

Designation: A 29/A 29M - 04

# Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for<sup>1</sup>

ASTM

This standard is issued under the fixed designation A 29/A 29M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

### 1. Scope\*

1.1 This specification<sup>2</sup> covers a group of common requirements which, unless otherwise specified in the purchase order or in an individual specification, shall apply to carbon and alloy steel bars under each of the following ASTM specifications (or under any other ASTM specification which invokes this specification or portions thereof):

Title	of	Specification
TILLE	UI.	Specification

	Designation <sup>A</sup>
Hot-Rolled Carbon Steel Bars:	
Steel Bars, Carbon, Quenched and Tempered	A 321
Steel Bars and Shapes, Carbon Rolled from "T" Rails	A 499
Steel Bars, Carbon, Merchant Quality, M-Grades	A 575
Steel Bars, Carbon, Hot-Wrought, Special Quality	A 576
Steel Bars, Carbon, Merchant Quality, Mechanical Properties	A 663
Steel Bars, Carbon, Hot-Wrought, Special Quality, Me-	A 675
Steel Bars for Springs, Carbon and Alloy	A 689
Cold-Finished Carbon Steel Bars:	
Steel Bars, Carbon, Cold-Finished, Standard Quality	A 108
Stress-Relieved Steel Bars Subject to Mechanical	A 311/A 311M
Property Requirements, Cold-Drawn Carbon	
Hot-Rolled Alloy Steel Bars:	
Steel Bars, Alloy, Standard Grades	A 322
Steel Bars, Alloy, Subject to End-Quench Hardenability	/SISA 30432640
Steel Bars, Alloy, Hot-Wrought or Cold-Finished, Quenched and Tempered	A 434
Steel Bars, Alloy, Hot-Wrought, for Elevated Tempera- ture or Pressure-Containing Parts, or Both	A 739
Cold-Finished Alloy Steel Bars: Steel Bars, Alloy, Hot-Rolled or Cold-Finished, Quenched and Tempered	A 434
Steel Bars, Carbon, Hot-Wrought or Cold-Finished, Special Quality, for Pressure Piping Components	A 696

<sup>A</sup> These designations refer to the latest issue of the respective specifications, which appear either in the *Annual Book of ASTM Standards*, Vol 01.05, or as reprints obtainable from ASTM.

1.2 In case of any conflict in requirements, the requirements of the purchase order, the individual material specification, and this general specification shall prevail in the sequence named. 1.3 The values stated in inch-pound units or SI units are to be regarded as the standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.4 For purposes of determining conformance to this specification and the various material specifications referenced in 1.1, dimensional values shall be rounded to the nearest unit in the right-hand place of figures used in expressing the limiting values in accordance with the rounding method of Practice E 29.

NOTE 1—Specification A 29 previously listed dimensional tolerances for cold-finished bars; these are now found in Specification A 108.

### 2. Referenced Documents

- 2.1 ASTM Standards: <sup>3</sup>
- A 108 Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
- A 304 Specification for Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements
  - A 311 Specification for Cold-Drawn, Stress-Relieved Carbon Steel Bars Subject to Mechanical Property Requirements
  - A 321 Specification for Steel Bars, Carbon, Quenched and Tempered
  - A 322 Specification for Steel Bars, Alloy, Standard Grades
  - A 331 Specification for Steel Bars, Alloy, Cold-Finished
  - A 370 Test Methods and Definitions for Mechanical Testing of Steel Products
  - A 434 Specification for Steel Bars, Alloy, Hot-Wrought or Cold-Finished, Quenched and Tempered
  - A 499 Specification for Steel Bars and Shapes, Carbon Rolled from "T" Rails
  - A 575 Specification for Steel Bars, Carbon, Merchant Quality, M-Grade

<sup>&</sup>lt;sup>1</sup> This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.15 on Bars.

Current edition approved March 1, 2004. Published April 2004. Originally approved in 1957. Last previous edition approved in 2003 as A 29/A 29M-03.

<sup>&</sup>lt;sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-29/SA-29M in Section II of that Code.

<sup>&</sup>lt;sup>3</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

- A 576 Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
- A 663 Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties
- A 675 Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
- A 689 Specification for Carbon and Alloy Steel Bars for Springs
- A 695 Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, for Fluid Power Applications<sup>4</sup>

A 696 Specification for Steel Bars, Carbon, Hot-Wrought or Cold-Finished, Special Quality for Pressure Piping Components

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment

A 739 Specification for Steel Bars, Alloy, Hot-Wrought, for Elevated Temperature or Pressure-Containing Parts, or Both

- A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E 112 Test Methods for Determining the Average Grain Size

2.2 Federal Standards:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)<sup>5</sup>

Fed. Std. No. 183 Continuous Identification Marking of Iron and Steel Products<sup>5</sup>

- 2.3 Military Standard:
- MIL-STD-163 Steel Mill Products—Preparation for Shipment and Storage<sup>5</sup>

2.4 Other Standards:

AIAG B-1 Bar Code Symbology Standard for 3-of-9 Bar Codes<sup>6</sup>

AIAGB-5 02.00 Primary Metals Tag Application Standard<sup>6</sup>

### 3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *Hot-Wrought Steel Bars*—Steel bars produced by hot forming ingots, blooms, billets, or other semifinished forms to

<sup>6</sup> Available from Automotive Industry Action Group, North Park Plaza, Ste. 830, 17117 W. Nine Mile Rd., Southfield, MI 48075. yield straight lengths (or coils, depending upon size, section, and mill equipment) in sections which are uniform throughout their length, and in the following sections and sizes:

3.1.1.1 Rounds, 7/32 to 10.0 in. [5.5 to 250 mm], inclusive,

3.1.1.2 Squares, 7/32 to 6.0 in. [6 to 160 mm], inclusive,

3.1.1.3 *Round-Cornered Squares*, <sup>7</sup>/<sub>32</sub> to 8.0 in. [6 to 200 mm], inclusive,

3.1.1.4 *Flats*,  $\frac{1}{4}$  to 8 in. inclusive, in width:  $\frac{13}{64}$  in. in minimum thickness up to 6 in. in width; and 0.230 in. in minimum thickness for over 6 to 8 in. in width, inclusive [over 5 mm in thickness up to 150 mm in width; and over 6 mm in thickness for over 150 mm through 200 mm in width]. Maximum thickness for all widths is 4 in. [100 mm].

3.1.1.5 *Hexagons and Octagons*, <sup>1</sup>/<sub>4</sub> to 4<sup>1</sup>/<sub>16</sub> in. [6 to 103 mm], inclusive, between parallel surfaces,

3.1.1.6 *Bar Size Shapes*—Angles, channels, tees, zees, when their greatest cross-sectional dimension is under 3 in. [75 mm], and

3.1.1.7 *Special Bar Sections*—Half-rounds, ovals, half-ovals, other special bar size sections.

3.1.2 *Cold-Finished Steel Bars*—Steel bars produced by cold finishing previously hot-wrought bars by means of cold drawing, cold forming, turning, grinding, or polishing (singly or in combination) to yield straight lengths or coils in sections which are uniform throughout their length and in the following sections and sizes:

3.1.2.1 Rounds, 9 in. [230 mm] and under in diameter,

3.1.2.2 *Squares*, 6 in. [150 mm] and under between parallel surfaces, **1** 

3.1.2.3 *Hexagons*, 4 in. [100 mm] and under between parallel surfaces,

A 3.1.2.4 *Flats*, <sup>1</sup>/<sub>8</sub> in. [3 mm] and over in thickness and not over 12 in. [300 mm] in width, and

3.1.2.5 Special Bar Sections.

3.1.3 Lot—Unless otherwise specified in the contract or order, a lot shall consist of all bars submitted for inspection at the same time of the same heat, condition, finish, size, or shape. For bars specified in the quenched and tempered condition, when heat treated in batch-type furnaces, a lot shall consist of all bars from the same heat, of the same prior condition, the same size, and subjected to the same heat treatment in one tempering charge. For bars specified in the quenched and tempered condition, when heat treated without interruption in a continuous-type furnace, a lot shall consist of all bars from the same prior condition, of the same size, and subjected to the same heat, of the same size, and subjected to the same heat treatment.

Crade Designation		Heat Chemical R	anges and Limits, %	
Grade Designation –	Carbon	Manganese	Phosphorus, max	Sulfur, max <sup>A</sup>
	N	onresulfurized Carbon Steels <sup>B,C,</sup>	D,E,F	
1005	0.06 max	0.35 max	0.040	0.050
1006	0.08 max	0.25-0.40	0.040	0.050
1008	0.10 max	0.30-0.50	0.040	0.050
1010	0.08-0.13	0.30-0.60	0.040	0.050
1011	0.08-0.13	0.60-0.90	0.040	0.050

<sup>&</sup>lt;sup>4</sup> Withdrawn.

<sup>&</sup>lt;sup>5</sup> Copies of military specifications, military standards, and federal standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer, or from the Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

# ▲ A 29/A 29M – 04

## TABLE 1 Continued

Grade Designation     Cathon     Manganese     Phosphotus, max     Sultur, max       12     0.140-015     0.33-0.60     0.040     0.050       13     0.11-0.15     0.33-0.60     0.040     0.050       14     0.11-0.15     0.33-0.60     0.040     0.050       15     0.11-0.15     0.33-0.60     0.040     0.050       16     0.11-0.22     0.32-0.60     0.040     0.050       16     0.11-0.23     0.07-1.100     0.040     0.050       17     0.11-0.23     0.07-1.100     0.040     0.050       0.22-0.25     0.33-0.60     0.040     0.050       0.22-0.25     0.33-0.60     0.040     0.050       0.22-0.24     0.80-0.90     0.040     0.050       0.22-0.25     0.33-0.60     0.040     0.050       0.22-0.24     0.80-0.90     0.040     0.050       0.22-0.23     0.37-0.60     0.040     0.050       0.22-0.24     0.80-0.90     0.040     0.050       0.22-0.25     0.32-0.38	Heat Chemical Ranges and Limits, %								
12     0.10-015     0.30-060     0.040     0.050       15     0.13-016     0.32-060     0.040     0.050       15     0.13-018     0.32-060     0.040     0.050       16     0.13-018     0.32-060     0.040     0.050       17     0.15-020     0.8-040     0.040     0.050       18     0.15-022     0.8-040     0.040     0.050       10     0.15-022     0.60-040     0.040     0.050       21     0.16-023     0.70-160     0.040     0.050       22     0.22-028     0.39-060     0.040     0.050       23     0.22-034     0.69-080     0.040     0.050       24     0.8-040     0.040     0.050     0.040     0.050       25     0.22-028     0.8-040     0.040     0.050     0.040     0.050       25     0.32-038     0.7-150     0.040     0.050     0.040     0.050       26     0.32-038     0.7-160     0.040     0.050     0.040	Grade Designation —	Carbon		<b>.</b>	nax Sulfur, max <sup>A</sup>				
15     0.13-0.18     0.30-6.00     0.040     0.050       16     0.13-0.18     0.06-0.90     0.040     0.050       17     0.15-0.20     0.30-6.00     0.040     0.050       18     0.15-0.20     0.30-6.00     0.040     0.050       20     0.15-0.23     0.20-6.00     0.040     0.050       21     0.18-0.23     0.20-6.00     0.040     0.050       22     0.18-0.23     0.30-6.00     0.040     0.050       23     0.22-0.28     0.30-6.00     0.040     0.050       24     0.22-0.28     0.30-6.00     0.040     0.050       25     0.22-0.28     0.30-6.00     0.040     0.050       26     0.22-0.38     0.00-6.90     0.040     0.050       27     0.22-0.38     0.00-6.90     0.040     0.050       28     0.27-0.42     0.00-6.90     0.040     0.050       29     0.40-0.47     0.70-1.00     0.040     0.050       29     0.40-0.47     0.70-1.00     0.0	2	0.10-0.15	0.30-0.60	0.040	0.050				
16     0.13-0.18     0.60-0.90     0.440     0.050       17     0.15-0.20     0.60-0.90     0.440     0.050       18     0.15-0.20     0.60-0.90     0.440     0.050       19     0.15-0.20     0.77-1.00     0.040     0.050       20     0.18-0.23     0.77-1.00     0.040     0.050       21     0.18-0.23     0.77-1.00     0.040     0.050       22     0.18-0.23     0.77-1.00     0.040     0.050       23     0.22-0.28     0.30-6.60     0.040     0.050       24     0.22-0.28     0.60-4.90     0.040     0.050       35     0.33-0.38     0.60-4.90     0.040     0.050       35     0.33-0.38     0.77-1.00     0.040     0.050       36     0.37-0.44     0.77-1.00     0.040     0.050       37     0.33-0.38     0.67-0.40     0.040     0.050       38     0.37-0.44     0.77-1.00     0.040     0.050       39     0.37-0.44     0.77-1.00     0.0	3	0.11-0.16	0.50-0.80	0.040	0.050				
17     0.15-0.20     0.30-0.60     0.440     0.050       19     0.15-0.20     0.70-1.00     0.440     0.050       10     0.18-0.23     0.30-0.60     0.440     0.050       11     0.18-0.23     0.30-0.60     0.440     0.050       12     0.18-0.23     0.30-0.60     0.440     0.050       13     0.12-0.23     0.30-0.60     0.440     0.050       14     0.22-0.23     0.26-0.90     0.440     0.050       15     0.22-0.34     0.60-0.90     0.440     0.050       16     0.22-0.34     0.60-0.90     0.440     0.050       17     0.32-0.38     0.60-0.90     0.440     0.050       17     0.32-0.38     0.60-0.90     0.440     0.050       17     0.32-0.38     0.60-0.90     0.440     0.050       18     0.40-0.47     0.60-0.90     0.440     0.050       19     0.37-0.44     0.60-0.90     0.440     0.050       19     0.44-0.450     0.71-1.00     0.									
18     0.15-0.20     0.60-0.90     0.440     0.059       19     0.15-0.20     0.77-1.00     0.440     0.059       0.16-0.23     0.30-0.60     0.440     0.059       0.16-0.23     0.30-0.60     0.440     0.059       0.22-0.28     0.30-0.60     0.440     0.059       0.22-0.28     0.30-0.60     0.440     0.059       0.22-0.28     0.60-0.90     0.440     0.059       0.22-0.31     0.60-0.90     0.440     0.059       0.22-0.32     0.30-0.60     0.440     0.059       0.22-0.33     0.60-0.90     0.440     0.050       0.33     0.33-0.42     0.60-0.90     0.440     0.050       0.43     0.37-0.44     0.60-0.90     0.440     0.050       0.44     0.60-0.90     0.440     0.050     0.040     0.050       0.44     0.45-0.50     0.77-1.00     0.440     0.050     0.040     0.050       0.44     0.43-0.50     0.77-1.00     0.440     0.050     0.040     0.050	6	0.13-0.18	0.60-0.90	0.040	0.050				
19     0.15-0.20     0.70-1.00     0.040     0.050       20     0.18-0.23     0.80-0.90     0.040     0.050       21     0.18-0.23     0.80-0.90     0.040     0.050       22     0.23-0.28     0.30-0.60     0.040     0.050       23     0.23-0.28     0.60-0.90     0.040     0.050       24     0.22-0.34     0.60-0.90     0.040     0.050       25     0.22-0.34     0.60-0.90     0.040     0.050       25     0.32-0.38     0.50-0.80     0.040     0.050       26     0.32-0.38     0.70-1.00     0.040     0.050       27     0.32-0.38     0.70-1.00     0.040     0.050       28     0.40-0.47     0.60-0.90     0.040     0.050       29     0.40-0.47     0.70-1.00     0.040     0.050       24     0.40-0.47     0.70-1.00     0.040     0.050       24     0.40-0.47     0.70-1.00     0.040     0.050       25     0.60-0.90     0.040     0.050 </td <td>7</td> <td>0.15-0.20</td> <td>0.30-0.60</td> <td>0.040</td> <td>0.050</td>	7	0.15-0.20	0.30-0.60	0.040	0.050				
00     0.16-0.23     0.30-0.60     0.040     0.050       21     0.16-0.23     0.70-100     0.440     0.050       22     0.16-0.23     0.70-100     0.440     0.050       23     0.20-0.25     0.30-0.60     0.440     0.050       24     0.30-0.60     0.440     0.050       25     0.22-0.28     0.30-0.60     0.440     0.050       26     0.22-0.38     0.60-0.80     0.440     0.050       27     0.32-0.38     0.60-0.80     0.440     0.650       28     0.37-0.44     0.60-0.90     0.440     0.650       29     0.37-0.44     0.60-0.90     0.440     0.650       20     0.44-0.47     0.60-0.90     0.440     0.650       20     0.44-0.55     0.60-0.90     0.440     0.650       20     0.44-0.55     0.70-1.00     0.440     0.650       20     0.44-0.55     0.70-1.00     0.440     0.650       20     0.44-0.55     0.70-1.00     0.440     0.650 <td></td> <td></td> <td></td> <td></td> <td></td>									
1     0.16-0.23     0.60-0.90     0.040     0.050       22     0.16-0.23     0.70-1.00     0.040     0.050       23     0.20-0.25     0.30-0.60     0.040     0.050       24     0.22-0.28     0.80-0.80     0.040     0.050       25     0.22-0.28     0.80-0.80     0.040     0.050       26     0.22-0.28     0.80-0.80     0.040     0.050       27     0.32-0.38     0.60-0.80     0.040     0.050       28     0.32-0.38     0.60-0.80     0.040     0.050       29     0.37-0.44     0.60-0.90     0.040     0.050       21     0.40-0.47     0.60-0.90     0.040     0.050       22     0.40-0.47     0.60-0.90     0.040     0.050       24     0.40-0.47     0.60-0.90     0.040     0.050       25     0.50-0.50     0.60-0.30     0.040     0.050       26     0.44-0.55     0.60-0.30     0.040     0.050       26     0.44-0.55     0.60-0.30     0.40	9	0.15-0.20	0.70–1.00	0.040	0.050				
22     0.18-0.23     0.70-100     0.404     0.050       23     0.22-0.25     0.33-0.60     0.404     0.050       25     0.22-0.23     0.30-0.60     0.404     0.050       26     0.22-0.23     0.60-0.90     0.404     0.050       29     0.22-0.23     0.60-0.90     0.404     0.050       20     0.22-0.23     0.60-0.90     0.404     0.050       21     0.22-0.23     0.60-0.90     0.404     0.050       22     0.32-0.33     0.50-0.80     0.404     0.050       23     0.32-0.42     0.60-0.90     0.404     0.050       24     0.40-0.47     0.60-0.90     0.404     0.050       24     0.44-0.55     0.60-0.90     0.404     0.050       25     0.62-0.90     0.404     0.650     0.66-0.90     0.404     0.650       25     0.66-0.90     0.404     0.650     0.66-0.90     0.404     0.650       26     0.66-0.70     0.66-0.90     0.404     0.650     0.660	0	0.18-0.23	0.30-0.60	0.040	0.050				
23     2.20-0.25     0.30-0.60     0.040     0.050       25     0.22-0.28     0.60-0.90     0.040     0.050       26     0.22-0.28     0.60-0.90     0.040     0.050       26     0.22-0.28     0.60-0.90     0.040     0.050       26     0.22-0.28     0.60-0.90     0.040     0.050       27     0.32-0.38     0.60-0.90     0.040     0.050       28     0.32-0.42     0.60-0.90     0.040     0.050       28     0.37-0.44     0.70-1.00     0.040     0.050       29     0.37-0.44     0.70-1.00     0.040     0.050       20     0.40-0.47     0.70-1.00     0.040     0.050       21     0.40-0.45     0.30-0.60     0.040     0.050       25     0.42-0.50     0.30-0.60     0.040     0.050       26     0.42-0.55     0.30-0.60     0.400     0.050       26     0.42-0.55     0.50-0.60     0.400     0.050       26     0.42-0.75     0.20-0.80     0.4	1	0.18-0.23	0.60-0.90	0.040	0.050				
25     0	2	0.18-0.23	0.70-1.00	0.040	0.050				
86     0.22-0.28     0.60-0.90     0.040     0.050       92     0.22-0.31     0.60-0.90     0.040     0.050       94     0.22-0.38     0.60-0.90     0.040     0.050       95     0.32-0.38     0.60-0.90     0.040     0.050       93     0.32-0.38     0.60-0.90     0.040     0.050       93     0.32-0.42     0.60-0.90     0.040     0.050       93     0.37-0.44     0.70-1.00     0.040     0.050       94     0.43-0.50     0.30-0.60     0.040     0.050       94     0.43-0.50     0.30-0.60     0.040     0.050       94     0.43-0.50     0.60-0.90     0.040     0.050       94     0.44-0.55     0.60-0.90     0.040     0.050       95     0.50-0.65     0.50-0.60     0.040     0.050       95     0.50-0.65     0.50-0.60     0.040     0.050       95     0.50-0.65     0.50-0.60     0.040     0.050       95     0.50-0.65     0.50-0.60     0.0	3	0.20-0.25	0.30-0.60	0.040	0.050				
29     0.25-0.31     0.60-0.90     0.040     0.050       04     0.32-0.33     0.50-0.80     0.040     0.050       0.32-0.33     0.50-0.80     0.040     0.050       0.32-0.33     0.70-1.00     0.040     0.050       0.32-0.33     0.70-1.00     0.040     0.050       0.33-0.42     0.60-0.90     0.040     0.050       0.43-0.44     0.70-1.00     0.040     0.050       0.40-0.47     0.70-1.00     0.040     0.050       121     0.40-0.47     0.70-1.00     0.040     0.050       123     0.40-0.47     0.70-1.00     0.040     0.050       124     0.40-0.47     0.70-1.00     0.040     0.050       125     0.42-0.50     0.70-1.00     0.040     0.050       126     0.42-0.55     0.70-1.00     0.040     0.050       126     0.42-0.55     0.70-1.00     0.040     0.050       126     0.42-0.55     0.70-1.00     0.040     0.050       127     0.50-0.65     0.6	5	0.22-0.28	0.30-0.60	0.040	0.050				
98     0.28–0.34     0.00     0.040     0.050       94     0.32–0.38     0.50–0.80     0.040     0.050       95     0.32–0.38     0.60–0.90     0.040     0.050       93     0.35–0.42     0.60–0.90     0.040     0.050       93     0.37–0.44     0.02–0.90     0.040     0.050       94     0.37–0.44     0.02–0.90     0.040     0.050       94     0.40–0.47     0.02–0.90     0.040     0.050       94     0.40–0.47     0.70–1.00     0.040     0.050       94     0.43–0.50     0.70–1.00     0.040     0.050       94     0.44–0.55     0.60–0.90     0.040     0.050       95     0.50–0.60     0.70–1.00     0.040     0.050       95     0.50–0.65     0.50–0.80     0.040     0.050       95     0.50–0.65     0.50–0.80     0.040     0.050       95     0.50–0.65     0.50–0.80     0.040     0.050       96     0.55–0.65     0.50–0.80     0.040 </td <td>6</td> <td>0.22-0.28</td> <td>0.60-0.90</td> <td>0.040</td> <td>0.050</td>	6	0.22-0.28	0.60-0.90	0.040	0.050				
44     0.32–0.38     0.60–0.80     0.040     0.050       0.32–0.38     0.60–0.90     0.040     0.050       0.32–0.38     0.70–1.00     0.040     0.050       0.33     0.37–0.44     0.60–0.90     0.040     0.050       0.40     0.37–0.44     0.60–0.90     0.040     0.050       24     0.40–0.47     0.60–0.90     0.040     0.050       24     0.40–0.47     0.60–0.90     0.040     0.050       24     0.40–0.47     0.60–0.90     0.040     0.050       24     0.40–0.47     0.60–0.90     0.040     0.050       24     0.40–0.55     0.30–0.60     0.040     0.050       25     0.45–0.55     0.70–1.00     0.040     0.050       26     0.55–0.65     0.50–0.60     0.040     0.050       26     0.55–0.65     0.60–0.80     0.040     0.050       26     0.55–0.65     0.60–0.80     0.040     0.050       27     0.50–0.65     0.60–0.90     0.040     0.050 <	9	0.25-0.31	0.60-0.90	0.040	0.050				
55     0.32-0.38     0.00-0.90     0.040     0.050       38     0.35-0.42     0.60-0.90     0.040     0.050       39     0.37-0.44     0.70-1.00     0.040     0.050       40     0.37-0.44     0.70-1.00     0.040     0.050       42     0.40-0.47     0.70-1.00     0.040     0.050       43     0.40-0.47     0.70-1.00     0.040     0.050       44     0.43-0.50     0.30-0.60     0.040     0.050       44     0.43-0.50     0.70-1.00     0.040     0.050       45     0.43-0.50     0.70-1.00     0.040     0.050       46     0.43-0.55     0.60-0.90     0.040     0.050       50     0.50-0.65     0.70-1.00     0.040     0.050       51     0.60-0.90     0.040     0.050     0.040     0.050       52     0.50-0.65     0.60-0.90     0.040     0.050     0.040     0.050       52     0.50-0.65     0.60-0.90     0.040     0.050     0.040     0.050 <td>0</td> <td>0.28-0.34</td> <td>0.60-0.90</td> <td>0.040</td> <td>0.050</td>	0	0.28-0.34	0.60-0.90	0.040	0.050				
37     0.32-0.38     0.70-1.00     0.040     0.050       38     0.35-0.42     0.60-0.90     0.040     0.050       39     0.37-0.44     0.70-1.00     0.040     0.050       40     0.37-0.44     0.60-0.90     0.040     0.050       42     0.40-0.47     0.70-1.00     0.040     0.050       43     0.40-0.47     0.70-1.00     0.040     0.050       45     0.43-0.50     0.70-1.00     0.040     0.050       46     0.43-0.50     0.60-0.90     0.040     0.050       50     0.48-0.55     0.60-0.90     0.040     0.050       51     0.50-0.60     0.60-0.90     0.040     0.050       52     0.50-0.65     0.60-0.90     0.040     0.050       54     0.60-0.70     0.60-0.70     0.040     0.050       55     0.50-0.65     0.60-0.80     0.040     0.050       56     0.60-0.70     0.40-0.70     0.40     0.050       59     0.55-0.65     0.60-0.70     0.40	4	0.32-0.38	0.50-0.80	0.040	0.050				
88     0.35-0.42     0.60-0.90     0.040     0.059       99     0.37-0.44     0.70-1.00     0.040     0.059       42     0.40-0.47     0.60-0.90     0.040     0.059       43     0.40-0.47     0.70-1.00     0.040     0.059       44     0.43-0.50     0.30-0.60     0.040     0.059       45     0.43-0.50     0.70-1.00     0.040     0.059       46     0.43-0.50     0.70-1.00     0.040     0.059       46     0.44-0.55     0.60-0.90     0.040     0.059       50     0.60-0.50     0.040     0.059     0.040     0.059       51     0.60-0.50     0.040     0.059     0.040     0.059       52     0.50-0.60     0.040     0.059     0.040     0.059       52     0.50-0.60     0.040     0.059     0.040     0.059       54     0.60-0.75     0.000     0.040     0.059       55     0.50-0.60     0.040     0.059       65     0.50-0.80 <td>5</td> <td>0.32-0.38</td> <td>0.60-0.90</td> <td>0.040</td> <td>0.050</td>	5	0.32-0.38	0.60-0.90	0.040	0.050				
88     0.35-0.42     0.60-0.90     0.040     0.059       99     0.37-0.44     0.70-1.00     0.040     0.059       42     0.40-0.47     0.60-0.90     0.040     0.059       43     0.40-0.47     0.70-1.00     0.040     0.059       44     0.43-0.50     0.30-0.60     0.040     0.059       45     0.43-0.50     0.70-1.00     0.040     0.059       46     0.43-0.50     0.70-1.00     0.040     0.059       46     0.44-0.55     0.60-0.90     0.040     0.059       50     0.60-0.50     0.040     0.059     0.040     0.059       51     0.60-0.50     0.040     0.059     0.040     0.059       52     0.50-0.60     0.040     0.059     0.040     0.059       52     0.50-0.60     0.040     0.059     0.040     0.059       54     0.60-0.75     0.000     0.040     0.059       55     0.50-0.60     0.040     0.059       65     0.50-0.80 <td></td> <td></td> <td></td> <td>0.040</td> <td></td>				0.040					
39     0.37-0.44     0.70-1.00     0.040     0.050       40     0.37-0.44     0.60-0.30     0.040     0.050       42     0.40-0.47     0.70-1.00     0.040     0.050       43     0.40-0.47     0.70-1.00     0.040     0.050       44     0.43-0.50     0.70-1.00     0.040     0.050       45     0.43-0.50     0.70-1.00     0.040     0.050       46     0.43-0.55     0.60-0.30     0.040     0.050       50     0.48-0.55     0.60-0.30     0.040     0.050       51     0.50-0.60     0.60-0.30     0.040     0.050       52     0.50-0.55     0.50-0.80     0.040     0.050       54     0.60-0.70     5.50-0.80     0.040     0.050       55     0.50-0.50     0.40-0.70     0.040     0.050       56     0.60-0.70     0.40-0.70     0.040     0.050       57     0.70-0.80     0.50-0.80     0.040     0.050       58     0.60-0.70     0.40-0.70     0.0									
40     0.37-0.44     0.60-0.30     0.040     0.050       42     0.40-0.47     0.60-0.30     0.040     0.050       43     0.40-0.47     0.70-1.00     0.040     0.050       44     0.43-0.50     0.30-0.66     0.040     0.050       45     0.43-0.50     0.70-1.00     0.040     0.050       46     0.44-0.53     0.60-0.30     0.040     0.050       50     0.44-0.55     0.60-0.30     0.040     0.050       51     0.50-0.65     0.70-1.00     0.040     0.050       52     0.50-0.65     0.70-1.00     0.040     0.050       55     0.50-0.65     0.50-0.80     0.040     0.050       56     0.50-0.65     0.50-0.80     0.040     0.050       56     0.60-0.70     0.40-0.70     0.040     0.050       70     0.65-0.75     0.40-0.70     0.040     0.050       71     0.65-0.75     0.40-0.70     0.040     0.050       74     0.70-0.80     0.40-0.70     0.									
42     0.40-0.47     0.60-0.80     0.040     0.650       43     0.40-0.47     0.70-1.00     0.040     0.650       44     0.43-0.50     0.60-0.80     0.040     0.650       45     0.43-0.50     0.60-0.80     0.040     0.650       46     0.43-0.55     0.60-0.80     0.040     0.650       50     0.44-0.55     0.60-0.80     0.040     0.650       51     0.44-0.55     0.60-0.80     0.040     0.650       52     0.50-0.65     0.60-0.80     0.040     0.650       52     0.50-0.65     0.60-0.80     0.040     0.650       54     0.56-0.65     0.60-0.70     0.040     0.650       54     0.56-0.65     0.60-0.80     0.040     0.650       54     0.56-0.65     0.60-0.80     0.040     0.650       55     0.70-0.80     0.75-1.05     0.040     0.650       66     0.80-0.70     0.60-0.80     0.040     0.650       71     0.85-0.70     0.75-0.81     0.0									
43     0.40-0.47     0.70-1.00     0.040     0.050       44     0.43-0.50     0.30-0.60     0.040     0.050       45     0.43-0.50     0.70-1.00     0.040     0.050       46     0.43-0.55     0.70-1.00     0.040     0.050       50     0.44-0.55     0.60-0.90     0.040     0.050       51     0.50-0.65     0.60-0.90     0.040     0.050       52     0.50-0.65     0.60-0.90     0.040     0.050       53     0.50-0.65     0.60-0.90     0.040     0.050       54     0.60-0.70     0.60-0.90     0.040     0.050       56     0.60-0.70     0.60-0.90     0.040     0.050       57     0.70-0.80     0.60-0.90     0.040     0.050       71     0.65-0.70     0.75-1.05     0.040     0.050       75     0.70-0.80     0.60-0.90     0.040     0.050       74     0.70-0.80     0.60-0.90     0.040     0.050       75     0.70-0.80     0.60-0.90     0.0									
44     0.43-0.50     0.30-0.60     0.040     0.050       45     0.43-0.50     0.60-0.90     0.040     0.050       46     0.43-0.50     0.70-1.00     0.040     0.050       50     0.48-0.55     0.60-0.90     0.040     0.050       51     0.60-0.80     0.040     0.050       52     0.50-060     0.60-0.80     0.040     0.050       55     0.60-070     0.60-0.80     0.040     0.050       56     0.60-0.77     0.60-0.80     0.040     0.050       56     0.60-0.70     0.60-0.70     0.040     0.050       57     0.60-0.70     0.60-0.70     0.040     0.050       58     0.60-0.70     0.60-0.70     0.040     0.050       59     0.66-0.75     0.040-0.70     0.040     0.050       74     0.65-0.75     0.040-0.70     0.040     0.050       75     0.70-0.80     0.40-0.70     0.040     0.050       74     0.75-0.83     0.30-0.60     0.040     0.050 </td <td></td> <td></td> <td></td> <td></td> <td></td>									
45     0.43-050     0.60-030     0.040     0.050       46     0.43-050     0.70-100     0.040     0.050       49     0.46-053     0.60-030     0.040     0.050       53     0.48-055     0.60-030     0.040     0.055       55     0.55-0.66     0.56-0.80     0.040     0.050       54     0.60-0.30     0.040     0.055       55     0.55-0.65     0.60-0.30     0.040     0.055       56     0.60-0.70     0.64-0.30     0.040     0.055       56     0.60-0.70     0.64-0.30     0.040     0.055       57     0.60-0.70     0.64-0.70     0.040     0.050       57     0.70-0.80     0.40-0.70     0.040     0.050       74     0.70-0.80     0.40-0.70     0.040     0.050       75     0.70-0.80     0.40-0.70     0.040     0.050       76     0.70-0.80     0.40-0.70     0.040     0.050       76     0.70-0.80     0.40-0.30     0.040     0.050									
46     0.43-0.50     0.70-1.00     0.040     0.050       50     0.48-0.55     0.60-0.90     0.040     0.050       51     0.48-0.55     0.60-0.90     0.040     0.050       52     0.60-0.80     0.040     0.050       53     0.48-0.55     0.60-0.80     0.040     0.050       59     0.55-0.65     0.50-0.80     0.040     0.050       60     0.55-0.65     0.50-0.80     0.040     0.050       65     0.60-0.70     0.60-0.80     0.040     0.050       65     0.60-0.77     0.60-0.80     0.040     0.050       70     0.65-0.75     0.040-0.70     0.040     0.050       74     0.70-0.80     0.50-0.80     0.040     0.050       74     0.70-0.80     0.40-0.70     0.040     0.050       74     0.70-0.80     0.40-0.70     0.040     0.050       74     0.70-0.80     0.40-0.70     0.040     0.050       75     0.70-0.80     0.40-0.30     0.040     0.050<									
49     0.46-053     0.60-090     0.400     0.050       50     0.48-055     0.60-090     0.400     0.050       53     0.20-080     0.400     0.050     0.040     0.050       54     0.20-080     0.400     0.040     0.050       55     0.20-080     0.400     0.040     0.050       56     0.20-080     0.400     0.040     0.050       55     0.20-070     St//Sta.050-080     0.400     0.050       56     0.60-070     St//Sta.050-080     0.400     0.050       56     0.60-070     0.60-030     0.400     0.050       57     0.40-070     0.400     0.050     0.400     0.050       77     0.65-075     0.40-070     0.400     0.050     0.50 </td <td></td> <td></td> <td></td> <td></td> <td></td>									
50     0.48-0.55     0.60-0.90     0.040     0.050       53     0.48-0.55     0.60-0.80     0.440     0.050       55     0.55-0.65     0.60-0.80     0.440     0.050       0.65-0.65     0.60-0.80     0.440     0.050       0.65-0.65     0.60-0.80     0.440     0.050       0.66-0.70     0.60-0.80     0.440     0.050       0.65-0.75     0.40-0.70     0.60-0.80     0.440     0.050       0.77     0.65-0.75     0.40-0.70     0.040     0.050       74     0.70-0.80     0.50-0.80     0.040     0.050       75     0.70-0.80     0.60-0.90     0.040     0.050       76     0.70-0.80     0.60-0.90     0.040     0.050       76     0.70-0.80     0.60-0.90     0.040     0.050       76     0.70-0.80     0.60-0.90     0.040     0.050       76     0.70-0.80     0.60-0.90     0.040     0.050       76     0.70-0.80     0.60-0.90     0.040     0.050									
S3     0.48-0.55     110 h     0.70-100     and S     0.040     0.055       55     0.50-0.60     0.55-0.65     0.50-0.80     0.040     0.055       60     0.55-0.65     0.50-0.80     0.040     0.055       60     0.60-0.80     0.400     0.055       63     0.60-0.70     0.60-0.80     0.400     0.055       65     0.60-0.70     0.60-0.80     0.400     0.055       70     0.65-0.75     0.40-0.70     0.040     0.055       71     0.65-0.75     0.70-0.80     0.40-0.70     0.040     0.055       74     0.70-0.80     0.40-0.70     0.040     0.055       75     0.70-0.80     0.60-0.90     0.040     0.055       80     0.72-0.85     0.50-0.80     0.040     0.055       81     0.72-0.83     0.30-0.50     0.040     0.055       82     0.80-0.93     0.30-0.50     0.040     0.055       90     0.80-0.93     0.30-0.50     0.040     0.060-0.13									
55     0.55-0.65     0.50-0.50     0.440     0.650       59     0.55-0.65     0.50-0.80     0.040     0.050       64     0.50-0.85     0.60-0.90     0.440     0.050       65     0.60-0.70     0.60-0.90     0.440     0.050       65     0.60-0.70     0.60-0.90     0.440     0.050       65     0.60-0.70     0.60-0.90     0.440     0.050       70     0.65-0.75     0.40-0.70     0.440     0.050       71     0.65-0.75     0.40-0.70     0.440     0.050       74     0.70-0.80     0.40-0.70     0.440     0.050       75     0.70-0.80     0.40-0.70     0.440     0.050       78     0.72-0.85     0.60-0.90     0.440     0.050       84     0.80-0.93     0.30-0.50     0.440     0.050       96     0.80-0.93     0.30-0.50     0.440     0.050       97     0.940     0.98-0.13     0.60-0.90     0.440     0.060-0.150       98     0.80-0.13     0									
59     0.55-0.65     0.50-0.80     0.040     0.050       64     0.55-0.65     0.60-0.70     0									
60     0.55-0.65     S://Sta     0.60-0.90     0.64     0.040     0.050       65     0.60-0.70     0.60-0.70     0.60-0.70     0.040     0.050       69     0.65-0.75     0.040     0.050     0.040     0.050       71     0.65-0.75     0.040     0.050     0.040     0.050       74     0.70-0.80     0.60-0.70     0.040     0.050       75     0.70-0.80     0.40-0.70     0.040     0.050       78     0.72-0.85     0.10, 0.30-0.60     0.040     0.050       80     0.75-0.88     0.80-0.93     0.040     0.050       81     0.72-0.85     0.60-0.90     0.040     0.050       84     0.80-0.93     0.30-0.50     0.040     0.050       84     0.80-0.93     0.30-0.50     0.040     0.050       99     0.86-0.93     0.040     0.050     0.96     0.96     0.96     0.96     0.96     0.96     0.96     0.96     0.96     0.96     0.96     0.96     0.96     <									
64     0.60-070     S/ SI 0.50-080     CINCL 0.401     0.650       655     0.660-070     0.66-0.70     0.040     0.050       70     0.65-0.75     0.40-0.70     0.040     0.050       71     0.65-0.75     0.040-070     0.040     0.050       74     0.70-0.80     0.55-0.80     0.040     0.050       75     0.70-0.80     0.40-0.70     0.040     0.050       75     0.70-0.80     0.40-0.70     0.040     0.050       75     0.70-0.80     0.40-0.70     0.040     0.050       76     0.72-0.85     ASTM 0.30-0.60     0.040     0.050       86     0.80-0.93     0.30-0.50     0.040     0.050       96     0.80-0.93     0.30-0.50     0.040     0.050       96     0.80-0.13     0.60-0.90     0.040     0.06-0.13       90     0.80-0.13     0.60-0.80     0.040     0.06-0.13       90     0.80-0.13     0.60-0.80     0.040     0.06-0.13       91     0.14-0.20     1.									
65     0.60-0.70     0.60-0.90     0.040     0.050       69     0.65-0.75     0.40-0.70     0.040     0.050       71     0.65-0.75     0.70-0.80     0.040     0.050       74     0.70-0.80     0.60-0.90     0.040     0.050       75     0.70-0.80     0.40-0.70     0.040     0.050       78     0.72-0.85     0.50-0.80     0.040     0.050       78     0.72-0.85     0.50-0.80     0.040     0.050       78     0.72-0.85     0.60-0.90     0.040     0.050       84     0.80-0.93     0.30-0.50     0.040     0.050       96     0.80-0.93     0.30-0.50     0.040     0.050       97     0.90-1.03     0.30-0.50     0.040     0.060-0.15       98     0.60-0.90     0.040     0.060-0.15     0.060-0.15       99     0.06-0.13     0.60-0.80     0.040     0.08-0.13       10     0.80-0.93     0.30-1.60     0.040     0.08-0.13       121     0.14-0.20     1.10-1.40<									
B9     0.65-0.75     0.40-0.70     0.40-0.70     0.400     0.050       70     0.65-0.75     0.40-0.70     0.400     0.050       74     0.70-0.80     0.50-0.80     0.400     0.050       75     0.70-0.80     0.40-0.70     0.404     0.050       75     0.70-0.80     0.40-0.70     0.404     0.050       76     0.72-0.85     ASTM 0.30-0.60     0.404     0.050       80     0.72-0.85     ASTM 0.30-0.60     0.404     0.050       80     0.72-0.85     0.60-0.90     0.404     0.050       81     0.80-0.93     0.30-0.50     0.404     0.050       90     0.86-0.93     0.30-0.50     0.404     0.050       90     0.86-0.13     0.60-0.90     0.404     0.050       90     0.08-0.13     0.60-0.90     0.404     0.08-0.13       10     0.08-0.13     0.30-0.50     0.404     0.08-0.13       116     0.14-0.20     1.10-1.40     0.404     0.08-0.13       129     0.14-0									
70     0.65-0.75     0.00     0.85-0.70     0.85-0.70     0.75-1.05     0.040     0.050       71     0.65-0.70     0.75-1.05     0.040     0.050       74     0.70-0.80     0.40-0.70     0.040     0.050       75     0.70-0.80     0.40-0.70     0.040     0.050       80     0.72-0.85     ASTID 0.30-0.60     0.040     0.050       840     0.72-0.85     ASTID 0.30-0.60     0.040     0.050       840     0.80-0.93     0.30-0.50     0.040     0.050       96     0.80-0.93     0.30-0.50     0.040     0.050       96     0.80-0.93     0.30-0.50     0.040     0.069-0.13       96     0.06-0.13     0.60-0.90     0.040     0.08-0.13       97     0.06-0.13     0.60-0.90     0.040     0.08-0.13       98     0.06-0.13     0.60-0.90     0.040     0.08-0.13       99     0.06-0.13     0.30-0.60     0.040     0.08-0.13       90     0.08-0.13     0.30-0.60     0.040     0.08-0.1									
71     0.65-0.70     0.75-1.05     0.040     0.050       74     0.70-0.80     0.50-0.80     0.040     0.050       75     0.70-0.80     0.40-0.70     0.040     0.050       76     0.72-0.85     0.60-0.90     0.040     0.050       80     0.72-0.85     0.60-0.90     0.040     0.050       84     0.80-0.93     0.30-0.50     0.040     0.050       86     0.80-0.93     0.30-0.50     0.040     0.050       90     0.85-0.98     0.60-0.90     0.040     0.050       95     0.90-1.03     0.30-0.50     0.040     0.050       Resulfurized Carbon Steels <sup>#.D.F</sup> 10     0.08-0.13     0.60-0.90     0.040     0.08-0.13       110     0.08-0.13     0.30-0.60     0.040     0.08-0.13       121     0.14-0.20     1.10-1.40     0.040     0.08-0.13       121     0.14-0.20     1.00-1.30     0.040     0.08-0.13       121     0.14-0.20     1.00-1.30     0.040     0.08-0.13									
74     0.70-0.80     0.50-0.80     0.040     0.050       75     0.70-0.80     0.40-0.70     0.040     0.050       83     0.72-0.85     ASTM     0.30-0.60     0.040     0.050       84     0.72-0.85     0.60-0.90     0.040     0.050       84     0.80-0.93     0.60-0.90     0.040     0.050       86     0.80-0.93     0.30-0.50     0.040     0.050       90     0.85-0.98     0.60-0.90     0.040     0.050       90     0.90-1.03     0.30-0.50     0.040     0.050       91     0.08-0.13     0.60-0.80     0.040     0.08-0.13       92     0.08-0.13     0.60-0.80     0.040     0.08-0.13       93     0.08-0.13     0.30-0.60     0.040     0.08-0.13       94     0.08-0.13     0.30-0.60     0.040     0.08-0.13       94     0.14-0.20     1.10-1.40     0.040     0.08-0.13       95     0.14-0.20     1.30-1.60     0.040     0.08-0.13       94     0.14-0.20 </td <td></td> <td></td> <td></td> <td></td> <td></td>									
75     0.70-0.80     0.40-0.70     0.040     0.050       78     0.72-0.85     ASTM     0.30-0.60     0.440     0.050       84     0.75-0.88     0.80-0.93     0.60-0.90     0.440     0.040     0.050       84     0.80-0.93     0.30-0.50     0.040     0.600		0.65-0.70	0.75-1.05						
78     0.72-0.85     ASTM     0.30-0.60     9M-04     0.040     0.050       80     0.75-0.88     0.60-0.90     0.4484-9281     0.040     0.050       86     0.80-0.93     0.30-0.50     0.040     0.050       86     0.80-0.93     0.30-0.50     0.040     0.050       90     0.85-0.98     0.60-0.90     0.040     0.050       90     0.90-1.03     0.30-0.50     0.040     0.050       91     0.90-1.03     0.30-0.50     0.040     0.08-0.13       92     0.08-0.13     0.60-0.80     0.040     0.08-0.13       93     0.08-0.13     0.60-0.90     0.040     0.08-0.13       94     0.08-0.13     0.30-0.60     0.040     0.08-0.13       10     0.08-0.13     0.30-0.60     0.040     0.08-0.13       10     0.08-0.13     0.30-0.60     0.040     0.08-0.13       10     0.14-0.20     1.00-1.30     0.040     0.08-0.13       121     0.14-0.20     1.00-1.30     0.040     0.08-0.13	4	0.70-0.80	0.50-0.80	0.040	0.050				
80     0.75-0.88     0.60-0.90     0.44     0.604     0.050       84Ups://standards.itch.ai/catalo.80-0.93     0.30-0.50     0.040     0.050       90     0.85-0.98     0.60-0.90     0.040     0.050       95     0.90-1.03     0.30-0.50     0.040     0.050       95     0.90-1.03     0.30-0.50     0.040     0.050       Resulfurized Carbon Steels <sup>#.0.F</sup> 10     0.08-0.13     0.60-0.90     0.040     0.08-0.13       10     0.08-0.13     0.60-0.90     0.040     0.08-0.13       10     0.08-0.13     0.30-0.50     0.040     0.08-0.13       116     0.14-0.20     1.10-1.40     0.040     0.08-0.13       116     0.14-0.20     1.00-1.30     0.040     0.08-0.13       117     0.14-0.20     1.00-1.30     0.040     0.08-0.13       129     0.14-0.20     1.00-1.30     0.040     0.08-0.13       137     0.32-0.39     1.35-1.65     0.040     0.08-0.13       139     0.33-0.43     1.35-1.65	5	0.70-0.80	0.40-0.70	0.040	0.050				
B44tps://standards.iteh.ai/catak.0.80-0.93     B2260.660-0.90     Cl.4484-92810.040 be94a858/astm-a.0.050       86     0.80-0.93     0.30-0.50     0.040     0.050       90     0.85-0.98     0.60-0.90     0.040     0.050       95     0.90-1.03     0.30-0.50     0.040     0.050       Resulfurized Carbon Steels <sup>8,0,F</sup> 38     0.08-0.13     0.60-0.80     0.040     0.08-0.13       99     0.08-0.13     0.60-0.80     0.040     0.08-0.13       10     0.08-0.13     0.30-0.60     0.040     0.08-0.12       16     0.14-0.20     1.10-1.40     0.040     0.08-0.12       17     0.14-0.20     1.30-1.60     0.040     0.08-0.13       18     0.14-0.20     1.00-1.30     0.040     0.08-0.13       32     0.27-0.34     1.35-1.65     0.040     0.08-0.13       332     0.27-0.34     1.35-1.65     0.040     0.08-0.13       341     0.32-0.39     1.35-1.65     0.040     0.08-0.13       352     0.27-0.34     1.35-1.65	8	0.72-0.85	ASTV 0.30-0.6029	0.040	0.050				
86     0.80-0.93     0.30-0.50     0.040     0.050       90     0.85-0.98     0.60-0.90     0.040     0.050       95     0.90-1.03     0.30-0.50     0.040     0.050       Resulfurized Carbon Steels <sup>6.0,F</sup> 28     0.08-0.13     0.60-0.80     0.040     0.08-0.13       99     0.08-0.13     0.60-0.90     0.040     0.08-0.13       10     0.08-0.13     0.30-0.60     0.040     0.08-0.13       16     0.14-0.20     1.10-1.40     0.040     0.08-0.13       16     0.14-0.20     1.30-1.60     0.040     0.08-0.13       17     0.14-0.20     1.30-1.60     0.040     0.08-0.13       18     0.14-0.20     1.30-1.65     0.040     0.08-0.13       19     0.14-0.20     1.00-1.30     0.040     0.08-0.13       20     0.27-0.34     1.35-1.65     0.040     0.08-0.13       32     0.32-0.39     1.35-1.65     0.040     0.08-0.13       39     0.32-0.43     1.35-1.65     0.040     <			0.60-0.90						
90     0.85-0.98     0.60-0.90     0.040     0.050       95     0.90-1.03     0.30-0.50     0.040     0.050       Resulfurized Carbon Steels <sup>B.D.F</sup> 00     0.08-0.13     0.60-0.80     0.040     0.08-0.13       10     0.08-0.13     0.60-0.80     0.040     0.08-0.13       10     0.08-0.13     0.30-0.60     0.040     0.08-0.13       16     0.14-0.20     1.10-1.40     0.040     0.08-0.13       17     0.14-0.20     1.00-1.30     0.040     0.08-0.13       18     0.14-0.20     1.30-1.60     0.040     0.08-0.13       19     0.14-0.20     1.30-1.60     0.040     0.08-0.13       32     0.27-0.34     1.35-1.65     0.040     0.08-0.13       34     0.32-0.39     1.35-1.65     0.040     0.08-0.13       35     0.32-0.39     1.35-1.65     0.040     0.08-0.13       36     0.37-0.44     0.70-1.00     0.040     0.08-0.13       36     0.42-0.49     0.70-1.00     0.040	4ttps://standards.iteh.a	1/cata 0.80-0.93 ards/s	sist/38e260.60-0.902d-	-4d84-9281-40.04066	e94a858/astm-a20.05029m-0				
95     0.90-1.03     0.30-0.50     0.040     0.050       Resulfurized Carbon Steels <sup>B,D,F</sup> 08     0.08-0.13     0.60-0.80     0.040     0.08-0.13       09     0.08-0.13     0.60-0.90     0.040     0.08-0.13       10     0.08-0.13     0.30-0.60     0.040     0.08-0.13       10     0.08-0.13     0.30-0.60     0.040     0.08-0.13       10     0.08-0.13     0.30-0.60     0.040     0.08-0.13       16     0.14-0.20     1.10-1.40     0.040     0.08-0.13       18     0.14-0.20     1.00-1.30     0.040     0.08-0.13       19     0.14-0.20     1.00-1.30     0.040     0.08-0.13       32     0.27-0.34     1.35-1.65     0.040     0.08-0.13       33     0.32-0.39     1.35-1.65     0.040     0.08-0.13       40     0.37-0.44     0.70-1.00     0.040     0.08-0.13       41     0.37-0.45     1.35-1.65     0.040     0.08-0.13       42     0.42-0.49     0.70-1.00     0.040	6	0.80-0.93	0.30-0.50	0.040	0.050				
Resulfurized Carbon Steels <sup>B,D,F</sup> 38     0.08–0.13     0.60–0.80     0.040     0.08–0.13       19     0.08–0.13     0.60–0.90     0.040     0.08–0.13       10     0.08–0.13     0.30–0.60     0.040     0.08–0.13       16     0.14–0.20     1.10–1.40     0.040     0.08–0.13       17     0.14–0.20     1.00–1.30     0.040     0.08–0.13       18     0.14–0.20     1.00–1.30     0.040     0.08–0.13       19     0.14–0.20     1.00–1.30     0.040     0.08–0.13       32     0.27–0.34     1.35–1.65     0.040     0.08–0.13       32     0.27–0.34     1.35–1.65     0.040     0.08–0.13       339     0.35–0.43     1.35–1.65     0.040     0.08–0.13       40     0.37–0.44     0.70–1.00     0.040     0.08–0.13       41     0.37–0.45     1.35–1.65     0.040     0.08–0.13       42     0.40–0.48     1.35–1.65     0.040     0.08–0.13       51     0.42–0.49     0.70–1.00     0.040 </td <td>0</td> <td>0.85-0.98</td> <td>0.60-0.90</td> <td>0.040</td> <td>0.050</td>	0	0.85-0.98	0.60-0.90	0.040	0.050				
0.8     0.08-0.13     0.60-0.80     0.040     0.08-0.13       0.99     0.08-0.13     0.60-0.90     0.040     0.08-0.13       10     0.08-0.13     0.30-0.60     0.040     0.08-0.13       16     0.14-0.20     1.10-1.40     0.040     0.08-0.13       17     0.14-0.20     1.00-1.30     0.040     0.08-0.13       18     0.14-0.20     1.00-1.30     0.040     0.08-0.13       19     0.14-0.20     1.00-1.30     0.040     0.08-0.13       19     0.14-0.20     1.00-1.30     0.040     0.08-0.13       19     0.14-0.20     1.00-1.30     0.040     0.08-0.13       19     0.14-0.20     1.00-1.30     0.040     0.08-0.13       32     0.27-0.34     1.35-1.65     0.040     0.08-0.13       39     0.35-0.43     1.35-1.65     0.040     0.08-0.13       40     0.37-0.44     0.70-1.00     0.040     0.08-0.13       41     0.47-0.49     0.70-1.00     0.040     0.08-0.13       51 <t< td=""><td>5</td><td>0.90-1.03</td><td>0.30-0.50</td><td>0.040</td><td>0.050</td></t<>	5	0.90-1.03	0.30-0.50	0.040	0.050				
09     0.08-0.13     0.60-0.90     0.040     0.08-0.13       10     0.08-0.13     0.30-0.60     0.040     0.08-0.13       16     0.14-0.20     1.10-1.40     0.040     0.08-0.13       16     0.14-0.20     1.00-1.30     0.040     0.08-0.13       17     0.14-0.20     1.30-1.60     0.040     0.08-0.13       18     0.14-0.20     1.30-1.60     0.040     0.08-0.13       19     0.14-0.20     1.30-1.60     0.040     0.08-0.13       32     0.27-0.34     1.35-1.65     0.040     0.08-0.13       33     0.35-0.43     1.35-1.65     0.040     0.08-0.13       39     0.35-0.43     1.35-1.65     0.040     0.08-0.13       40     0.37-0.44     0.70-1.00     0.040     0.08-0.13       41     0.37-0.45     1.35-1.65     0.040     0.08-0.13       42     0.42-0.49     0.70-1.00     0.040     0.08-0.13       44     0.42-0.49     0.70-1.00     0.040     0.08-0.13       51     0			Resulfurized Carbon Stee	ls <sup>B,D,F</sup>					
10     0.08-0.13     0.30-0.60     0.040     0.08-0.13       16     0.14-0.20     1.10-1.40     0.040     0.16-0.23       17     0.14-0.20     1.00-1.30     0.040     0.08-0.13       18     0.14-0.20     1.30-1.60     0.040     0.08-0.13       19     0.14-0.20     1.30-1.65     0.040     0.08-0.13       22     0.27-0.34     1.35-1.65     0.040     0.08-0.13       37     0.32-0.39     1.35-1.65     0.040     0.08-0.13       40     0.37-0.43     1.35-1.65     0.040     0.08-0.13       41     0.37-0.44     0.70-1.00     0.040     0.08-0.13       45     0.42-0.49     0.70-1.00     0.040     0.08-0.13       45     0.42-0.49     0.70-1.00     0.040     0.08-0.13       45     0.42-0.49     0.70-1.00     0.040     0.08-0.13       46     0.42-0.49     0.70-1.00     0.040     0.08-0.13       51     0.48-0.55     0.70-1.00     0.040     0.08-0.13       612	8	0.08–0.13	0.60-0.80	0.040	0.08–0.13				
16   0.14-0.20   1.10-1.40   0.040   0.16-0.23     17   0.14-0.20   1.00-1.30   0.040   0.08-0.13     18   0.14-0.20   1.30-1.60   0.040   0.08-0.13     19   0.14-0.20   1.00-1.30   0.040   0.08-0.13     19   0.14-0.20   1.00-1.30   0.040   0.08-0.13     20   0.27-0.34   1.35-1.65   0.040   0.08-0.13     37   0.32-0.39   1.35-1.65   0.040   0.08-0.13     39   0.35-0.43   1.35-1.65   0.040   0.08-0.13     40   0.37-0.44   0.70-1.00   0.040   0.08-0.13     41   0.37-0.45   1.35-1.65   0.040   0.08-0.13     44   0.40-0.48   1.35-1.65   0.040   0.24-0.33     45   0.42-0.49   0.70-1.00   0.040   0.08-0.13     51   0.42-0.49   0.70-1.00   0.040   0.08-0.13     51   0.48-0.55   0.70-1.00   0.040   0.08-0.13     51   0.48-0.55   0.70-1.00   0.040   0.08-0.13     51   0.					0.08–0.13				
17   0.14-0.20   1.00-1.30   0.040   0.08-0.13     18   0.14-0.20   1.30-1.60   0.040   0.08-0.13     19   0.14-0.20   1.00-1.30   0.040   0.24-0.33     32   0.27-0.34   1.35-1.65   0.040   0.08-0.13     37   0.32-0.39   1.35-1.65   0.040   0.08-0.13     39   0.35-0.43   1.35-1.65   0.040   0.08-0.13     40   0.37-0.44   0.70-1.00   0.040   0.08-0.13     41   0.37-0.45   1.35-1.65   0.040   0.08-0.13     44   0.40-0.48   1.35-1.65   0.040   0.08-0.13     44   0.40-0.48   1.35-1.65   0.040   0.08-0.13     45   0.42-0.49   0.70-1.00   0.040   0.08-0.13     51   0.42-0.49   0.70-1.00   0.040   0.08-0.13     51   0.42-0.49   0.70-1.00   0.040   0.08-0.13     51   0.48-0.55   0.70-1.00   0.040   0.08-0.13     51   0.48-0.55   0.70-1.00   0.040   0.08-0.13     51   0.					0.08–0.13				
18   0.14-0.20   1.30-1.60   0.040   0.08-0.13     19   0.14-0.20   1.00-1.30   0.040   0.24-0.33     32   0.27-0.34   1.35-1.65   0.040   0.08-0.13     37   0.32-0.39   1.35-1.65   0.040   0.08-0.13     39   0.35-0.43   1.35-1.65   0.040   0.08-0.13     40   0.37-0.44   0.70-1.00   0.040   0.08-0.13     41   0.37-0.45   1.35-1.65   0.040   0.08-0.13     44   0.40-0.48   1.35-1.65   0.040   0.08-0.13     44   0.40-0.48   1.35-1.65   0.040   0.08-0.13     45   0.42-0.49   0.70-1.00   0.040   0.04-0.03     46   0.42-0.49   0.70-1.00   0.040   0.08-0.13     51   0.48-0.55   0.70-1.00   0.040   0.08-0.13     51   0.48-0.55   0.70-1.00   0.040   0.08-0.13     51   0.48-0.55   0.70-1.00   0.040   0.08-0.13     51   0.13 max   0.60-0.90   0.07-0.12   0.10-0.15   1.00     <					0.16–0.23				
19   0.14-0.20   1.00-1.30   0.040   0.24-0.33     32   0.27-0.34   1.35-1.65   0.040   0.08-0.13     37   0.32-0.39   1.35-1.65   0.040   0.08-0.13     39   0.35-0.43   1.35-1.65   0.040   0.08-0.13     40   0.37-0.44   0.70-1.00   0.040   0.08-0.13     41   0.37-0.45   1.35-1.65   0.040   0.08-0.13     44   0.40-0.48   1.35-1.65   0.040   0.08-0.13     45   0.42-0.49   0.70-1.00   0.040   0.04-0.03     45   0.42-0.49   0.70-1.00   0.040   0.08-0.13     51   0.48-0.55   0.70-1.00   0.040   0.08-0.13     51   0.48-0.55   0.70-1.00   0.040   0.08-0.13     51   0.48-0.55   0.70-1.00   0.040   0.08-0.13     51   0.48-0.55   0.70-1.00   0.040   0.08-0.13     51   0.48-0.55   0.70-1.00   0.040   0.08-0.13     51   0.13 max   0.60-0.90   0.07-0.12   0.10-0.15   1.00     <		0.14-0.20			0.08–0.13				
32     0.27-0.34     1.35-1.65     0.040     0.08-0.13       37     0.32-0.39     1.35-1.65     0.040     0.08-0.13       39     0.35-0.43     1.35-1.65     0.040     0.08-0.13       40     0.37-0.44     0.70-1.00     0.040     0.08-0.13       41     0.37-0.45     1.35-1.65     0.040     0.08-0.13       41     0.37-0.45     1.35-1.65     0.040     0.08-0.13       44     0.40-0.48     1.35-1.65     0.040     0.08-0.13       45     0.42-0.49     0.70-1.00     0.040     0.04-0.03       45     0.42-0.49     0.70-1.00     0.040     0.08-0.13       51     0.48-0.55     0.70-1.00     0.040     0.08-0.13       51     0.48-0.55     0.70-1.00     0.040     0.08-0.13       51     0.48-0.55     0.70-1.00     0.040     0.08-0.13       51     0.48-0.55     0.70-1.00     0.040     0.08-0.13       51     0.13 max     0.60-0.90     0.07-0.12     0.10-0.15     1.121	3	0.14-0.20	1.30-1.60	0.040	0.08–0.13				
37     0.32–0.39     1.35–1.65     0.040     0.08–0.13       39     0.35–0.43     1.35–1.65     0.040     0.13–0.20       40     0.37–0.44     0.70–1.00     0.040     0.08–0.13       41     0.37–0.45     1.35–1.65     0.040     0.08–0.13       44     0.37–0.48     1.35–1.65     0.040     0.08–0.13       44     0.40–0.48     1.35–1.65     0.040     0.08–0.13       45     0.42–0.49     0.70–1.00     0.040     0.04–0.03       45     0.42–0.49     0.70–1.00     0.040     0.08–0.13       51     0.48–0.55     0.70–1.00     0.040     0.08–0.13       51     0.48–0.55     0.70–1.00     0.040     0.08–0.13       Rephosphorized and Resulfurized Carbon Steels <sup>D.G,F</sup> Tephosphorized and Resulfurized Carbon Steels <sup>D.G,F</sup> I 211     0.13 max     0.60–0.90     0.07–0.12     0.10–0.15     101       1212     0.13 max     0.70–1.00     0.07–0.12     0.16–0.23     101       1212     0.13 max	Э	0.14-0.20	1.00-1.30	0.040	0.24–0.33				
39     0.35-0.43     1.35-1.65     0.040     0.13-0.24       40     0.37-0.44     0.70-1.00     0.040     0.08-0.13       41     0.37-0.45     1.35-1.65     0.040     0.08-0.13       44     0.40-0.48     1.35-1.65     0.040     0.08-0.13       45     0.42-0.49     0.70-1.00     0.040     0.04-0.03       46     0.42-0.49     0.70-1.00     0.040     0.08-0.13       51     0.48-0.55     0.70-1.00     0.040     0.08-0.13       51     0.48-0.55     0.70-1.00     0.040     0.08-0.13       Rephosphorized and Resulfurized Carbon Steels <sup>D.G,F</sup> Image: State Designation     Carbon     Manganese     Phosphorous     Sulfur     Le       1211     0.13 max     0.60-0.90     0.07-0.12     0.10-0.15	2	0.27-0.34	1.35–1.65	0.040	0.08–0.13				
40     0.37-0.44     0.70-1.00     0.040     0.08-0.13       41     0.37-0.45     1.35-1.65     0.040     0.08-0.13       44     0.40-0.48     1.35-1.65     0.040     0.24-0.33       45     0.42-0.49     0.70-1.00     0.040     0.04-0.03       46     0.42-0.49     0.70-1.00     0.040     0.08-0.13       51     0.48-0.55     0.70-1.00     0.040     0.08-0.13       Rephosphorized and Resulfurized Carbon Steels <sup>D.G.F.</sup> Image: Phosphorous Sulfur Lege       1211     0.13 max     0.60-0.90     0.07-0.12     0.10-0.15     1212     0.13 max     0.70-1.00     0.07-0.12     0.16-0.23     1212     0.13 max     0.70-1.00     0.07-0.12     0.16-0.23     1212     0.13 max     0.70-1.00     0.07-0.12     0.04.0.02     121     0.13 max     0.70-1.00     0.07-0.12     0.16-0.23     121     0.13 max     0.70-1.00     0.07-0.12     0.04.0.02     121     0.14.0.02     121     0.14.0.02     121     0.14.0.02     121     0.14.0.02     121	7	0.32-0.39	1.35–1.65	0.040	0.08–0.13				
41     0.37-0.45     1.35-1.65     0.040     0.08-0.13       44     0.40-0.48     1.35-1.65     0.040     0.24-0.33       45     0.42-0.49     0.70-1.00     0.040     0.04-0.03       46     0.42-0.49     0.70-1.00     0.040     0.08-0.13       51     0.48-0.55     0.70-1.00     0.040     0.08-0.13       Rephosphorized and Resulfurized Carbon Steels <sup>D.G,F</sup> Image: Sulfur the second steels of the s	9	0.35-0.43	1.35-1.65	0.040	0.13-0.20				
41     0.37-0.45     1.35-1.65     0.040     0.08-0.13       44     0.40-0.48     1.35-1.65     0.040     0.24-0.33       45     0.42-0.49     0.70-1.00     0.040     0.04-0.03       46     0.42-0.49     0.70-1.00     0.040     0.08-0.13       51     0.48-0.55     0.70-1.00     0.040     0.08-0.13       Rephosphorized and Resulfurized Carbon Steels <sup>D.G,F</sup> Image: Sulfur the second steels of the s	0	0.37-0.44	0.70-1.00	0.040	0.08–0.13				
44     0.40-0.48     1.35-1.65     0.040     0.24-0.33       45     0.42-0.49     0.70-1.00     0.040     0.04-0.03       46     0.42-0.49     0.70-1.00     0.040     0.08-0.13       51     0.48-0.55     0.70-1.00     0.040     0.08-0.13       Rephosphorized and Resulfurized Carbon Steels <sup>D.G,F</sup> Image: Sulfur steels     Left steels       1211     0.13 max     0.60-0.90     0.07-0.12     0.10-0.15        1212     0.13 max     0.70-1.00     0.07-0.12     0.16-0.23        1212     0.13 max     0.70-1.00     0.07-0.12     0.16-0.23					0.08–0.13				
45     0.42–0.49     0.70–1.00     0.040     0.04–0.03       46     0.42–0.49     0.70–1.00     0.040     0.08–0.13       51     0.48–0.55     0.70–1.00     0.040     0.08–0.13       Rephosphorized and Resulfurized Carbon Steels <sup>D,G,F</sup> Image: Sulfur     Leg       1211     0.13 max     0.60–0.90     0.07–0.12     0.10–0.15        1212     0.13 max     0.70–1.00     0.07–0.12     0.16–0.23        1212     0.13 max     0.70–1.00     0.07–0.12     0.16–0.23					0.24–0.33				
46     0.42–0.49     0.70–1.00     0.040     0.08–0.13       51     0.48–0.55     0.70–1.00     0.040     0.08–0.13       Rephosphorized and Resulfurized Carbon Steels <sup>D,G,F</sup> Grade Designation     Carbon     Manganese     Phosphorous     Sulfur     Le       1211     0.13 max     0.60–0.90     0.07–0.12     0.10–0.15        1212     0.13 max     0.70–1.00     0.07–0.12     0.16–0.23        1212     0.13 max     0.70–1.00     0.07–0.12     0.16–0.23					0.04–0.07				
51     0.48–0.55     0.70–1.00     0.040     0.08–0.13       Rephosphorized and Resulfurized Carbon Steels <sup>D,G,F</sup> Grade Designation     Carbon     Manganese     Phosphorous     Sulfur     Le       1211     0.13 max     0.60–0.90     0.07–0.12     0.10–0.15        1212     0.13 max     0.70–1.00     0.07–0.12     0.16–0.23					0.08–0.13				
Grade Designation     Carbon     Manganese     Phosphorous     Sulfur     Le       1211     0.13 max     0.60–0.90     0.07–0.12     0.10–0.15     .       1212     0.13 max     0.70–1.00     0.07–0.12     0.16–0.23     .       1212     0.13 max     0.70–1.00     0.07–0.12     0.16–0.23     .					0.08–0.13				
Grade Designation     Carbon     Manganese     Phosphorous     Sulfur     Le       1211     0.13 max     0.60–0.90     0.07–0.12     0.10–0.15     .       1212     0.13 max     0.70–1.00     0.07–0.12     0.16–0.23     .       1212     0.13 max     0.70–1.00     0.07–0.12     0.16–0.23     .			Rephosphorized	and Resulfurized Carbon Ste	els <sup>D,G,F</sup>				
1212 0.13 max 0.70-1.00 0.07-0.12 0.16-0.23 .	Grade Designation	Carbon							
1212 0.13 max 0.70-1.00 0.07-0.12 0.16-0.23 .	1211	0.13 max	0.60-0.90	0.07–0.12	0.10–0.15				
	1213	0.13 max	0.70–1.00	0.07-0.12	0.24–0.33				

# 🌐 A 29/A 29M – 04

TABLE 1 Continued

	Rephosphorized and Resulfurized Carbon Steels <sup>D,G,F</sup>								
Grade Designation	Carbon	Manganese	Phosphorous	Sulfur	Lead				
12L15	0.09 max	0.75–1.05	0.04-0.09	0.26-0.35	0.15–0.35				
		High-Mang	anese Carbon Steels <sup>B,C,D,</sup>	E,F					
Grade	Former			Phosphorous,	Sulfur,				
Designation	Designation	Carbon	Manganese	max	max				
1513		0.10-0.16	1.10-1.40	0.040	0.050				
1518		0.15-0.21	1.10-1.40	0.040	0.050				
1522		0.18-0.24	1.10-1.40	0.040	0.050				
1524	1024	0.19-0.25	1.35-1.65	0.040	0.050				
1525		0.23-0.29	0.80-1.10	0.040	0.050				
1526		0.22-0.29	1.10-1.40	0.040	0.050				
1527	1027	0.22-0.29	1.20-1.50	0.040	0.050				
1536	1036	0.30-0.37	1.20-1.50	0.040	0.050				
1541	1041	0.36-0.44	1.35-1.65	0.040	0.050				
1547		0.43-0.51	1.35-1.65	0.040	0.050				
1548	1048	0.44-0.52	1.10-1.40	0.040	0.050				
1551	1051	0.45-0.56	0.85-1.15	0.040	0.050				
1552	1052	0.47-0.55	1.20-1.50	0.040	0.050				
1561	1061	0.55-0.65	0.75-1.05	0.040	0.050				
1566	1066	0.60-0.71	0.85-1.15	0.040	0.050				
1572	1072	0.65–0.76	1.00-1.30	0.040	0.050				
	Heat Chemical Ranges and Limits, percent								
		Merchant Q	uality M Series Carbon Ste	el Bars					
Grade				sphorous,					
Designation	Carbon	Manganes	e <sup>G</sup>	max	Sulfur, max				

Basissatias	O a vita a vi	Managara	r noophorouo,	Quiltur man
Designation	Carbon	Manganese <sup>G</sup>	max	Sulfur, max
M 1008	0.10 max	0.25–0.60	0.04	0.05
M 1010	0.07-0.14	0.25–0.60	0.04	0.05
M 1012	0.09–0.16	0.25-0.60	0.04	0.05
M 1015	0.12-0.19	0.25-0.60	0.04	0.05
M 1017	0.14-0.21	0.25-0.60	0.04	0.05
M 1020	0.17-0.24	0.25-0.60	0.04	0.05
M 1023	0.19–0.27	0.25-0.60	0.04	0.05
M 1025	0.20-0.30	0.25-0.60	0.04	0.05
M 1031	0.26–0.36	0.25–0.60	0.04	0.05
M 1044	0.40-0.50	0.25-0.60	0.04	0.05

<sup>A</sup> Maximum unless otherwise indicated.

<sup>B</sup> When silicon is required, the following ranges and limits are commonly specified: 0.10 %, max, 0.10 % to 0.20 %, 0.15 % to 0.35 %, 0.20 % to 0.40 %, or 0.30 % to 0.60 %.

<sup>C</sup> Copper can be specified when required as 0.20 % minimum. <sup>D</sup> When lead is required as an added element to a standard steel, a range of 0.15 to 0.35 % inclusive is specified. Such a steel is identified by inserting the letter "L"

between the second and third numerals of the grade designation, for example, 10 L 45. A cast or heat analysis is not determinable when lead is added to the ladle stream. <sup>E</sup> When boron treatment for killed steels is specified, the steels can be expected to contain 0.0005 to 0.003 % boron. If the usual titanium additive is not permitted, the steels can be expected to contain up to 0.005 % boron.

<sup>F</sup> The elements bismuth, calcium, selenium, or tellurium may be added as agreed upon between purchaser and supplier.

<sup>G</sup> Unless prohibited by the purchaser, the manganese content may exceed 0.60 % on heat analysis to a maximum of 0.75 %, provided the carbon range on heat analysis has the minimum and maximum reduced by 0.01 % for each 0.05 % manganese over 0.60 %.

#### TABLE 2 Grade Designations and Chemical Compositions of Alloy Steel Bars

NOTE 1—Small quantities of certain elements are present in alloy steels which are not specified or required. These elements are considered as incidental and may be present to the following maximum amounts: copper, 0.35 %; nickel, 0.25 %; chromium, 0.20 % and molybdenum, 0.06 %.

NOTE 2-Where minimum and maximum sulfur content is shown it is indicative of resulfurized steel.

Note 3—The chemical ranges and limits shown in Table 2 are produced to product analysis tolerances shown in Table 6.

NOTE 4—Standard alloy steels can be produced with a lead range of 0.15–0.35 %. Such steels are identified by inserting the letter "L" between the second and third numerals of the AISI number, for example, 41 L 40. A cast or heat analysis is not determinable when lead is added to the ladle stream.

Grade	Heat Chemical Ranges and Limits, %								
Designation	Carbon	Manganese	Phosphorus, max	Sulfur, max	Silicon <sup>A</sup>	Nickel	Chromium	Molybdenum	
1330	0.28-0.33	1.60-1.90	0.035	0.040	0.15 to 0.35				
1335	0.33-0.38	1.60-1.90	0.035	0.040	0.15 to 0.35				
1340	0.38-0.43	1.60-1.90	0.035	0.040	0.15 to 0.35				
1345	0.43-0.48	1.60-1.90	0.035	0.040	0.15 to 0.35				
4012	0.09-0.14	0.75-1.00	0.035	0.040	0.15 to 0.35			0.15-0.25	
4023	0.20-0.25	0.70-0.90	0.035	0.040	0.15 to 0.35			0.20-0.30	
4024	0.20-0.25	0.70-0.90	0.035	0.035-0.050	0.15 to 0.35			0.20-0.30	
4027	0.25-0.30	0.70-0.90	0.035	0.040	0.15 to 0.35			0.20-0.30	

• • •	29/A	29M	- 04	
-------------	------	-----	------	--

TABLE 2 Continued

Grade	Heat Chemical Ranges and Limits, %								
Designation	Carbon	Manganese	Phosphorus, max	Sulfur, max	Silicon <sup>A</sup>	Nickel	Chromium	Molybdenum	
4028	0.25-0.30	0.70-0.90	0.035	0.035-0.050	0.15 to 0.35			0.20-0.30	
4032	0.30-0.35	0.70-0.90	0.035	0.040	0.15 to 0.35			0.20-0.30	
4037	0.35-0.40	0.70-0.90	0.035	0.040	0.15 to 0.35			0.20-0.30	
4042	0.40-0.45	0.70-0.90	0.035	0.040	0.15 to 0.35			0.20-0.30	
4047	0.45-0.50	0.70-0.90	0.035	0.040	0.15 to 0.35			0.20-0.30	
4118	0.18-0.23	0.70-0.90	0.035	0.040	0.15 to 0.35		0.40-0.60	0.08-0.15	
4120	0.18-0.23	0.90-1.20	0.035	0.040	0.15 to 0.35		0.40-0.60	0.13-0.20	
4121	0.18-0.23	0.75-1.00	0.035	0.040	0.15 to 0.35		0.45-0.65	0.20-0.30	
4130	0.28-0.33	0.40-0.60	0.035	0.040	0.15 to 0.35		0.80-1.10	0.15-0.25	
4135	0.33-0.38	0.70-0.90	0.035	0.040	0.15 to 0.35		0.80-1.10	0.15-0.25	
1137	0.35-0.40	0.70-0.90	0.035	0.040	0.15 to 0.35		0.80-1.10	0.15-0.25	
1140	0.38-0.43	0.75-1.00	0.035	0.040	0.15 to 0.35		0.80-1.10	0.15-0.25	
1142	0.40-0.45	0.75-1.00	0.035	0.040	0.15 to 0.35		0.80-1.10	0.15-0.25	
1145	0.43-0.48	0.75-1.00	0.035	0.040	0.15 to 0.35		0.80-1.10	0.15-0.25	
4147	0.45-0.50	0.75-1.00	0.035	0.040	0.15 to 0.35		0.80-1.10	0.15-0.25	
4150	0.48-0.53	0.75-1.00	0.035	0.040	0.15 to 0.35		0.80-1.10	0.15-0.25	
1161	0.56-0.64	0.75-1.00	0.035	0.040	0.15 to 0.35		0.70-0.90	0.25-0.35	
1320	0.17-0.22	0.45-0.65	0.035	0.040	0.15 to 0.35	1.65-2.00	0.40-0.60	0.20-0.30	
4340	0.38-0.43	0.60-0.80	0.035	0.040	0.15 to 0.35	1.65-2.00	0.70-0.90	0.20-0.30	
E4340	0.38-0.43	0.65-0.85	0.025	0.025	0.15 to 0.35	1.65-2.00	0.70-0.90	0.20-0.30	
4419	0.18-0.23	0.45-0.65	0.035	0.040	0.15 to 0.35			0.45-0.60	
4422	0.20-0.25	0.70-0.90	0.035	0.040	0.15 to 0.35			0.35-0.45	
4427	0.24-0.29	0.70-0.90	0.035	0.040	0.15 to 0.35			0.35-0.45	
4615	0.13-0.18	0.45-0.65	0.035	0.040	0.15 to 0.35	1.65-2.00		0.20-0.30	
4620	0.17-0.22	0.45-0.65	0.035	0.040	0.15 to 0.35	1.65-2.00		0.20-0.30	
4621	0.18-0.23	0.70-0.90	0.035	0.040	0.15 to 0.35	1.65-2.00		0.20-0.30	
4626	0.24-0.29	0.45-0.65	0.035	0.040	0.15 to 0.35	0.70-1.00		0.15-0.25	
4715	0.13-0.18	0.70-0.90	0.035	0.040	0.15 to 0.35	0.70-1.00	0.45-0.65	0.45-0.60	
4718	0.16-0.21	0.70-0.90	0.035	0.040	0.15 to 0.35	0.90-1.20	0.35-0.55	0.30-0.40	
1720	0.17-0.22	0.50-0.70	0.035	0.040	0.15 to 0.35	0.90-1.20	0.35-0.55	0.15-0.25	
4815	0.13-0.18	0.40-0.60	0.035	0.040	0.15 to 0.35	3.25-3.75		0.20-0.30	
4817	0.15-0.20	0.40-0.60	0.035	0.040	0.15 to 0.35	3.25-3.75		0.20-0.30	
4820	0.18-0.23	0.50-0.70	0.035	0.040	0.15 to 0.35	3.25-3.75		0.20-0.30	
5015	0.12-0.17	0.30-0.50	0.035	0.040	0.15 to 0.35		0.30-0.50		
5046	0.43-0.48	0.75–1.00	0.035	0.040	0.15 to 0.35		0.20-0.35		
5115	0.13–0.18	0.70-0.90	0.035	0.040	0.15 to 0.35		0.70-0.90		
5120 5130	0.17–0.22 0.28–0.33	0.70–0.90 0.70–0.90	0.035 0.035	0.040 0.040 A 2	0.15 to 0.35		0.70–0.90 0.80–1.10		
5132	0.30-0.35	0.60-0.80	0.035	0.040	0.15 to 0.35		0.75-1.00		
5135 tps://standa		talo0.60-0.80	ds/ 0.035 8	26-0.040 82	0.15 to 0.35	-4695 <u>6</u> e94a	0.80-1.05	9-a29m-04	
5135 (p. 577) 5 (a) (a) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c	0.38-0.43	0.70-0.90	0.035	0.040	0.15 to 0.35		0.70-0.90		
5140	0.43-0.48	0.70-0.90	0.035	0.040	0.15 to 0.35		0.70-0.90		
5145	0.46-0.51	0.70-0.95	0.035	0.040	0.15 to 0.35		0.85-1.15		
5150	0.48-0.53	0.70-0.90	0.035	0.040	0.15 to 0.35		0.70-0.90		
5155			0.035	0.040					
5155	0.51–0.59 0.56–0.61	0.70–0.90 0.75–1.00	0.035	0.040	0.15 to 0.35 0.15 to 0.35		0.70–0.90 0.70–0.90		
E50100	0.98–1.10	0.25-0.45	0.035	0.040			0.40-0.60		
					0.15 to 0.35				
E51100 E52100	0.98-1.10	0.25–0.45 0.25–0.45	0.025	0.025 0.025	0.15 to 0.35		0.90-1.15		
52100 <sup>B</sup>	0.98–1.10 0.93–1.05	0.25-0.45	0.025 0.025	0.025	0.15 to 0.35 0.15 to 0.35		1.30–1.60 1.35–1.60		
								 (0 10_0 15 \/)	
6118 8150	0.16-0.21	0.50-0.70	0.035 0.035	0.040	0.15 to 0.35 0.15 to 0.35		0.50-0.70	(0.10–0.15 V)	
6150 8115	0.48-0.53	0.70-0.90		0.040			0.80-1.10	(0.15 min V)	
3115	0.13-0.18	0.70-0.90	0.035	0.040	0.15 to 0.35	0.20-0.40	0.30-0.50	0.08-0.15	
3615 8617	0.13-0.18	0.70-0.90	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40–0.60 0.40–0.60	0.15-0.25	
3617 8620	0.15-0.20	0.70-0.90	0.035	0.040	0.15 to 0.35 0.15 to 0.35	0.40-0.70		0.15-0.25	
3620	0.18-0.23	0.70-0.90	0.035	0.040	0.15 to 0.35 0.15 to 0.35	0.40-0.70	0.40–0.60 0.40–0.60	0.15-0.25	
3622	0.20-0.25	0.70-0.90	0.035	0.040		0.40-0.70		0.15-0.25	
3625	0.23-0.28	0.70-0.90	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40-0.60	0.15-0.25	
3627	0.25-0.30	0.70-0.90	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40-0.60	0.15-0.25	
3630	0.28-0.33	0.70-0.90	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40-0.60	0.15-0.25	
3637	0.35-0.40	0.75-1.00	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40-0.60	0.15-0.25	
3640	0.38-0.43	0.75-1.00	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40-0.60	0.15-0.25	
3642	0.40-0.45	0.75-1.00	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40-0.60	0.15-0.25	
3645	0.43-0.48	0.75-1.00	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40-0.60	0.15-0.25	
3650	0.48-0.53	0.75-1.00	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40-0.60	0.15-0.25	
3655	0.51-0.59	0.75-1.00	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40-0.60	0.15-0.25	
3660	0.56-0.64	0.75-1.00	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40-0.60	0.15-0.25	
8720	0.18-0.23	0.70-0.90	0.035	0.040	0.15 to 0.35	0.40-0.7	0.40-0.60	0.20-0.30	
3740	0.38-0.43	0.75-1.00	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40-0.60	0.20-0.30	
8822	0.20-0.25†	0.75-1.00	0.035	0.040	0.15 to 0.35	0.40-0.70	0.40-0.60	0.30-0.40	
9254	0.51-0.59	0.60-0.80	0.035	0.040	1.20-1.60		0.60-0.80		

🖽 A 29/A 29M – 04

TABLE	2	Continued
-------	---	-----------

Grade	Heat Chemical Ranges and Limits, %								
Designation	Carbon	Manganese	Phosphorus, max	Sulfur, max	Silicon <sup>A</sup>	Nickel	Chromium	Molybdenum	
9255	0.51-0.59	0.70-0.95	0.035	0.040	1.80-2.20				
9259	0.56-0.64	0.75-1.00	0.035	0.040	0.70-1.10		0.45-0.65		
9260	0.56-0.64	0.75-1.00	0.035	0.040	1.80-2.20				
E9310	0.08-0.13	0.45-0.65	0.025	0.025	0.15 to 0.30	3.00-3.50	1.00-1.40	0.08–0.15	
			Stan	idard Boron S	teels <sup>C</sup>				
50B44	0.43-0.48	0.75-1.00	0.035	0.040	0.15-0.35		0.20-0.60		
50B46	0.44-0.49	0.75-1.00	0.035	0.040	0.15-0.35		0.20-0.35		
50B50	0.48-0.53	0.75-1.00	0.035	0.040	0.15-0.35		0.40-0.60		
50B60	0.56-0.64	0.75-1.00	0.035	0.040	0.15-0.35		0.40-0.60		
51B60	0.56-0.64	0.75-1.00	0.035	0.040	0.15-0.35		0.70-0.90		
81B45	0.43-0.48	0.75-1.00	0.035	0.040	0.15-0.35	0.20-0.40	0.35-0.55	0.08-0.15	
94B17	0.15-0.20	0.75-1.00	0.035	0.040	0.15-0.35	0.30-0.60	0.30-0.50	0.80-0.15	
94B30	0.28-0.33	0.75-1.00	0.035	0.040	0.15-0.35	0.30-0.60	0.30-0.50	0.08-0.15	

<sup>A</sup> Silicon may be specified by the purchaser as 0.10% maximum. The need for 0.10% maximum generally relates to severe cold-formed parts.

<sup>B</sup> The purchaser may also require the following maximums: copper 0.30 %; aluminum 0.050 %; oxygen 0.0015 %.

<sup>C</sup> These steels can be expected to contain 0.0005 to 0.003 % boron. If the usual titanium additive is not permitted, the steels can be expected to contain up to 0.005 % boron

+ Editorially corrected.

### 4. Chemical Composition

4.1 Limits:

4.1.1 The chemical composition shall conform to the requirements specified in the purchase order or the individual product specifications. For convenience the grades commonly specified for carbon steel bars are shown in Tables 1 and 2. Bars may be ordered to these grade designations and when so ordered shall conform to the specified limits by heat analysis.

4.1.2 When compositions other than those shown in Tables 1 and 2 are required, the composition limits shall be prepared using the ranges and limits shown in Table 3 for carbon steel and Table 4 for alloy steel.

4.2 Heat or Cast Analysis:

<u>ASTM A29/A</u>

4.2.1 The chemical composition of each heat or cast shall be determined by the manufacturer in accordance with Test Methods, Practices, and Terminology A 751.

4.2.2 The heat or cast analysis shall conform to the requirements specified in the product specification or purchase order. These can be the heat chemical range and limit for a grade designated in Tables 1 and 2, or another range and limit in accordance with 4.1.2, or with requirements of the product specification.

NOTE 2—Heat analysis for lead is not determinable since lead is added to the ladle stream while each ingot is poured. When specified as an added element to a standard steel, the percentage of lead is reported as 0.15 to 0.35 incl, which is the range commonly specified for this element.

4.2.3 If requested or required, the heat analysis shall be reported to the purchaser or his representative.

4.2.4 Reporting of significant figures and rounding shall be in accordance with Test Methods, Practices, and Terminology A 751.

4.3 Product Analysis:

4.3.1 Merchant quality carbon bar steel is not subject to rejection for product analysis unless misapplication of a heat is clearly indicated.

4.3.2 Analyses may be made by the purchaser from finished bars other than merchant quality representing each heat of

open-hearth, basic-oxygen, or electric-furnace steel. The chemical composition thus determined shall not vary from the limits specified in the applicable specification by more than the amounts prescribed in Table 5 and Table 6, but the several determinations of any element, excluding lead, in a heat may not vary both above and below the specified range. Rimmed or capped steel is characterized by a lack of homogeneity in its composition, especially for the elements carbon, phosphorus, and sulfur; therefore, when rimmed or capped steel is specified or required, the limitations for these elements shall not be applicable. Because of the degree to which phosphorus and sulfur segregate, the limitations for these elements shall not be applicable to rephosphorized or resulfurized steels.

4.3.3 Samples for product analysis shall be taken by one of the following methods:

4.3.3.1 Applicable to small sections whose cross-sectional area does not exceed 0.75 in.<sup>2</sup> [500 mm<sup>2</sup>] such as rounds, squares, hexagons, etc. Chips are taken by milling or machining the full cross section of the piece. Drilling is not a feasible method for sampling sizes 0.75 in.<sup>2</sup> and smaller.

4.3.3.2 Applicable to products where the width of the cross section greatly exceeds the thickness, such as bar size shapes and light flat bars. Chips are taken by drilling entirely through the steel at a point midway between the edge and the middle of the section, or by milling or machining the entire cross section.

4.3.3.3 Applicable to large rounds, squares semifinished, etc. Chips are taken at any point midway between the outside and the center of the piece by drilling parallel to the axis or by milling or machining the full cross section. In cases where these methods are not practicable, the piece may be drilled on the side, but chips are not taken until they represent the portion midway between the outside and the center.

4.3.3.4 When the steel is subject to tension test requirements, the tension test specimen can also be used for product analysis. In that case, chips for product analysis can be taken by drilling entirely through the tension test specimens or by the method described in 4.3.3.1.