see 3.3).
- (f) If finish other than as hot rolled is required (see 1.2.2 and 3.4.1).
- (g) If other than No. 1 finish is required for cold rolled steel (see 1.2.2, 3.4.2 and 6.4).
- (h) Edge finish for hot rolled sheet (see 1.2.3 and 3.5.1).
- (i) Edge finish for hot rolled strip (see 1.2.3 and 3.5.2.1).
- (j) Edge finish for cold rolled strip (see 1.2.3 and 3.5.2.2).
- (k) Whether spheroidize anneal is required (see 3.6).
- (l) Drawing quality or drawing quality special killed, if required (see 1.2.1 and 3.7).
- (m) Size and tolerances (see 3.8).
- (n) Identification marking (see 3.9).
- (o) Level of preservation (see 5.2 and level of packaging required (see 5.3).

### 6.3 Selection of chemical composition.

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

- (a) By a maximum limit.
- (b) By a minimum limit.
- (c) By a minimum and maximum limits.

Termed the range; by common usage the range is the arithmetical difference between the two limits (e.g., 0.10 and 0.15 is a 0.05 range).

**6.3.2 Steel grade designation.** While it is not common practice to specify commercial quality sheet and strip to numerical designations indicating chemical compositions, designations cover-

ing composition (ladle analysis) commonly produced to this specification are shown in table IV and may be used as a guide in procurement. Unless a modification is indicated the designations are as shown in Federal Standard No. 66 for sheet and strip.

**6.4 Finishes.** Standard commercial finishes available for colled rolled material are as follows:

No. 1—Dull finish for strip or matte finish for sheet are finishes without luster produced by rolling on rolls roughened by mechanical or chemical means.

No. 2—Regular bright finish for strip or luster finish for sheets are finishes produced by rolls having a moderately smooth finish.

No. 3—Best bright finish for strip or bright finish for sheets is the highest quality finish produced. It is of high luster due to selective rolling practice on specially prepared rolls and is suitable for electroplating.

**6.5 Cold-rolled strip.** This material is commonly produced to the various tempers with the following carbon limitations:

Temper No.	Commonly produced Carbon, Maximum
No. 4 & 5 .....	0.15%
No. 3 .....	0.25%
No. 2 .....	0.25%
No. 1 .....	0.25%

**6.6 Supersession data.** This specification supersedes Federal Specifications QQ-S-636 dated June 20, 1941, QQ-S-692 dated November 7, 1960 in part, QQ-S-693 dated November 7, 1960 in part, and QQ-S-00640 (Army-Ord) dated August 8, 1952, in part, and contains the requirements of OAC-PD-32A dated 1 May 1959. For the above specifications for carbon content over 0.25 percent, Federal Specification QQ-S-700 will be the superseding document.

**6.7 Relationship to commercial specifications.** Plain commercial quality hot rolled sheet (HRCQ) of this specification, 0.15 carbon content, maximum is similar to ASTM A415-58T. Plain commercial hot rolled strip of this specification, 0.15 carbon content, maximum, is similar

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to ASTM A425-58T. Commercial quality cold rolled sheet (CRCQ), 0.15 carbon content, maximum, of this specification is similar to ASTM A100-58T. Drawing quality special killed cold rolled sheet ordered to this specification is similar to ASTM 365-58T.

**6.8 Transportation description.** Transportation descriptions and minimum weights applicable to this commodity are:

**Rail—Sheet steel—**

Steel, sheet, not otherwise indexed by name, plain. Carload minimum weight 40,000 pounds.

**Motor—**

Steel, sheet not otherwise indexed, plain truckload minimum weight (w) 36.6 pounds, (w) subject to rule 34, National Motor Freight Classification.

**Rail—Strip steel—**

Strip steel, not otherwise indexed by name carload minimum weight 45,000 pounds.

**Motor—**

Strip steel, not otherwise indexed. Motor volume minimum weight 40,000 pounds.

**6.9 Selection of mechanical properties.**

**6.9.1 Tensile properties.** When tensile properties are specified for physical quality sheet or strip, the following tensile ranges are commonly specified as shown in table V for sheet and table VI for strip.

**6.9.2 Hardness properties.**

**6.9.2.1 Sheet.** When hardness properties are specified for physical quality cold rolled sheet they are customarily ordered to a hardness range, indicated by both minimum and maximum Rockwell B limits of at least 15 points spread. Two tempers have become recognized as those in common use for wide variety of application as follows:

**6.9.2.2 Strip.** When cold rolled steel is specified to hardness values the No. 1 temper is specified to a minimum Rockwell B hardness, the No. 2 and 3 tempers are specified to Rockwell B ranges. This range is generally with a fixed minimum and an approximate maximum. No. 4 and 5 tempers are specified to an approximate Rockwell B maximum. Table VIII shows the hardness values for the various tempers.

**6.10 Relationship of superseded specifications:***Steel sheet hot rolled:*

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Commercial quality .....	Commercial quality .....	Class B .....	Chemical composition .....
Physical quality .....	.....	.....	Physical properties .....
Drawing quality .....	Deep drawing quality .....	Class A .....	Drawing quality .....

*Steel sheet cold rolled:*

QQ-S-698	QQ-S-636	QQ-S-692	QQ-S-00640
Commercial quality .....	Commercial quality .....	Class B .....	Chemical composition .....
Physical quality .....	.....	.....	Physical properties .....
Drawing quality .....	Deep drawing quality .....	Class A .....	Drawing quality .....
Drawing quality special killed .....	.....	Class C .....	.....

*Steel strip hot rolled:*

QQ-S-698	QQ-S-636	QQ-S-693	QQ-S-00640
Commercial quality .....	Commercial quality .....	No coverage .....	Chemical composition .....
Physical quality .....	.....	No coverage .....	Physical properties .....
Drawing quality .....	Deep drawing quality .....	No coverage .....	Drawing quality .....

*Steel strip cold rolled:*

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No. 1 Full hard temper .....	No. 1 Hard temper .....	No coverage .....	No. 1 Hard .....
No. 2 Half-hard temper .....	No. 2 Half-hard temper .....	No coverage .....	No. 2 Half-hard .....
No. 3 Quarter-hard temper .....	No. 3 Quarter-hard temper .....	No coverage .....	No. 3 Quarter-hard .....
No. 4 Skin-passed temper .....	No. 4 Soft-skin rolled temper .....	No coverage .....	No. 4 Soft-skin rolled .....
No. 5 Dead-soft temper .....	No. 5 Dead-soft temper .....	No coverage .....	No. 5 Dead-soft .....

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TABLE I.—Cold bending requirements.

Condition of steel	Degree of bend	Ratio of inside radius to thickness	Relation of bend to direction of rolling
<i>Hot rolled sheet and strip, and cold rolled sheet (except as cold rolled):</i>			
Up to .15 carbon incl. ....	180°	0 (Flat)	Any
Over .15 to .25 carbon incl. ....	180°	½t	Any
<i>Cold rolled strip (see 6.5):</i>			
No. 4 & 5 temper .....	180°	0	Any
No. 3 temper .....	180°	½t	Across
	90°	t	In
No. 2 temper .....	90°	t	Across
No. 1 temper .....	No requirements	.....	.....

TABLE II.—Dimensional tolerance references to Federal Standard No. 48.

Form	Dimensional tolerance	Federal Standard No. 48 Reference
<i>Sheet:</i>		
Hot rolled (including pickled sheet)	Thickness .....	11a3
	Width (cut edge) .....	11a4
	Width (mill edge) .....	11a5
	Length .....	11a6
	Out of square (cut edge not resquared) .....	11a9
	Out of square (resquared) .....	11a10
	Camber .....	11a12
	Flatness (not specified to stretcher level flatness) .....	11a13
	Flatness (specified to stretcher level flatness) .....	11a14
Cold rolled	Thickness .....	12a2
	Width (not resquared) .....	12a3
	Length .....	12a5
	Out of square .....	12a6
	Out of square (resquared) .....	12a7
	Camber .....	12a9
	Flatness (not specified to stretcher level flatness) .....	12a10
	Flatness (specified to stretcher level flatness) .....	12a11
<i>Strip:</i>		
Hot rolled	Thickness .....	14a1
	Crown .....	14a2
	Width .....	14a3
	Length .....	14a4
	Camber .....	14a5
	Flatness .....	14a6
Cold rolled	Thickness .....	15a1
	Crown .....	15a2
	Width (special edges) .....	15a3
	Width (No. 2 edge) .....	15a4
	Width (No. 3 edge) .....	15a5
	Length .....	15a6
	Camber .....	15a7
	Flatness .....	15a8

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TABLE III.—Ladle chemical ranges and limits basic and acid open hearth, basic oxygen and acid bessemer carbon steels.

Element	Standard Chemical Ranges and Limits, Per cent		
	When maximum of specified element is	Range	Lowest Max.
Carbon (see note 1)	To 0.15 incl. ....	0.06	0.10
	Over 0.15 to 0.25 incl. ....	0.07	
Manganese	To 0.50 incl. ....	0.20	0.40
	Over 0.50 to 1.15 incl. ....	0.30	
	Over 1.15 to 1.65 incl. ....	0.35	
Phosphorus	Acid and basic open hearth to 0.08 incl. ....	0.03	0.04 0.04 0.05 0.11
	Acid and basic open hearth and acid bessemer over 0.08 to 0.15 incl. ....	0.05	
	Basic open hearth .....		
	Basic oxygen .....		
	Acid open hearth .....		
	Acid Bessemer .....		
Sulphur	To 0.08 incl. ....	0.03	0.05 0.05 0.05 0.06
	Over 0.08 to 0.15 incl. ....	0.05	
	Over 0.15 to 0.23 incl. ....	0.07	
	Over 0.23 to 0.33 incl. ....	0.10	
	Basic open hearth .....		
	Basic oxygen .....		
	Acid open hearth .....		
Acid Bessemer .....			
Silicon (see note 2)	To 0.15 incl. ....	0.08	0.10
	Over 0.15 to 0.30 incl. ....	0.15	
	Over 0.30 to 0.60 incl. ....	0.30	
Copper	When copper is required 0.20 minimum is commonly specified .....		

NOTE 1. Carbon: The carbon ranges shown in the column headed "Range" apply when the specified maximum limit for manganese does not exceed 1.00 per cent. When the maximum manganese limit exceeds 1.00 per cent, add 0.01 to the carbon ranges shown above.

NOTE 2. Silicon: Acid open hearth steel is normally produced with a 0.15-0.30 silicon range. Because of the technological nature of the process, acid Bessemer steels are not produced with specified silicon content.

TABLE IV.—Chemical compositions, ladle analysis<sup>1, 2</sup>

Numerical designation	Carbon range	Manganese range	Phosphorus, max.	Sulfur, max.
	Percent	Percent	Percent	Percent
1008 .....	0.10 max.	25/50	.040	.050
1009 .....	0.15	60 max.	.040	.050
1015 .....	.12/.19	30/60	.040	.050
1018 (modified) .....	.13/.20	60/90	.040	.050
1018 .....	.14/.21	60/90	.040	.050
1020 .....	.17/.24	30/60	.040	.050

<sup>1</sup> When so specified, the silicon content shall be as follows: 0.10 max. or 0.10-0.25.

<sup>2</sup> When ordered "copper bearing," copper content will be not less than 0.20 percent.

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TABLE V.—Tensile properties for sheet<sup>1</sup>

	Specified minimum tensile limits	Tensile range
	P.s.i.	P.s.i.
For sheet 12 gage and heavier, 0.0972 inch and thicker .....	To 62,000 incl.	10,000
	Over 62,000 to 66,000 incl.	13,000
	Over 66,000 to 80,000 incl.	15,000
For sheets lighter than 12 gage, 0.0971 inch and thinner .....	To 80,000	15,000

<sup>1</sup>The ratio of a specified minimum yield point to the specified minimum tensile strength should be not greater than is required for the respective grades of ASTM Standard A245-58T as follows:

	Grade A	Grade B	Grade C
Tensile strength, min. p.s.i. ....	48,000	52,000	55,000
Yield point, min. p.s.i. ....	25,000	30,000	33,000

TABLE VI.—Tensile properties for strip

Specified minimum tensile limits, p.s.i.	Tensile Range p.s.i.
To 60,000 exclusive .....	10,000
60,000 to 67,000 exclusive .....	12,000
67,000 to 80,000 inclusive .....	15,000

TABLE VII.—Cold rolled sheet Rockwell Hardness range

Temper	Min.	Max.
Quarter hard .....	B-60	B-75
Half hard .....	B-70	B-85 Approx.

TABLE VIII.—Rockwell hardness cold rolled strip

Temper	Ladle carbon percent	Rockwell hardness	
		Min.	Max.
No. 1 .....	.025 max.	B-84 thicknesses 0.070 and greater B-90 thickness less than 0.070	.....
No. 2 .....	.25 max.	B-70	B-85 Approx.
No. 3 .....	.25 max.	B-60	B-75 Approx.
No. 4 .....	.15 max.	....	B-65 Approx.
No. 5 .....	.15 max.	....	B-55 Approx.

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