



# Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels<sup>1</sup>

This standard is issued under the fixed designation A479/A479M; 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 (ε) indicates an editorial change since the last revision or reapproval.

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

## 1. Scope\*

1.1 This specification<sup>2</sup> covers hot- and cold-finished bars of stainless steel, including rounds, squares, and hexagons, and hot-rolled or extruded shapes such as angles, tees, and channels for use in boiler and pressure vessel construction.<sup>2</sup>

NOTE 1—There are standards covering high nickel, chromium, austenitic corrosion, and heat-resisting alloy materials. These standards are under the jurisdiction of ASTM Subcommittee B02.07 and may be found in *Annual Book of ASTM Standards*, Vol 02.04.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 Unless the order specifies the applicable “M” specification designation, the material shall be furnished to the inch-pound units.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</sup>

**A262** Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

**A370** Test Methods and Definitions for Mechanical Testing of Steel Products

**A484/A484M** Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings

**A751** Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

**E112** Test Methods for Determining Average Grain Size

**E527** Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

### 2.2 SAE Document:<sup>4</sup>

**SAE J 1086** Recommended Practice for Numbering Metals and Alloys

## 3. General Requirements

3.1 The following requirements for orders for material furnished under this specification shall conform to the applicable requirements of the current edition of Specification **A484/A484M**.

- 3.1.1 Definitions,
- 3.1.2 General requirements for delivery,
- 3.1.3 Ordering information,
- 3.1.4 Process,
- 3.1.5 Special tests,
- 3.1.6 Heat treatment,
- 3.1.7 Dimensions and permissible variations,
- 3.1.8 Workmanship, finish, and appearance,
- 3.1.9 Number of tests/test methods,
- 3.1.10 Specimen preparation,
- 3.1.11 Retreatment,
- 3.1.12 Inspection,
- 3.1.13 Rejection and reheating,
- 3.1.14 Material test report,
- 3.1.15 Certification, and
- 3.1.16 Packaging, marking, and loading.

## 4. Other Requirements

4.1 In addition to the requirements of this specification, all requirements of the current editions of Specification **A484/A484M** shall apply. Failure to comply with the general requirements of Specification **A484/A484M** constitutes non-conformance with this specification.

<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 **A01.17** on Flat-Rolled and Wrought Stainless Steel.

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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-479/SA-479M in Section II of that Code.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>4</sup> Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

\*A Summary of Changes section appears at the end of this standard



## 5. Chemical Composition

5.1 Chemical composition shall be reported to the purchaser, or his representative, and shall conform to the requirements specified in **Table 1**.

5.2 When a product analysis is performed or requested by the purchaser, the tolerance limits as described in Specification **A484/A484M** apply unless Supplementary Requirement S3 is invoked.

5.3 Methods and practices relating to chemical analysis required by this specification shall be in accordance with Test Methods, Practices, and Terminology **A751**.

## 6. Grain Size for Austenitic Grades

6.1 All austenitic grades shall be tested for average grain size by Test Methods **E112**.

6.2 The H grades shall conform to an average grain size as follows:

6.2.1 ASTM No. 6 or coarser for Types 304H, 309H, 310H, and 316H,

6.2.2 ASTM No. 7 or coarser for Types 321H, 347H, and 348H.

6.3 For S32615, the grain size as determined in accordance with Test Methods **E112**, comparison method, Plate 11, shall be No. 3 or finer.

6.4 For N08810 and N08811, the average grain size as determined in accordance with Test Methods **E112** shall be No. 5 or coarser.

6.5 Supplementary Requirement S1 shall be invoked when non-H grade austenitic stainless steels are ordered for ASME Code applications for service above 1000°F [540°C].

## 7. Mechanical Properties Requirements

7.1 The material shall conform to the mechanical property requirements specified in **Table 2** for the grade ordered. At least one room-temperature test shall be performed by the manufacturer on a sample from at least one bar or shape from each lot of material.

7.2 The yield strength shall be determined by the offset (0.2 %) method as prescribed in Test Methods and Definitions **A370**.

7.3 Martensitic material supplied in the annealed condition shall be capable of meeting the hardened and tempered mechanical properties when heat treated.

7.4 Hardness measurements, when required, shall be made at a location midway between the surface and the center of the cross section.

7.5 Martensitic grades shall be capable of meeting the hardness requirements after heat treating as specified in **Table 3**.

## 8. Corrosion Testing

8.1 Austenitic stainless steels solution annealed by the alternative method shall be tested and pass the intergranular corrosion test requirements described in S2.

## 9. Testing for Intermetallic Compounds

9.1 When specified by the purchaser in the purchase order, the manufacturer shall test the austenitic or austenitic-ferritic (duplex) stainless steel material in its final condition in accordance with supplementary test requirements S6.

NOTE 2—Many, if not all, duplex stainless steels and some austenitic stainless steels will form intermetallic phases or compounds such as sigma, chi, and laves phases when exposed to temperatures below the specified annealing temperature or cooled slowly from a higher temperature during casting, welding, or annealing. These phases can have a negative effect on mechanical properties and corrosion resistance. These phases can typically be removed by correct annealing and cooling practices. The presence of these phases can be demonstrated by tests, typically involving metallography, impact toughness, or corrosion resistance, although the testing requirements may be different for different alloy grades. Such testing may or may not be routinely performed by the manufacturer.

## 10. Certification

10.1 The material manufacturer's certificate of compliance certifying that the material was manufactured and tested in accordance with this specification, together with a report of the results required by this specification and the purchase order, shall be furnished at the time of shipment. The certification shall be positively relatable to the lot of material represented.

## 11. Product Marking

11.1 In addition to the marking requirements of Specification **A484/A484M**, materials that have been heat treated or have been strain hardened shall be identified by placement of the following symbols after the grade designation:

### 11.1.1 Austenitic Grades:

11.1.1.1 All grades in the annealed condition—A,

11.1.1.2 Strain hardened Type 316, Level 1—S1,

11.1.1.3 Strain hardened Type 316, Level 2—S2,

11.1.1.4 Hot-rolled Type XM-19—H,

11.1.1.5 Strain hardened Type XM-19—S,

11.1.1.6 Material meeting Supplementary Requirement S1—ELT (unnecessary for H grades).

11.1.1.7 In addition to all other marking requirements of this specification, when S1 is invoked, all grades in the direct quenched condition shall be marked "D".

11.1.2 Austenitic-Ferritic Grades—All grades in the annealed condition—A.

11.1.3 Ferritic Grades—All grades in the annealed condition—A.

### 11.1.4 Martensitic Grades:

11.1.4.1 All grades in the annealed condition—A.

11.1.4.2 Types 403 and 410—COND 1, COND 2, or COND 3 as appropriate for the tempering temperature employed.

11.1.4.3 Type 414, S41500, and Type XM-30 tempered materials—T.

## 12. Keywords

12.1 austenitic stainless steel; austenitic-ferritic duplex stainless steel; ferritic stainless steel; martensitic stainless steel; pressure-containing parts; pressure vessel service; stainless steel bars; stainless steel shapes; temperature service applications—high



TABLE 1 Chemical Requirements

| UNS Designation <sup>A</sup> | Type               | Composition, % <sup>B</sup> |                |                 |        |           |           |           |           |                 |                                                                                                |
|------------------------------|--------------------|-----------------------------|----------------|-----------------|--------|-----------|-----------|-----------|-----------|-----------------|------------------------------------------------------------------------------------------------|
|                              |                    | Carbon                      | Man-<br>ganese | Phos-<br>phorus | Sulfur | Silicon   | Chromium  | Nickel    | Nitrogen  | Molyb-<br>denum | Other Elements <sup>C</sup>                                                                    |
| Austenitic Grades            |                    |                             |                |                 |        |           |           |           |           |                 |                                                                                                |
| N08020                       | Alloy 20           | 0.07                        | 2.00           | 0.045           | 0.035  | 1.00      | 19.0–21.0 | 32.0–38.0 | ...       | 2.00–3.00       | Cu 3.0–4.0;<br>Cb 8xC–1.00                                                                     |
| N08367                       | ...                | 0.030                       | 2.00           | 0.040           | 0.030  | 1.00      | 20.0–22.0 | 23.5–25.5 | 0.18–0.25 | 6.0–7.0         | Cu 0.75                                                                                        |
| N08800                       | 800                | 0.10                        | 1.50           | 0.045           | 0.015  | 1.00      | 19.0–23.0 | 30.0–35.0 | ...       | ...             | Fe <sup>K</sup> 39.5 min.<br>Cu 0.75<br>Al 0.15–0.60<br>Ti 0.15–0.60                           |
| N08810                       | 800H               | 0.05–0.10                   | 1.50           | 0.045           | 0.015  | 1.00      | 19.0–23.0 | 30.0–35.0 | ...       | ...             | Fe <sup>K</sup> 39.5 min.<br>Cu 0.75<br>Al 0.15–0.60<br>Ti 0.15–0.60                           |
| N08811                       | ...                | 0.06–0.10                   | 1.50           | 0.045           | 0.015  | 1.00      | 19.0–23.0 | 30.0–35.0 | ...       | ...             | Fe <sup>K</sup> 39.5 min.<br>Cu 0.75<br>Al <sup>L</sup> 0.25–0.60<br>Ti <sup>L</sup> 0.25–0.60 |
| N08700                       | ...                | 0.040                       | 2.00           | 0.040           | 0.030  | 1.00      | 19.0–23.0 | 24.0–26.0 | ...       | 4.3–5.0         | Cu 0.50;<br>Cb 8xC–0.40                                                                        |
| N08904                       | 904L               | 0.020                       | 2.00           | 0.045           | 0.035  | 1.00      | 19.0–23.0 | 23.0–28.0 | 0.10      | 4.0–5.0         | Cu 1.0–2.0                                                                                     |
| N08925                       | ...                | 0.020                       | 1.00           | 0.045           | 0.030  | 0.50      | 19.0–21.0 | 24.0–26.0 | 0.10–0.20 | 6.0–7.0         | Cu 0.80–1.50                                                                                   |
| N08926                       | ...                | 0.020                       | 2.00           | 0.030           | 0.010  | 0.50      | 19.0–21.0 | 24.0–26.0 | 0.15–0.25 | 6.0–7.0         | Cu 0.50–1.50                                                                                   |
| S20161                       | ...                | 0.15                        | 4.0–6.0        | 0.045           | 0.030  | 3.0–4.0   | 15.0–18.0 | 4.0–6.0   | 0.08–0.20 | ...             | ...                                                                                            |
| S20910                       | XM-19              | 0.06                        | 4.0–6.0        | 0.045           | 0.030  | 1.00      | 20.5–23.5 | 11.5–13.5 | 0.20–0.40 | 1.50–3.00       | Cb 0.10–0.30;<br>V 0.10–0.30                                                                   |
| S21600                       | XM-17              | 0.08                        | 7.5–9.0        | 0.045           | 0.030  | 1.00      | 17.5–20.5 | 5.0–7.0   | 0.25–0.50 | 2.00–3.00       | ...                                                                                            |
| S21603                       | XM-18              | 0.03                        | 7.5–9.0        | 0.045           | 0.030  | 1.00      | 17.5–20.5 | 5.0–7.0   | 0.25–0.50 | 2.00–3.00       | ...                                                                                            |
| S21800                       | ...                | 0.10                        | 7.0–9.0        | 0.060           | 0.030  | 3.5–4.5   | 16.0–18.0 | 8.0–9.0   | 0.08–0.18 | ...             | ...                                                                                            |
| S21904                       | XM-11              | 0.04                        | 8.0–10.0       | 0.045           | 0.030  | 1.00      | 19.0–21.5 | 5.5–7.5   | 0.15–0.40 | ...             | ...                                                                                            |
| S24000                       | XM-29              | 0.08                        | 11.5–14.5      | 0.060           | 0.030  | 1.00      | 17.0–19.0 | 2.3–3.7   | 0.20–0.40 | ...             | ...                                                                                            |
| S30200                       | 302                | 0.15                        | 2.00           | 0.045           | 0.030  | 1.00      | 17.0–19.0 | 8.0–10.0  | 0.10      | ...             | ...                                                                                            |
| S30400                       | 304                | 0.08 <sup>D</sup>           | 2.00           | 0.045           | 0.030  | 1.00      | 18.0–20.0 | 8.0–10.5  | ...       | ...             | ...                                                                                            |
| S30403                       | 304L               | 0.030                       | 2.00           | 0.045           | 0.030  | 1.00      | 18.0–20.0 | 8.0–12.0  | ...       | ...             | ...                                                                                            |
| S30409                       | 304H               | 0.04–0.10                   | 2.00           | 0.045           | 0.030  | 1.00      | 18.0–20.0 | 8.0–10.5  | ...       | ...             | ...                                                                                            |
| S30451                       | 304N               | 0.08                        | 2.00           | 0.045           | 0.030  | 1.00      | 18.0–20.0 | 8.0–12.0  | 0.10–0.16 | ...             | ...                                                                                            |
| S30453                       | 304LN              | 0.030                       | 2.00           | 0.045           | 0.030  | 1.00      | 18.0–20.0 | 8.0–11.0  | 0.10–0.16 | ...             | ...                                                                                            |
| S30600                       | ...                | 0.018                       | 2.00           | 0.020           | 0.020  | 3.7–4.3   | 17.0–18.5 | 14.0–15.5 | ...       | 0.20            | Cu 0.50                                                                                        |
| S30815                       | ...                | 0.05–0.10                   | 0.80           | 0.040           | 0.030  | 1.40–2.00 | 20.0–22.0 | 10.0–12.0 | 0.14–0.20 | ...             | Ce 0.03–0.08                                                                                   |
| S30908                       | 309S               | 0.08                        | 2.00           | 0.045           | 0.030  | 1.00      | 22.0–24.0 | 12.0–15.0 | ...       | ...             | ...                                                                                            |
| S30909                       | 309H               | 0.04–0.10                   | 2.00           | 0.045           | 0.030  | 1.00      | 22.0–24.0 | 12.0–15.0 | ...       | ...             | ...                                                                                            |
| S30940                       | 309Cb              | 0.08                        | 2.00           | 0.045           | 0.030  | 1.00      | 22.0–24.0 | 12.0–16.0 | ...       | ...             | Cb 10xC- 1.10                                                                                  |
| S30880                       | ER308 <sup>E</sup> | 0.08                        | 1.00–2.50      | 0.030           | 0.030  | 0.25–0.60 | 19.5–22.0 | 9.0–11.0  | ...       | ...             | ...                                                                                            |
| S31008                       | 310S               | 0.08                        | 2.00           | 0.045           | 0.030  | 1.00      | 24.0–26.0 | 19.0–22.0 | ...       | ...             | ...                                                                                            |
| S31009                       | 310H               | 0.04–0.10                   | 2.00           | 0.045           | 0.030  | 1.00      | 24.0–26.0 | 19.0–22.0 | ...       | ...             | ...                                                                                            |
| S31010 <sup>F</sup>          | ...                | 0.030                       | 5.50–6.50      | 0.030           | 0.0010 | 0.25–0.75 | 28.5–30.5 | 14.0–16.0 | 0.80–0.90 | 1.5–2.5         | Al 0.05<br>B 0.005                                                                             |
| S31040                       | 310Cb              | 0.08                        | 2.00           | 0.045           | 0.030  | 1.00      | 24.0–26.0 | 19.0–22.0 | ...       | ...             | Cb 10xC-1.10                                                                                   |
| S31050                       | ...                | 0.025                       | 2.00           | 0.020           | 0.015  | 0.4       | 24.0–26.0 | 20.5–23.5 | 0.09–0.15 | 1.60–2.60       | ...                                                                                            |
| S31254                       | ...                | 0.020                       | 1.00           | 0.030           | 0.010  | 0.80      | 19.5–20.5 | 17.5–18.5 | 0.18–0.25 | 6.0–6.5         | Cu 0.50–1.00                                                                                   |
| S31266                       | ...                | 0.030                       | 2.00–4.00      | 0.035           | 0.020  | 1.00      | 23.0–25.0 | 21.0–24.0 | 0.35–0.60 | 5.2–6.2         | Cu 1.00–2.50<br>W 1.50–2.50                                                                    |
| S31600                       | 316                | 0.08 <sup>C</sup>           | 2.00           | 0.045           | 0.030  | 1.00      | 16.0–18.0 | 10.0–14.0 | ...       | 2.00–3.00       | ...                                                                                            |
| S31603                       | 316L               | 0.030                       | 2.00           | 0.045           | 0.030  | 1.00      | 16.0–18.0 | 10.0–14.0 | ...       | 2.00–3.00       | ...                                                                                            |
| S31609                       | 316H               | 0.04–0.10                   | 2.00           | 0.045           | 0.030  | 1.00      | 16.0–18.0 | 10.0–14.0 | ...       | 2.00–3.00       | ...                                                                                            |
| S31635                       | 316Ti              | 0.08                        | 2.00           | 0.045           | 0.030  | 1.00      | 16.0–18.0 | 10.0–14.0 | 0.10      | 2.00–3.00       | Ti 5x(C+N)- 0.70                                                                               |
| S31640                       | 316Cb              | 0.08                        | 2.00           | 0.045           | 0.030  | 1.00      | 16.0–18.0 | 10.0–14.0 | 0.10      | 2.00–3.00       | Cb 10xC- 1.10                                                                                  |
| S31651                       | 316N               | 0.08                        | 2.00           | 0.045           | 0.030  | 1.00      | 16.0–18.0 | 10.0–14.0 | 0.10–0.16 | 2.00–3.00       | ...                                                                                            |
| S31653                       | 316LN              | 0.030                       | 2.00           | 0.045           | 0.030  | 1.00      | 16.0–18.0 | 10.0–14.0 | 0.10–0.16 | 2.00–3.00       | ...                                                                                            |
| S31700                       | 317                | 0.08                        | 2.00           | 0.045           | 0.030  | 1.00      | 18.0–20.0 | 11.0–15.0 | ...       | 3.0–4.0         | ...                                                                                            |
| S31725                       | ...                | 0.030                       | 2.00           | 0.045           | 0.030  | 1.00      | 18.0–20.0 | 13.5–17.5 | 0.20      | 4.0–5.0         | ...                                                                                            |
| S31726                       | ...                | 0.030                       | 2.00           | 0.045           | 0.030  | 1.00      | 17.0–20.0 | 14.5–17.5 | 0.10–0.20 | 4.0–5.0         | ...                                                                                            |
| S31727                       | ...                | 0.030                       | 1.00           | 0.030           | 0.030  | 1.00      | 17.5–19.0 | 14.5–16.5 | 0.15–0.21 | 3.8–4.5         | Cu 2.8–4.0                                                                                     |
| S32050                       | ...                | 0.030                       | 1.50           | 0.035           | 0.020  | 1.00      | 22.0–24.0 | 20.0–23.0 | 0.21–0.32 | 6.0–6.8         | Cu 0.40                                                                                        |
| S32053                       | ...                | 0.030                       | 1.00           | 0.030           | 0.010  | 1.00      | 22.0–24.0 | 24.0–26.0 | 0.17–0.22 | 5.0–6.0         | ...                                                                                            |
| S32100                       | 321                | 0.08 <sup>D</sup>           | 2.00           | 0.045           | 0.030  | 1.00      | 17.0–19.0 | 9.0–12.0  | ...       | ...             | Ti 5x(C+N)- 0.70 <sup>G</sup>                                                                  |
| S32109                       | 321H               | 0.04–0.10                   | 2.00           | 0.045           | 0.030  | 1.00      | 17.0–19.0 | 9.0–12.0  | ...       | ...             | Ti 4x(C+N)- 0.70 <sup>G</sup>                                                                  |
| S32615                       | ...                | 0.07                        | 2.00           | 0.045           | 0.030  | 4.8–6.0   | 16.5–19.5 | 19.0–22.0 | ...       | 0.30–1.50       | Cu 1.50–2.50                                                                                   |
| S32654                       | ...                | 0.020                       | 2.0–4.0        | 0.030           | 0.005  | 0.50      | 24.0–25.0 | 21.0–23.0 | 0.45–0.55 | 7.0–8.0         | Cu 0.30–0.60                                                                                   |
| S33228                       | ...                | 0.04–0.08                   | 1.00           | 0.020           | 0.015  | 0.30      | 26.0–28.0 | 31.0–33.0 | ...       | ...             | Cb 0.60–1.00;<br>Ce 0.05–0.10;<br>Al 0.025                                                     |
| S34565                       | ...                | 0.030                       | 5.0–7.0        | 0.030           | 0.010  | 1.00      | 23.0–25.0 | 16.0–18.0 | 0.40–0.60 | 4.0–5.0         | Cb 0.10                                                                                        |
| S34700                       | 347                | 0.08 <sup>D</sup>           | 2.00           | 0.045           | 0.030  | 1.00      | 17.0–19.0 | 9.0–12.0  | ...       | ...             | Cb 10xC–1.10                                                                                   |



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TABLE 1 Continued

| UNS Designation <sup>A</sup>                                                                           | Type                                                 | Composition, % <sup>B</sup>                                           |                                                                 |                                                                      |                                                                      |                                                              |                                                                                                      |                                                                                          |                                                                                                      |                                                                                     |                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------|------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                        |                                                      | Carbon                                                                | Manganese                                                       | Phosphorus                                                           | Sulfur                                                               | Silicon                                                      | Chromium                                                                                             | Nickel                                                                                   | Nitrogen                                                                                             | Molybdenum                                                                          | Other Elements <sup>C</sup>                                                                                                                                                                         |
| S34709<br>S34800                                                                                       | 347H<br>348                                          | 0.04–0.10<br>0.08 <sup>D</sup>                                        | 2.00<br>2.00                                                    | 0.045<br>0.045                                                       | 0.030<br>0.030                                                       | 1.00<br>1.00                                                 | 17.0–19.0<br>17.0–19.0                                                                               | 9.0–12.0<br>9.0–12.0                                                                     | ...<br>...                                                                                           | ...<br>...                                                                          | Cb 8xC–1.10<br>(Cb+Ta) 10xC–1.10;<br>Ta 0.10;<br>Co 0.20                                                                                                                                            |
| S34809                                                                                                 | 348H                                                 | 0.04–0.10                                                             | 2.00                                                            | 0.045                                                                | 0.030                                                                | 1.00                                                         | 17.0–19.0                                                                                            | 9.0–12.0                                                                                 | ...                                                                                                  | ...                                                                                 | (Cb + Ta) 8xC–1.10;<br>Co 0.20;<br>Ta 0.10                                                                                                                                                          |
| S35315<br>S38815                                                                                       | ...<br>...                                           | 0.04–0.08<br>0.030                                                    | 2.00<br>2.00                                                    | 0.040<br>0.040                                                       | 0.030<br>0.020                                                       | 1.20–2.00<br>5.50–6.50                                       | 24.0–26.0<br>13.0–15.0                                                                               | 34.0–36.0<br>15.0–17.0                                                                   | 0.12–0.18<br>...                                                                                     | ...<br>0.75–1.50                                                                    | Ce 0.03–0.08<br>Al 0.30;<br>Cu 0.75–1.50                                                                                                                                                            |
| Austenitic-Ferritic Grades                                                                             |                                                      |                                                                       |                                                                 |                                                                      |                                                                      |                                                              |                                                                                                      |                                                                                          |                                                                                                      |                                                                                     |                                                                                                                                                                                                     |
| S31803<br>S32101<br>S32202<br>S32205<br>S32506<br>S32550<br>S32750 <sup>M</sup><br>S32760 <sup>H</sup> | ...<br>...<br>...<br>...<br>...<br>...<br>...<br>... | 0.030<br>0.040<br>0.030<br>0.030<br>0.030<br>0.04<br>0.030<br>0.030   | 2.00<br>4.0–6.0<br>2.00<br>2.00<br>1.00<br>1.50<br>1.20<br>1.00 | 0.030<br>0.040<br>0.040<br>0.030<br>0.040<br>0.040<br>0.035<br>0.030 | 0.020<br>0.030<br>0.010<br>0.020<br>0.015<br>0.030<br>0.020<br>0.010 | 1.00<br>1.00<br>1.00<br>1.00<br>0.90<br>1.00<br>0.80<br>1.00 | 21.0–23.0<br>21.0–22.0<br>21.5–24.0<br>22.0–23.0<br>24.0–26.0<br>24.0–27.0<br>24.0–26.0<br>24.0–26.0 | 4.5–6.5<br>1.35–1.70<br>1.00–2.80<br>4.5–6.5<br>5.5–7.2<br>4.5–6.5<br>6.0–8.0<br>6.0–8.0 | 0.08–0.20<br>0.20–0.25<br>0.18–0.26<br>0.14–0.20<br>0.08–0.20<br>0.10–0.25<br>0.24–0.32<br>0.20–0.30 | 2.5–3.5<br>0.10–0.80<br>0.45<br>3.0–3.5<br>3.0–3.5<br>2.9–3.9<br>3.0–5.0<br>3.0–4.0 | ...<br>Cu 0.10–0.80<br>...<br>...<br>W 0.05–0.30<br>Cu 1.50–2.50<br>Cu 0.50<br>Cu 0.50–1.00;<br>W 0.50–1.00<br>W 2.10–2.50<br>Cu 0.80<br>...<br>Cu 1.20–2.00<br>W 0.80–1.20<br>Cu 0.10–0.80         |
| S32808<br>S32906<br>S32950<br>S39277<br>S82441                                                         | ...<br>...<br>...<br>...<br>...                      | 0.030<br>0.030<br>0.03<br>0.025<br>0.030                              | 1.10<br>0.80–1.50<br>2.00<br>0.80<br>2.5–4.0                    | 0.030<br>0.030<br>0.035<br>0.025<br>0.035                            | 0.010<br>0.030<br>0.010<br>0.002<br>0.005                            | 0.50<br>0.50<br>0.60<br>0.80<br>0.70                         | 27.0–27.9<br>28.0–30.0<br>26.0–29.0<br>24.0–26.0<br>23.0–25.0                                        | 7.0–8.2<br>5.8–7.5<br>3.5–5.2<br>6.5–8.0<br>3.0–4.5                                      | 0.30–0.40<br>0.30–0.40<br>0.15–0.35<br>0.23–0.33<br>0.20–0.30                                        | 0.80–1.2<br>1.50–2.60<br>1.00–2.50<br>3.0–4.0<br>1.00–2.00                          | ...<br>...<br>...<br>...<br>...                                                                                                                                                                     |
| Ferritic Grades                                                                                        |                                                      |                                                                       |                                                                 |                                                                      |                                                                      |                                                              |                                                                                                      |                                                                                          |                                                                                                      |                                                                                     |                                                                                                                                                                                                     |
| S40500<br>S43000<br>S43035<br>S44400<br>S44627<br>S44700<br>S44800                                     | 405<br>430<br>439<br>444<br>XM-27<br>..<br>...       | 0.08<br>0.12<br>0.07<br>0.025<br>0.010 <sup>I</sup><br>0.010<br>0.010 | 1.00<br>1.00<br>1.00<br>1.00<br>0.40<br>0.30<br>0.30            | 0.040<br>0.040<br>0.040<br>0.040<br>0.020<br>0.025<br>0.025          | 0.030<br>0.030<br>0.030<br>0.030<br>0.020<br>0.020<br>0.020          | 1.00<br>1.00<br>1.00<br>1.00<br>0.40<br>0.20<br>0.20         | 11.5–14.5<br>16.0–18.0<br>17.0–19.0<br>17.5–19.5<br>25.0–27.5<br>28.0–30.0<br>28.0–30.0              | 0.50<br>...<br>0.50<br>1.00<br>0.50<br>0.15<br>2.00–2.50                                 | ...<br>...<br>0.04<br>0.035<br>0.015 <sup>I</sup><br>0.020<br>0.020                                  | ...<br>...<br>...<br>1.75–2.50<br>0.75–1.50<br>3.5–4.2<br>3.5–4.2                   | Al 0.10–0.30<br>...<br>Ti 0.20 + 4 x (C+N)<br>–1.10; Al 0.15<br>(Ti+Cb) 0.20 + 4 x<br>(C+N)–0.80<br>Cu 0.20;<br>Cb 0.05–0.20;<br>(Ni+Cu) 0.50<br>(C+N) 0.025;<br>Cu 0.15<br>(C+N) 0.025;<br>Cu 0.15 |
| Martensitic Grades                                                                                     |                                                      |                                                                       |                                                                 |                                                                      |                                                                      |                                                              |                                                                                                      |                                                                                          |                                                                                                      |                                                                                     |                                                                                                                                                                                                     |
| S40300<br>S41000<br>S41040<br>S41400<br>S41425<br>S41500<br>S43100                                     | 403<br>410<br>XM-30<br>414<br>...<br>J<br>431        | 0.15<br>0.15<br>0.18<br>0.15<br>0.05<br>0.05<br>0.20                  | 1.00<br>1.00<br>1.00<br>1.00<br>0.50–1.00<br>0.50–1.00<br>1.00  | 0.040<br>0.040<br>0.040<br>0.040<br>0.020<br>0.030<br>0.040          | 0.030<br>0.030<br>0.030<br>0.030<br>0.005<br>0.030<br>0.030          | 0.50<br>1.00<br>1.00<br>1.00<br>0.50<br>0.60<br>1.00         | 11.5–13.0<br>11.5–13.5<br>11.5–13.5<br>11.5–13.5<br>12.0–15.0<br>11.5–14.0<br>15.0–17.0              | ...<br>...<br>...<br>1.25–2.50<br>4.0–7.0<br>3.5–5.5<br>1.25–2.50                        | ...<br>...<br>...<br>...<br>0.06–0.12<br>...<br>...                                                  | ...<br>...<br>...<br>...<br>1.50–2.00<br>0.50–1.00<br>...                           | ...<br>...<br>Cb 0.05–0.30<br>...<br>Cu 0.30<br>...<br>...<br>...                                                                                                                                   |

<sup>A</sup> New designations established in accordance with Practice E527 and SAE J 1086 published jointly by ASTM and SAE. See ASTM DS–56C, available from ASTM Headquarters.

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

<sup>C</sup> Except as required for specific alloy type, molybdenum, titanium, nickel, cobalt, tantalum, nitrogen, and copper need not be reported but shall not be present in other than residual amounts, the intent being to prohibit substitution of one alloy type for another due to absence of control of the above named elements in certain alloys.

<sup>D</sup> See Supplementary Requirement S1.

<sup>E</sup> American Welding Society designation.

<sup>F</sup> UNS S31010 is a highly alloyed austenitic stainless steel type 3b as defined in NACE MR0175/ISO 15156-3.

<sup>G</sup> Nitrogen content is to be reported for this grade.

<sup>H</sup> % Cr + 3.3 x % Mo + 16 x % N ≥ 40.

<sup>I</sup> Product analysis tolerance over the maximum limit for carbon and nitrogen to be 0.002 %.

<sup>J</sup> Wrought version of CA6NM.

<sup>K</sup> Iron shall be determined arithmetically by difference of 100 minus the sum of specified elements.

<sup>L</sup> (Al+Ti) 0.85–1.20.

<sup>M</sup> % Cr + 3.3 x % Mo + 16 x % N ≥ 41.



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**TABLE 2 Mechanical Property Requirements**

| UNS Designation                                                                                                                                                                                        | Type                                                                                                                                                  | Condition           | Tensile Strength, min, ksi [MPa] | Yield Strength, <sup>A</sup> min, ksi [MPa] | Elongation in 2 in. [50 mm] or 4D, min, % | Reduction of Area, min, % <sup>B,C</sup> | Brinell Hardness, max |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------------------|---------------------------------------------|-------------------------------------------|------------------------------------------|-----------------------|
| Austenitic Grades                                                                                                                                                                                      |                                                                                                                                                       |                     |                                  |                                             |                                           |                                          |                       |
| N08020                                                                                                                                                                                                 | Alloy 20                                                                                                                                              | stabilized-annealed | 80 [550]                         | 35 [240]                                    | 30 <sup>D</sup>                           | 50                                       |                       |
|                                                                                                                                                                                                        | Up to 2 in. [50.8 mm], incl                                                                                                                           | strain-hardened     | 90 [620]                         | 60 [415]                                    | 15                                        | 40                                       |                       |
| N08367                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 95 [655]                         | 45 [310]                                    | 30                                        | ...                                      | 241                   |
| N08800                                                                                                                                                                                                 | 800                                                                                                                                                   | annealed            | 75 [515]                         | 30 [205]                                    | 30                                        | ...                                      | 192                   |
| N08810                                                                                                                                                                                                 | 800H                                                                                                                                                  | annealed            | 65 [450]                         | 25 [170]                                    | 30                                        | ...                                      | 192                   |
| N08811                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 65 [450]                         | 25 [170]                                    | 30                                        | ...                                      | 192                   |
| N08700                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 80 [550]                         | 35 [240]                                    | 30                                        | 50                                       | ...                   |
| N08904                                                                                                                                                                                                 | 904L                                                                                                                                                  | annealed            | 71 [490]                         | 31 [220]                                    | 35                                        | ...                                      | ...                   |
| N08925                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 87 [600]                         | 43 [295]                                    | 40                                        | ...                                      | 217                   |
| N08926                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 94 [650]                         | 43 [295]                                    | 35                                        | ...                                      | 256                   |
| S20161                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 125 [860]                        | 50 [345]                                    | 40                                        | 40                                       | 311                   |
| S20910                                                                                                                                                                                                 | XM-19                                                                                                                                                 | annealed            | 100 [690]                        | 55 [380]                                    | 35                                        | 55                                       | 293                   |
|                                                                                                                                                                                                        | Up to 2 in. [50.8 mm], incl                                                                                                                           | hot-rolled          | 135 [930]                        | 105 [725]                                   | 20                                        | 50                                       | ...                   |
|                                                                                                                                                                                                        | Over 2 to 3 in. [50.8 to 76.2 mm], incl                                                                                                               | hot-rolled          | 115 [795]                        | 75 [515]                                    | 25                                        | 50                                       | ...                   |
|                                                                                                                                                                                                        | Over 3 to 8 in. [76.2 to 203.2 mm], incl                                                                                                              | hot-rolled          | 100 [690]                        | 60 [415]                                    | 30                                        | 50                                       | ...                   |
|                                                                                                                                                                                                        | Up to 1½ in. [38.1 mm], incl                                                                                                                          | strain-hardened     | 145 [1000]                       | 125 [860]                                   | 12                                        | 40                                       | ...                   |
|                                                                                                                                                                                                        | Over 1½ to 2½ in. [38.1 to 57.2 mm], incl                                                                                                             | strain-hardened     | 120 [825]                        | 105 [725]                                   | 15                                        | 45                                       | ...                   |
| S21600, S21603                                                                                                                                                                                         | XM-17, XM-18                                                                                                                                          | annealed            | 90 [620]                         | 50 [345]                                    | 40                                        | 50                                       | 212                   |
| S21800                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 95 [655]                         | 50 [345]                                    | 35                                        | 55                                       | 241                   |
| S21904                                                                                                                                                                                                 | XM-11                                                                                                                                                 | annealed            | 90 [620]                         | 50 [345]                                    | 45                                        | 60                                       | ...                   |
| S24000                                                                                                                                                                                                 | XM-29                                                                                                                                                 | annealed            | 100 [690]                        | 55 [380]                                    | 30                                        | 50                                       | ...                   |
| S30200, S30400, S30409, S30453, S30880, S30908, S30909, S30940, S31008, S31009, S31040, S31600, S31609, S31635, S31640, S31653, S31700, S32100, S32109, S34700, S34709, S34800, S34809, S30403, S31603 | 302, 304, 304H, 304LN, ER308, <sup>E</sup> 309S, 309H, 309Cb, 310S, 310H, 310Cb, 316, 316H, 316Ti, 316Cb, 316LN, 317, 321, 321H, 347, 347H, 348, 348H | annealed            | 75 [515] <sup>F</sup>            | 30 [205]                                    | 30                                        | 40                                       | ...                   |
|                                                                                                                                                                                                        | 316, 316L                                                                                                                                             | strain-hardened     | 85 [585]                         | 65 [450] <sup>G</sup>                       | 30                                        | 60                                       | ...                   |
|                                                                                                                                                                                                        | 304, 304L                                                                                                                                             | level 1             |                                  |                                             |                                           |                                          |                       |
|                                                                                                                                                                                                        | 2 in. and under                                                                                                                                       | strain-hardened     | 95 [655]                         | 75 [515]                                    | 25                                        | 40                                       | ...                   |
|                                                                                                                                                                                                        | Over 2 to 2½ in. [50.8 to 63.5 mm], incl.                                                                                                             | strain-hardened     | 90 [620]                         | 65 [450]                                    | 30                                        | 40                                       | ...                   |
|                                                                                                                                                                                                        | Over 2½ to 3 in. [63.5 to 76.2 mm], incl                                                                                                              | strain-hardened     | 80 [550]                         | 55 [380]                                    | 30                                        | 40                                       | ...                   |
| S30403, S31603                                                                                                                                                                                         | 304L, 316L                                                                                                                                            | annealed            | 70 [485]                         | 25 [170]                                    | 30                                        | 40                                       | ...                   |
| S30451, S31651                                                                                                                                                                                         | 304N, 316N                                                                                                                                            | annealed            | 80 [550]                         | 35 [240]                                    | 30                                        | 40                                       | ...                   |
| S30600                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 78 [540]                         | 35 [240]                                    | 40                                        | ...                                      | ...                   |
| S30815                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 87 [600]                         | 45 [310]                                    | 40                                        | 50                                       | ...                   |
| S31010                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 110 [760]                        | 75 [515]                                    | 40                                        | 50                                       | 330                   |
| S31050                                                                                                                                                                                                 | 0.25 in. [6 mm] and under                                                                                                                             | annealed            | 84 [580]                         | 39 [270]                                    | 25                                        | 40                                       | ...                   |
|                                                                                                                                                                                                        | Over 0.25 in. [6 mm]                                                                                                                                  | annealed            | 78 [540]                         | 37 [255]                                    | 25                                        | 40                                       | ...                   |
| S31254                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 95 [655]                         | 44 [305]                                    | 35                                        | 50                                       | ...                   |
| S31266                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 109 [750]                        | 61 [420]                                    | 35                                        | ...                                      | ...                   |
| S31725                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 75 [515]                         | 30 [205]                                    | 40                                        | ...                                      | ...                   |
| S31726                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 80 [550]                         | 35 [240]                                    | 40                                        | ...                                      | ...                   |
| S31727                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 80 [550]                         | 36 [245]                                    | 35                                        | ...                                      | 217                   |
| S32050                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 98 [675]                         | 48 [330]                                    | 40                                        | ...                                      | ...                   |
| S32053                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 93 [640]                         | 43 [295]                                    | 40                                        | ...                                      | 217                   |
| S32615                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 80 [550]                         | 32 [220]                                    | 25                                        | 40                                       | ...                   |
| S32654                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 109 [750]                        | 62 [430]                                    | 40                                        | 40                                       | 250                   |
| S33228                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 73 [500]                         | 27 [185]                                    | 30                                        | ...                                      | ...                   |
| S34565                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 115 [795]                        | 60 [415]                                    | 35                                        | 40                                       | 230                   |
| S35315                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 94 [650]                         | 39 [270]                                    | 40                                        | ...                                      | ...                   |
| S38815                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 78 [540]                         | 37 [255]                                    | 30                                        | ...                                      | ...                   |
| Austenitic-Ferritic Grades                                                                                                                                                                             |                                                                                                                                                       |                     |                                  |                                             |                                           |                                          |                       |
| S31803                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 90 [620]                         | 65 [450]                                    | 25                                        | ...                                      | 290                   |
| S32101                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 94 [650]                         | 65 [450]                                    | 30                                        | ...                                      | 290                   |
| S32202                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 94 [650]                         | 65 [450]                                    | 30                                        | ...                                      | 290                   |
| S32205                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 95 [655]                         | 65 [450]                                    | 25                                        | ...                                      | 290                   |
| S32506                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 90 [620]                         | 65 [450]                                    | 18                                        | ...                                      | 302                   |
| S32550                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 110 [760]                        | 80 [550]                                    | 15                                        | ...                                      | 297                   |
| S32750                                                                                                                                                                                                 | 2 in. and under                                                                                                                                       | annealed            | 116 [800]                        | 80 [550]                                    | 15                                        | ...                                      | 310                   |
|                                                                                                                                                                                                        | over 2 in.                                                                                                                                            | annealed            | 110 [760]                        | 75 [515]                                    | 15                                        | ...                                      | 310                   |
| S32760                                                                                                                                                                                                 | ...                                                                                                                                                   | annealed            | 109 [750]                        | 80 [550]                                    | 25                                        | ...                                      | 310                   |

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| UNS Designation           | Type                      | Condition               | Tensile Strength, min, ksi [MPa] | Yield Strength, <sup>A</sup> min, ksi [MPa] | Elongation in 2 in. [50 mm] or 4D, min, % | Reduction of Area, min, % <sup>B,C</sup> | Brinell Hardness, max |
|---------------------------|---------------------------|-------------------------|----------------------------------|---------------------------------------------|-------------------------------------------|------------------------------------------|-----------------------|
| S32808                    |                           | annealed                | 101 [700]                        | 72 [500]                                    | 15                                        | ...                                      | 310                   |
| S32906                    | ...                       | annealed                | 109 [750]                        | 80 [550]                                    | 25                                        | ...                                      | 310                   |
| S32950                    | ...                       | annealed                | 100 [690]                        | 70 [485]                                    | 15                                        | ...                                      | 297                   |
| S39277                    | ...                       | annealed                | 118 [820]                        | 85 [585]                                    | 25                                        | 50                                       | 293                   |
| S82441                    | Under 7/16 in. [11 mm]    | annealed                | 107 [740]                        | 78 [540]                                    | 25                                        | ...                                      | 290                   |
| S82441                    | 7/16 in. and over [11 mm] | annealed                | 99 [680]                         | 70 [480]                                    | 25                                        | ...                                      | 290                   |
| <b>Ferritic Grades</b>    |                           |                         |                                  |                                             |                                           |                                          |                       |
| S40500                    | 405                       | annealed                | 60 [415]                         | 25 [170]                                    | 20                                        | 45                                       | 207                   |
| S43000, S43035            | 430, 439                  | annealed                | 70 [485]                         | 40 [275]                                    | 20 <sup>H</sup>                           | 45 <sup>H</sup>                          | 192                   |
| S44627                    | XM-27                     | annealed                | 65 [450]                         | 40 [275]                                    |                                           | 45 <sup>H</sup>                          | 217                   |
| S44401                    | ...                       | annealed                | 60 [415]                         | 45 [310]                                    | 20 <sup>I</sup>                           | 45 <sup>I</sup>                          | 217                   |
| S44700                    | ...                       | annealed                | 70 [485]                         | 55 [380]                                    | 20                                        | 40                                       | ...                   |
| S44800                    | ...                       | annealed                | 70 [485]                         | 55 [380]                                    | 20                                        | 40                                       | ...                   |
| <b>Martensitic Grades</b> |                           |                         |                                  |                                             |                                           |                                          |                       |
| S40300, S41000            | 403, 410                  | annealed                | 70 [485]                         | 40 [275]                                    | 20 <sup>I</sup>                           | 45 <sup>I</sup>                          | 223                   |
|                           |                           | 1                       | 70 [485]                         | 40 [275]                                    | 20 <sup>I</sup>                           | 45 <sup>I</sup>                          | 223                   |
|                           |                           | 2                       | 110 [760]                        | 85 [585]                                    | 15                                        | 45                                       | 269                   |
|                           |                           | 3                       | 130 [895]                        | 100 [690]                                   | 12                                        | 35                                       | 331                   |
| S41400                    | 414                       | tempered                | 115 [795]                        | 90 [620]                                    | 15                                        | 45                                       | 321                   |
| S41425                    | ...                       | tempered                | 120 [825]                        | 95 [655]                                    | 15                                        | 45                                       | 321                   |
| S41500                    | ...                       | normalized and tempered | 115 [795]                        | 90 [620]                                    | 15                                        | 45                                       | 293                   |
| S43100                    | 431 <sup>J</sup>          | annealed                | ...                              | ...                                         | ...                                       | ...                                      | 277                   |
|                           |                           | tempered                | 115 [795]                        | 90 [620]                                    | 15                                        | 45                                       | 321                   |
| S41040                    | XM-30                     | annealed                | 70 [485]                         | 40 [275]                                    | 13 <sup>H</sup>                           | 45 <sup>H</sup>                          | 235                   |
|                           |                           | quenched and tempered   | 125 [860]                        | 100 [690]                                   | 13                                        | 45                                       | 302                   |

<sup>A</sup> See Section 7.<sup>B</sup> Reduction of area does not apply on flat bars 3/16 in. [4.80 mm] and under in thickness, as this determination is not generally made in this product size.<sup>C</sup> The material shall be capable of meeting the required reduction of area where listed, but actual measurement and reporting of the reduction of area are not required unless specified in the purchase order.<sup>D</sup> Cold-finished shapes require only 15 %, minimum, elongation.<sup>E</sup> American Welding Society designation.<sup>F</sup> Tensile strength 70 ksi [485 MPa] min permitted for extruded shapes.<sup>G</sup> For bars greater than 2 in. [51 mm], a cross section, 60 ksi [415 MPa] min, shall be permitted.<sup>H</sup> Elongation in 2 in. or 50 mm of 12 % min and reduction of area of 35 % min permitted for cold-finished bars.<sup>I</sup> Elongation in 2 in. of 12 % min and reduction of area of 35 % min permitted for cold-drawn or cold-rolled bars.<sup>J</sup> Annealed bars shall be capable of meeting the tempered condition requirements when heat treated.**TABLE 3 Response To Heat Treatment**

| Type <sup>A</sup> | Heat Treatment Temperature <sup>B</sup> °F (°C), min | Quenchant | Hardness HRC, min |
|-------------------|------------------------------------------------------|-----------|-------------------|
| 403               | 1750 [955]                                           | Air       | 35                |
| 410               | 1750 [955]                                           | Air       | 35                |
| 414               | 1750 [955]                                           | Oil       | 42                |

<sup>A</sup> Samples for testing shall be in the form of a section not exceeding 3/8 in. [9.50 mm] in thickness.<sup>B</sup> Temperature tolerance is ±25°F [15°C].



## SUPPLEMENTARY REQUIREMENTS

The following may be made requirements when the purchaser specifies them to be applicable.

**S1. Materials for High-Temperature Service**

S1.1 Unless an H grade has been ordered, this supplementary requirement shall be specified for ASME Code applications for service above 1000°F [540°C].

S1.2 The user is permitted to use an austenitic stainless steel as the corresponding H grade when the material meets all requirements of the H grade including chemistry, annealing temperature, and grain size (see Section 6).

S1.3 The user is permitted to use an L grade austenitic stainless steel for service above 1000°F [540°C], subject to the applicable allowable stress table of the ASME Code, when the material meets all requirements of this specification and the grain size is ASTM No. 7 or coarser as determined in accordance with Test Methods E112. The grain size shall be reported on a Certified Test Report.

**S2. Corrosion Tests**

S2.1 Intergranular corrosion tests shall be performed by the manufacturer on sensitized specimens of Types 304L, 316L, 321, 347, and 348, and for the other austenitic grades, on specimens representative of the as-shipped condition. All austenitic stainless steels shall be capable of passing intergranular corrosion tests in the as-shipped condition. Tests shall be performed in accordance with Practice E of Practices A262.

**S3. Product Analysis**

S3.1 An analysis shall be made by the manufacturer on a sample from one bar in each lot as defined in Specification A484/A484M. The analysis shall meet the requirements of Table 1. In the event of failure, the lot represented shall be

rejected except that, at the option of the manufacturer, each bar in the lot may be tested for acceptance. Product analysis tolerance provisions do not apply.

**S4. Material for High Cycle Fatigue Service**

S4.1 The mechanical properties of bars furnished in lengths under 20 ft [6 m] shall be determined by testing one end of each bar. Bars furnished in lengths of 20 ft [6 m] and over shall be tested at each end.

**S5. Material for Optimum Resistance to Stress Corrosion Cracking**

S5.1 This supplementary requirement is to be referenced when austenitic stainless steels are to be purchased with solution-annealing as the final operation and with no subsequent cold drawing permitted. Straightening is permitted as a final operation to meet the straightness requirements of Specification A484/A484M unless specifically prohibited by the purchaser.

**S6. Demonstration of the Absence of Detrimental Intermetallic Phase in Austenitic and Austenitic-Ferritic (Duplex) Grades**

S6.1 This supplementary requirement is to be referenced when the austenitic or duplex stainless steels are to be purchased with testing to demonstrate the absence of detrimental intermetallic phases that can have negative effects on mechanical properties or corrosion resistance of the material. The test method(s), reporting requirements, and acceptance criteria shall be agreed upon by the manufacturer and purchaser in the purchase agreement.

## APPENDIX

## (Nonmandatory Information)

**X1. RATIONALE REGARDING DEFINITION OF SOLUTION ANNEALING**

X1.1 It is generally recognized that austenitic stainless steels are solution annealed by heating to a temperature that dissolves (takes into solution) chromium carbides and quenching rapidly so that the chromium carbides will not precipitate in the grain boundaries, which could cause susceptibility to intergranular corrosion in a critically corrosive environment. Thus, solution annealing also can be accomplished for non-stabilized grades by taking advantage of hot rolling temperatures (which always exceed solution annealing temperature requirements), maintaining hot rolling finishing temperatures well above minimum solution annealing requirements, and immediately quenching integral with hot rolling. Stabilized grades (with columbium or titanium added) cannot be handled this way, since they would become destabilized due to colum-

bium or titanium carbide solution, without subsequent reheating.

X1.2 For Boiler Code applications involving temperatures at which optimum resistance to creep is desired, the larger grain size of material solution annealed by reheating is generally desired. For that reason, a minimum grain size has been required of the H grades (created for optimum elevated temperature properties), and a mandatory grain size test and report has been added for the non-H grades so that the information is available for those desiring to reclassify a non-H grade to H grade.

X1.3 To satisfy the concerns of inadvertent assignment of fine grained material to elevated temperature applications,

special marking has been added for material that meets the requirements of Supplementary Requirement S1.

as has been done in the past for material solution annealed by reheating.

X1.4 A mandatory test for susceptibility to intergranular corrosion has been added for material solution annealed by the alternative method so that a history of data can be accumulated,

## SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A479/A479M – 16a) that may impact the use of this standard. (Approved March 15, 2017.)

(1) Added UNS S31010 alloy to Tables 1 and 2.

Committee A01 has identified the location of selected changes to this standard since the last issue (A479/A479M – 16) that may impact the use of this standard. (Approved May 1, 2016.)

(1) Increased the maximum hardness for UNS S32760 in Table 2 to 310 HBW

Committee A01 has identified the location of selected changes to this standard since the last issue (A479/A479M – 14) that may impact the use of this standard. (Approved Jan. 1, 2016.)

(1) Revised Table 1 to include a minimum % Cr +  $3.3 \times \% \text{ Mo}$  +  $16 \times \% \text{ N}$  value for Grade S32750 by adding footnote L.

Committee A01 has identified the location of selected changes to this standard since the last issue (A479/A479M – 14) that may impact the use of this standard. (Approved July 15, 2015.)

(1) Added Alloy S31266 to Tables 1 and 2.

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