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Designation: A336/A336M-09 Designation: A336/A336M - 10

Standard Specification for Alloy Steel Forgings for Pressure and High-Temperature Parts¹

This standard is issued under the fixed designation A336/A336M; 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 Department of Defense.

1. Scope*

1.1 This specification² covers ferritic steel forgings for boilers, pressure vessels, high-temperature parts, and associated equipment.

1.2 Forgings made of steel grades listed in Specification A335/A335M, may also be ordered under this specification. The chemical, tensile, heat treatment, and marking requirements of Specification A335/A335M shall apply, except the forging shall conform to the chemical requirements of Tables 1 and 2 of Specification A335/A335M only with respect to heat analysis. On product analysis they may deviate from these limits to the extent permitted in Table 1 of this specification.

1.3 Supplementary Requirements S1 to S9 are provided for use when additional testing or inspection is desired. These shall apply only when specified individually by the purchaser in the order.

1.4 Unless the order specifies the applicable "M" specification designation, the material shall be furnished to the inch-pound units.

1.5 Specification A336/A336M formerly included austenitic steel forgings, which are now found in Specification A965/A965M.

1.6 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.

2. Referenced Documents

2.1 ASTM Standards:³

A275/A275M Practice for Magnetic Particle Examination of Steel Forgings

A335/A335M Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A788/A788M Specification for Steel Forgings, General Requirements

A965/A965M Specification for Steel Forgings, Austenitic, for Pressure and High Temperature Parts m-a336-a336m-10

E165 Practice for Liquid Penetrant Examination for General Industry

2.2 Other Standard:

ASME Boiler and Pressure Vessel Code Section III, Nuclear Facility Components and Section IX, Welding Qualifications⁴

3. Ordering Information and General Requirements

3.1 In addition to the ordering information required by Specification A788/A788M, the purchaser should include with the inquiry and order the following information:

3.1.1 A drawing or sketch that shows test locations when the testing is in accordance with 8.1.1.3.

3.1.2 The intended use of forgings if 5.1 is applicable.

3.2 Material supplied to this specification shall conform to the requirements of Specification A788/A788M, which outlines additional ordering information, manufacturing requirements, testing and retesting methods and procedures, marking, certification,

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

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¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.06 on Steel Forgings and Billets.

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² For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-336/SA-336M in Section II of that Code.

³ 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.

⁴ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

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| | | | F22V | F22V | 85- 760] 760] 760] 760] 760] | 60 [415] 60 [415] | 18 | 8 | 45 |
| | | Clade A | F3VCb | F3VCb | 85- 110 760] 760] 760] 760] | 60 [415] [415] | 18 | 18 | 45 |
| | | | F3V | F3V | 85- 110 760] 85- 760] 85- 110 [585- 760] | 60 [415] 60 [415] | 1 8 | 18 | 45 |
| | | | | F92 | 830] 830] 830] | <u>64</u> [440] | | 20 | 45 |
| | | | F911 | F911 | 830 <u>-</u> 120-9-9-9-9-9-9- | 64 [440] [440] [440] | 50 | 20 | 40 |
| | | | F91 | F91 | 760 760 760 760 760 760 760 760 760 760 | 60 <u>60</u> [415] | 50 | 20 | 40 |
| | | | F22, Class 1 | <u>F22,</u> Class 1 | 60- 585 60- 585 60- 585 7415- 585 585 | 30 [205] [205] | 59 | 50 | 45 |
| | | | F22, Class 3 | <u>F22,</u> Class <u>3</u> | 75- 100 [515- [515- [515- [515- [515- [515- [510]] | 45 [310] [310] | 61 | 19 | 40 |
| | | | F21, Class 1 | <u>F21,</u> Class 1 | 60 85 585 585 585 585 585 585 585 585 585 | 30 30 205] | 50 | 50 | 45 |
| | Ferritic Steels | | F2 1, Class 3 | F21, Class 3 | 75- 515- 515- 515- 515- 515- 515- 590 | 45 [310] [310] | 10 | 19 | 40 |
| nhau and | Ferriti | | Fenm | F6NM | 965 <u>1</u> 146 115- 265 <u>1</u> 140 265 <u>1</u> 140 265 <u>1</u> | 80 [620] [620] | ţ. | 15 | 45 |
| | | | E6 | <u>F6</u> | 85- 110 760] 855- 110 760] 760] | 55 [380] [380] | 18 | 18 | 35 |
| | ام/4 | | SæV | 6 <u>6</u> | 85- 110 760] 760] 760] 760] 760] | 55 55 380] | 6 773 | <mark>2</mark> | 40 |
| | 107 | | F5A | F5A | 80- 105- 105- 105- 105- 105- 105- 105- 10 | 50 345 345 | 6 | 6 윤 | ی جو ع |
| | | | F5 | E5 | 69 585 585 585 585 585 585 585 585 | 36 [250] 36 [250] | 50 | 20 | 40 |
| | | | F12 | F12 | 74 485 100 100 100 100 100 100 100 10 | 4 0 [275] [275] | 50 | 20 | 40 |
| | | | F11, Class 1 | <u>E11,</u> Class 1 | 60- 585 60- 585 60- 585 585 585 585 | 30 30 205] | 50 | 50 | 45 |
| | | | F11, Class 3 | <u>F11,</u> <u>Class 3</u> | 75- 100 (515- (515- (515- [515- [515- [515- (500] | 45 [310] 310] [310] | 1 8 | <u>18</u> | 40 |
| | | | F11, Class 2 | <u>F11,</u> <u>Class 2</u> | 70- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485- 1485 | 40 [275] 40 [275] | 50 | 20 | 40 |
| | | | 뵤 | 티 | 70 660 95 660 95 660 660 660 660 | 40 [275] 40 [275] | 50 | 20 | 40 |
| | | | | | Tensile strength- ksi [MPA] Tensile strength, ksi [MPA] | Yield strength, min, ksi [MPa] Yield strength, min, ksi [MPa] | Elongation in 2 in. or 50 mm, min, % | Elongation in 2 in. or 50 mm, min, <u>%</u> | Reduction of area, min, % |

A336/A336M - 10

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A336/A336M - 10

product analysis variations, and additional supplementary requirements.

3.3 If the requirements of this specification are in conflict with the requirements of Specification A788/A788M, the requirements of this specification shall prevail.

3.4 For hubbed flanges and tube sheets ordered for ASME Boiler and Pressure Vessel Code application, Supplementary Requirement S12 of Specification A788/A788M shall be specified.

3.5 At the purchaser's request the forgings shall be rough machined before heat treatment (5.2).

3.6 For Section III, Part NB of the ASME Boiler and Pressure Vessel Code application, Supplementary Requirement S3 shall be specified.

4. Melting and Forging

4.1 In addition to the melting and forging requirements of Specification A788/A788M, which may be supplemented by Supplementary Requirement S8, the following conditions apply:

4.1.1 A sufficient discard shall be made to secure freedom from injurious pipe and undue segregation.

5. Machining

5.1 Forged pressure vessels for steam power service shall have the inner surface machined or ground. Unfired pressure vessels shall have the inner surfaces sufficiently free of scale to permit inspection.

5.2 Unless otherwise specified by the purchaser, when rough machining is performed, it may be done either before or after heat treatment at the manufacturer's option.

6. Heat Treatment

6.1Except as permitted in

Grade

<u>6.1 Except as permitted in 6.1.1 for Grade F22V, and in 6.1.2 for Grade F91 and Grade F92, the steel forgings shall be annealed or normalized and tempered but alternatively may be liquid quenched and tempered when mutually agreed upon between the manufacturer and the purchaser. For all grades, normalizing or liquid quenching shall be followed by tempering at a subcritical temperature as shown in 6.1.4.</u>

6.1.1 Grade F22V forgings shall be normalized and tempered or liquid quenched and tempered at the manufacturer's option. 6.1.1.1For Grade F22V forgings the minimum austenizing temperature shall be 1650°F [900°C].

6.1.2For Grade F91 and F911 forgings the austenitizing temperature shall be in the range of 1900 to 1975°F [1040 to 1080°C]. 6.1.1.1 For Grade F22V forgings the minimum austenitizing temperature shall be 1650°F [900°C].

<u>6.1.2 Grade F91 forgings having any section thickness greater than 3 in. [75 mm] shall be normalized and tempered or liquid quenched and tempered at the manufacturer's option. Grade F92 forgings shall be normalized and tempered or liquid quenched and tempered at the manufacturer's option.</u>

6.1.2.1 For Grade F91, F911, and F92 forgings, the austenitizing temperature shall be in the range of 1900 to 1975°F [1040 to 1080°C].

6.1.3 For Grade F6NM the austenitizing temperature shall be 1850°F [1010°C] minimum. The tempering temperature range shall be as shown in 6.1.4.

Tempering Temperature

6.1.4 Except for the following grades, the minimum tempering temperature shall be 1100°F [595°C]:

| | Minimum or Range, °F [°C] |
|-----------------|--------------------------------|
| F6 | 1150 [620] |
| F6NM | 1040-1120 [560-600] |
| F11, Class 2 | 1150 [620] |
| F11, Class 3 | 1150 [620] |
| F11, Class 1 | 1150 [620] |
| F5 | 1250 [675] |
| F9 | 1250 [675] |
| F21, Class 1 | 1250 [675] |
| F3V, F3VCb | 1250 [675] |
| F22, Class 1 | 1250 [675] |
| F22V | 1250 [675] |
| F91 | 1350-1470 [730-800] |
| <u>F91, F92</u> | <u>1350-1470 [730-800]</u> |
| F911 | 1365-1435 [740-780] |
| F22, Class 3 | 1250 [675] |
| | |

7. Chemical Composition

7.1 *Heat Analysis*—The heat analysis obtained from sampling in accordance with Specification A788/A788M and shall comply with Table 2.

7.2 *Product Analysis*—The manufacturer shall use the product analysis provision of Specification A788/A788M to obtain a product analysis from a forging representing each heat or multiple heat. The product analysis for columbium and calcium for Grade F22V shall conform to the requirements of Table 2 of this specification. Boron is not subject to product analysis. The purchaser may also make this determination in accordance with Specification A788/A788M.

A336/A336M - 10

TABLE 2 Chemical Requirements^A

| | | | | Compos | sition, % | | | | |
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| | | | | Gra | ade | | | | |
| Element | F1 | F11, Classes 2 and 3 | F11, Class 1 | F12 | F5 ^{<i>AB</i>} | F5A [≁] ≞ | F9 | F6 | F6NM |
| Carbon | 0.20-0.30 | 0.10-0.20 | 0.05-0.15 | 0.10-0.20 | 0.15 max | 0.25 max | 0.15 max | 0.12 max | 0.05 max |
| langanese | 0.60-0.80 | 0.30-0.80 | 0.30-0.60 | 0.30-0.80 | 0.30-0.60 | 0.60 max | 0.30-0.60 | 1.00 max | 0.50-1.00 |
| hosphorus, | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.020 |
| nax | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.015 |
| Sulfur, max Silicon | 0.025 0.20–0.35 | 0.025 0.50–1.00 | 0.025 0.50–1.00 | 0.025 0.10–0.60 | 0.025 0.50 max | 0.025 0.50 max | 0.025 0.50–1.00 | 0.025 1.00 max | 0.015 0.60 max |
| lickel | 0.20-0.33 | 0.50-1.00 | 0.50-1.00 | 0.10-0.00 | 0.50 max | 0.50 max | 0.50-1.00 | 0.50 max | 3.5–5.5 |
| Chromium | | 1.00-1.50 | 1.00–1.50 | 0.80–1.10 | 4.0-6.0 | 4.0-6.0 | 8.0–10.0 | 11.5–13.5 | 11.5–14 |
| lolybdenum | 0.40-0.60 | 0.45-0.65 | 0.44-0.65 | 0.45-0.65 | 0.45-0.65 | 0.45-0.65 | 0.90-1.10 | | 0.50-1.00 |
| | | | | Gr | ade | | | | |
| lement | F21, Classes | F22, Classes | | | | | | | |
| | 1 and 3 | 1 and 3 | | | | | | | |
| Carbon | 0.05-0.15 | 0.05-0.15 | | | | | | | |
| langanese | 0.30-0.60 | 0.30-0.60 | | | | | | | |
| hosphorus, | 0.025 | 0.025 | | | | | | | |
| nax Sulfur, max | 0.025 | 0.025 | | | | | | | |
| Silicon | 0.50 max | 0.50 max | | | | | | | |
| lickel | | | | | | | | | |
| Chromium | 2.7–3.3 | 2.00-2.50 | | | | | | | |
| lolybdenum | 0.80-1.06 | 0.90-1.10 | | | | | | | |
| anadium | | | | | | | | | |
| Copper litrogen | | | | | | | | | |
| Columbium | | | | | | | | | |
| lement | Grade F91 | Grade F911 | | 501 | 501(0) | 5001/ | | | |
| | | | | | - EXV(:p | E DOV | | | |
| Element | Grade F91 | Grade F911 | Grade F92 | S F3V | F3VCb F3VCb | F22V F22V | | | |
| Carbon | <u>Grade F91</u> 0.08-0.12 | <u>Grade F911</u> 0.09-0.13 | Doo | <u>F3V</u> 0.10-0.15 | <u>F3VCb</u> 0.10-0.15 | <u>F22V</u> 0.11-0.15 | | | |
| Carbon Carbon | <u>Grade F91</u> 0.08-0.12 0.08-0.12 | <u>Grade F911</u> 0.09-0.13 0.09-0.13 | 0.07-0.13 | <u>F3V</u> 0.10-0.15 0.10-0.15 | <u>F3VCb</u> 0.10-0.15 0.10-0.15 | F22V | | | |
| Carbon Carbon Manganese | <u>Grade F91</u> 0.08-0.12 0.08-0.12 0.30-0.60 | <u>Grade F911</u> 0.09-0.13 0.09-0.13 0.30-0.60 | 0.07–0.13 0.30–0.60 | F3V 0.10-0.15 0.10-0.15 0.30-0.60 | F3VCb 0.10-0.15 0.10-0.15 0.30-0.60 | F22V 0.11-0.15 0.11-0.15 | | | |
| Carbon Carbon Manganese Manganese | <u>Grade F91</u> 0.08-0.12 0.08-0.12 | <u>Grade F911</u> 0.09-0.13 0.09-0.13 | 0.07-0.13 | <u>F3V</u> 0.10-0.15 0.10-0.15 | F3VCb 0.10-0.15 0.10-0.15 0.30-0.60 0.30-0.60 | <u>F22V</u> 0.11-0.15 | | | |
| Carbon Carbon Manganese Manganese Phosphorus, nax | <u>Grade F91</u> 0.08-0.12 0.08-0.12 0.30-0.60 0.30-0.60 0.025 | Grade F911 0.09-0.13 0.09-0.13 0.30-0.60 0.30-0.60 0.020 | 0.07–0.13 0.30–0.60 0.30–0.60 | <u>F3V</u> 0.10-0.15 0.30-0.60 0.30-0.60 0.020 | <u>F3VCb</u> 0.10-0.15 0.30-0.60 0.30-0.60 0.020 | <u>F22V</u> 0.11-0.15 0.11-0.15 0.30-0.60 | | | |
| Carbon Carbon Manganese Manganese Mosphorus, nax Sulfur, max | Grade F91 0.08-0.12 0.30-0.60 0.30-0.60 0.025 0.025 | Grade F911 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.010 | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 | <u>F3V</u> 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.020 | <u>F3VCb</u> 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.020 | <u>F22V</u> 0.11-0.15 0.11-0.15 0.30-0.60 0.015 0.010 | | | |
| Carbon Carbon Aanganese Aanganese Phosphorus, nax Culfur, max Sulfur, max | Grade F91 0.08-0.12 0.30-0.60 0.30-0.60 0.025 0.025 0.025 0.025 | <u>Grade F911</u> <u>0.09-0.13</u> <u>0.30-0.60</u> <u>0.30-0.60</u> <u>0.30-0.60</u> <u>0.020</u> <u>0.010</u> <u>0.010</u> <u>0.010</u> <u>0.010</u> <u>0.010</u> | 0.07–0.13 0.30–0.60 0.30–0.60 | F3V 0.10-0.15 0.30-0.60 0.020 | F3VCb 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.020 | <u>F22V</u> 0.11-0.15 0.10-0.60 0.015 0.010 | | | |
| Carbon Sarbon Hanganese Manganese Phosphorus, hosphorus, hax Sulfur, max Sulfur, max Sulfur, max | $\begin{array}{c} \underline{\text{Grade F91}}\\ \hline 0.08-0.12\\ \hline 0.08-0.12\\ \hline 0.30-0.60\\ \hline 0.025\\ \hline 0.025\\ \hline 0.025\\ \hline 0.025\\ \hline 0.20-0.59\\ \hline \end{array}$ | Grade F911 0.09-0.13 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.020 0.010 0.10-0.50 | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 | <u>F3V</u> 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.020 0.020 0.10 max | F3VCb 0.10-0.15 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.020 0.010 0.10 max | <u>F22V</u> 0.11-0.15 0.11-0.15 0.30-0.60 0.015 0.010 0.010 0.10 max | | | |
| Carbon Carbon Aanganese Aanganese Phosphorus, nax Phosphorus, nax Ulfur, max Vilfur, max Vilfur, max Vilfur, max | Grade F91 0.08-0.12 0.30-0.60 0.30-0.60 0.025 0.025 0.025 0.025 | <u>Grade F911</u> <u>0.09-0.13</u> <u>0.30-0.60</u> <u>0.30-0.60</u> <u>0.30-0.60</u> <u>0.020</u> <u>0.010</u> <u>0.010</u> <u>0.010</u> <u>0.010</u> <u>0.010</u> | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 | F3V 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.020 0.020 0.10 max 0.10 max | F3VCb 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.020 | <u>F22V</u> 0.11-0.15 0.10-0.60 0.015 0.010 | | | |
| Carbon Aanganese Aanganese Chosphorus, nax Sulfur, max Sulfur, max Sulfur, max Sulfur, max Sulfur, max Sulfur, max | Grade F91 0.08-0.12 0.08-0.12 0.30-0.60 0.025 0.025 0.025 0.025 0.225 0.225 0.225 0.225 0.20-0.50 | <u>Grade F911</u> 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.010 0.010 0.10-0.50 0.40 max 0.40 max | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 | <u>F3V</u> 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.020 0.020 0.10 max | F3VCb 0.10-0.15 0.10-0.15 0.30-0.60 0.30-0.60 0.020 | 0.11-0.15 0.11-0.15 0.30-0.60 0.015 0.010 0.010 0.010 0.10 max 0.25 max 0.25 max | | | |
| earbon Aanganese Aanganese Aanganese hosphorus, nax wifur, max wifur, max wifur, max wifuen ilicon ilicon lickel chromium | Grade F91 0.08-0.12 0.08-0.12 0.30-0.60 0.30-0.60 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.0 | Grade F911 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.010 0.10-0.50 0.40 max 0.40 max 8.5-9.5 | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 0.020 0.50 0.40 | F3V 0.10-0.15 0.30-0.60 0.020 0.020 0.10 max 0.10 max 0.10 max 2.7 3.3 | E3VCb 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.010 0.10 max 0.10 max 0.10 max 0.25 max 0.25 max 2.7-3.3 | <u>F22V</u> 0.11-0.15 0.10-0.60 0.015 0.010 0.010 0.10 max 0.25 max 2.00-2.50 | | | |
| arbon langanese hosphorus, iax ulfur, max ulfur, max ulfur, max ilicon iickel hromium thromium | Grade F91 0.08-0.12 0.30-0.60 0.30-0.60 0.025 0.025 0.20-0.50 0.20-0.50 0.40 max 8.0-9.5 8.0-9.5 | Grade F911 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.010 0.10-0.50 0.10-0.50 0.40 max 8.5-9.5 8.5-9.5 | 0.07-0.13 0.30 0.60 0.30-0.60 0.020 0.020 | F3V 0.10-0.15 0.30-0.60 0.020 0.020 0.10 max 0.10 max 0.10 max 0.10 max 2.7-3.3 2.7-3.3 | E3VCb 0.10-0.15 0.30-0.60 0.30-0.60 0.30-0.60 0.020 0.020 0.010 0.10 max 0.25 max 0.25 max 2.7-3.3 2.7-3.3 | F22V 0.11-0.15 0.10 0.010 0.010 0.10 max 0.10 max 0.25 max 2.00-2.50 2.00-2.50 | | | |
| Carbon Aanganese Manganese hosphorus, nax culfur, max illicon lickel hromium chromium delybdenum | Grade F91 0.08-0.12 0.30-0.60 0.30-0.60 0.025 0.225 0.20-0.50 0.20-0.50 0.20-0.50 0.40 max 8.0-9.5 0.85-1.05 | Grade F911 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.010 0.10-0.50 0.10-0.50 0.40 max 0.40 max 8.5-9.5 0.90-1.10 | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 0.020 0.50 0.40 8.50-9.50 | F3V 0.10-0.15 0.30-0.60 0.020 0.020 0.10 max 0.10 max 0.10 max 0.7-3.3 2.7-3.3 0.90-1.10 | F3VCb 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.020 0.010 0.10 max 0.25 max 2.7 - 3.3 2.7 - 3.3 0.90 - 1.10 | F22V 0.11-0.15 0.10 0.010 0.010 0.10 max 0.10 max 0.25 max 2.00-2.50 2.00-2.50 0.90-1.10 | | | |
| Carbon Carbon langanese langanese langanese losphorus, nax sulfur, max sulfur, max lilicon lickel lickel lickel lickel hromium horputum loybdenum loybdenum | Grade F91 0.08-0.12 0.30-0.60 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.05 | Grade F911 0.09-0.13 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.010 0.10-0.50 0.10-0.50 0.10-0.50 0.40 max 8.5-9.5 8.5-9.5 0.90-1.10 0.90-1.10 | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 0.020 | F3V 0.10-0.15 0.30-0.60 0.020 0.020 0.10 max 0.10 max 0.10 max 0.10 max 2.7-3.3 2.7-3.3 | E3VCb 0.10-0.15 0.30-0.60 0.30-0.60 0.30-0.60 0.020 0.020 0.010 0.10 max 0.25 max 0.25 max 2.7-3.3 2.7-3.3 | F22V 0.11-0.15 0.10 0.010 0.010 0.10 max 0.10 max 0.25 max 2.00-2.50 2.00-2.50 | | | |
| arbon Aanganese Aanganese Ianganese Ianganese Inosphorus, max Iulfur, max Iulfur, max Iulf | Grade F91 0.08-0.12 0.08-0.12 0.30-0.60 0.025 0.025 0.025 0.20-0.50 0.20-0.50 0.20-0.50 0.20-0.50 0.20-0.50 0.40 max 8.0-9.5 8.0-9.5 0.85-1.05 0.85-1.05 0.18-0.25 0.18-0.25 | Grade F911 0.09-0.13 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.010 0.010 0.10-0.50 0.40 max 8.5-9.5 8.5-9.5 8.5-9.5 0.90-1.10 0.90-1.10 0.90-1.10 0.18-0.25 0.18-0.25 | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 0.020 0.50 0.40 8.50-9.50 | F3V 0.10-0.15 0.30-0.60 0.30-0.60 0.30-0.60 0.020 0.020 0.020 0.10 max | F3VCb 0.10-0.15 0.10-0.15 0.30-0.60 0.020 0.010 0.10 max 0.25 max 2.7-3.3 0.90-1.10 0.20-0.30 | F22V 0.11-0.15 0.11-0.15 0.30-0.60 0.015 0.010 0.010 0.10 max 0.25 max 2.00-2.50 0.90-1.10 0.90-1.10 0.25-0.35 | | | |
| Carbon Aanganese Aanganese Aanganese hosphorus, nax Sulfur, max Sulfur, max Su | Grade F91 0.08-0.12 0.08-0.12 0.30-0.60 0.30-0.60 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.050 0.050 0.050 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.105 0.18 0.025 0.18 0.025 0.18 0.025 0.18 0.025 0.18 0.025 0.18 0.025 0.18 0.025 0.18 0.025 0.18 0.025 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.18 0.055 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 | | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 0.020 0.50 0.40 8.50-9.50 0.30-0.60 0.15-0.25 | F3V 0.10-0.15 0.30-0.60 0.30-0.60 0.30-0.60 0.020 0.10 max 0.20-3.3 0.90-1.10 0.20-0.30 | F3VCb 0.10-0.15 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.010 0.10 max 0.25 max 2.7-3.3 2.7-3.3 0.90-1.10 0.90-1.10 0.20-0.30 0.015-0.070 | F22V 0.11-0.15 0.11-0.15 0.30-0.60 0.015 0.010 0.010 0.10 max 0.25 max 2.00-2.50 0.90-1.10 0.925-0.35 0.25-0.35 0.05-0.35 0.07-max | | | |
| Carbon langanese langanese hosphorus, hax sulfur, max sulfur, ma | Grade F91 0.08-0.12 0.08-0.12 0.30-0.60 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.18 0.25 0.18 0.25 0.18 0.25 0.18 0.25 0.06 0.10 0.06 0.10 | Grade F911 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.010 0.10-0.50 0.10-0.50 0.40 max 8.5-9.5 0.90-1.10 0.90-1.10 0.18-0.25 0.06-0.10 0.06-0.10 | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 0.020 0.50 0.40 8.50-9.50 0.30-0.60 | F3V 0.10-0.15 0.30-0.60 0.020 0.10-0.15 0.30-0.60 0.020 0.10 max 0.10 0.20 0.10 0.20 0.10 0.20 0.10 0.20 0.10 0.20 | F3VCb 0.10-0.15 0.30-0.60 0.020 0.010 0.10 max 0.25 max 2.7-3.3 2.7-3.3 0.90-1.10 0.90-1.10 0.90-1.10 0.20-0.30 0.015-0.070 | F22V 0.11-0.15 0.11-0.15 0.30-0.60 0.015 0.010 0.010 0.10 max 0.25 max 2.00-2.50 0.90-1.10 0.90-1.10 0.92-0.35 0.25-0.35 0.07 max | | | |
| Sarbon Aanganese Aanganese Yhosphorus, aax Sulfur, max Sulfur, max | Grade F91 0.08-0.12 0.30-0.60 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.05 0.05 0.05 0.05 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.06 0.10 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 | Grade F911 0.09-0.13 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.010 0.10-0.50 0.10-0.50 0.40 max 0.40 max 0.40 max 8.5-9.5 0.90-1.10 0.90-1.10 0.18-0.25 0.18-0.25 0.06-0.10 0.06-0.10 0.04-0.09 | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 0.020 0.50 0.40 8.50-9.50 0.30-0.60 0.15-0.25 | F3V 0.10-0.15 0.30-0.60 0.020 0.10-0.15 0.30-0.60 0.020 0.10 max 0.10 0.20 0.10 0.20 0.10 0.20 0.10 0.20 0.10 0.20 | F3VCb 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.020 0.010 0.10 max 0.25 max 0.25 max 0.25 max 2.7-3.3 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-1.00 0.90-0.00 0.90-1.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 0.90-0.00 | F22V 0.11-0.15 0.11-0.15 0.30-0.60 0.015 0.010 0.010 0.10 max 0.25 max 2.00-2.50 0.90-1.10 0.90-1.10 0.90-1.10 0.92-0.35 0.07 max | | | |
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| Carbon Aanganese Aanganese Aanganese Phosphorus, nax Sulfur, max Sulfur, max S | Grade F91 0.08-0.12 0.00-0.60 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.026 0.025 0.025 0.08 0.025 0.08 0.025 0.08 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0. | Grade F911 0.09-0.13 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.010 0.010 0.10-0.50 0.40 max 0.40 max 8.5-9.5 8.5-9.5 0.90-1.10 0.90-1.10 0.18-0.25 0.06-0.10 0.06-0.10 0.04-0.09 0.02 max ^B 0.02 max ^C | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 0.50 0.40 8.50-9.50 0.30-0.60 0.15-0.25 0.04-0.09 | F3V 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.10 max 0.10 max 0.7-3.3 0.90-1.10 0.90-1.10 0.20-0.30 0.10-0.10 0.20-0.30 | F3VCb 0.10-0.15 0.10-0.15 0.30-0.60 0.020 0.10 max 0.10 max 0.25 max 2.7-3.3 2.7-3.3 2.7-3.3 0.90-1.10 0.90-1.10 0.20-0.30 0.015-0.070 | F22V 0.11-0.15 0.11-0.15 0.30-0.60 0.015 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.25 max 0.00-2.50 0.00-2.50 0.00-2.50 0.00-1.10 0.25-0.35 0.07 max | | | |
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| Sarbon Aanganese Aanganese Aanganese Phosphorus, nax Sulfur, max Sulfur, max S | Grade F91 0.08-0.12 0.08-0.12 0.30-0.60 0.30-0.60 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.040 max 8.0-9.5 0.85-1.05 0.85-1.05 0.85-1.05 0.85-1.05 0.18-0.25 0.06-0.10 0.03-0.07 0.02-max ^B 0.02 max ^C | Grade F911 0.09-0.13 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.010 0.10-0.50 0.10-0.50 0.40 max 0.40 max 8.5-9.5 0.90-1.10 0.18-0.25 0.06-0.10 0.06-0.10 0.06-0.10 0.04-0.09 0.02 max ⁶ 0.002 max ⁶ 0.0003-0.006 0.0003-0.006 | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 0.020 0.50 0.40 8.50-9.50 0.30-0.60 0.15-0.25 0.04-0.09 0.030-0.070 | F3V 0.10-0.15 0.30-0.60 0.020 0.10-0.15 0.30-0.60 0.020 0.10 max 0.20-0.30 0.001-0.003 0.001-0.003 | F3VCb 0.10-0.15 0.10-0.15 0.30-0.60 0.020 0.010 0.10 max 0.25 max 2.7-3.3 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-1.10 0.90-0.30 0.015-0.070 | F22V 0.11-0.15 0.11-0.15 0.30-0.60 0.015 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.025 max 0.000 0.000 0.000 0.000 0.0020 max 0.0020 max | | | |
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| Carbon Aanganese Aanganese Aanganese Aanganese Phosphorus, nax Sulfur, max Sulfur, max Sul | Grade F91 0.08-0.12 0.08-0.12 0.30-0.60 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.00-0.50 0.20-0.50 0.20-0.50 0.20-0.50 0.40 max 8.0-9.5 0.85-1.05 0.85-1.05 0.85-1.05 0.85-1.05 0.85-1.05 0.85-1.05 0.85-1.05 0.85-1.05 0.85-1.05 0.85-1.05 0.85-1.05 0.85-1.05 0.00-0.10 0.03-0.07 0.03-0.07 0.03-0.07 0.03-0.07 0.03-0.07 0.02 max ⁶ 0.01 max ⁶ | Grade F911 0.09-0.13 0.09-0.13 0.30-0.60 0.30-0.60 0.020 0.010 0.10-0.50 0.40 max 8.5-9.5 8.5-9.5 8.5-9.5 0.90-1.10 0.18-0.25 0.06-0.10 0.04-0.09 0.02-0.00 0.02 max ^C 0.0003-0.006 0.90-1.10 0.02 max ^C 0.0003-0.006 0.001 max ^C 0.01 max ^C | 0.07-0.13 0.30-0.60 0.30-0.60 0.020 0.020 0.50 0.40 8.50-9.50 0.30-0.60 0.15-0.25 0.04-0.09 0.030-0.070 0.02 0.001-0.006 1.50-2.00 0.01 | F3V 0.10-0.15 0.30-0.60 0.30-0.60 0.30-0.60 0.020 0.020 0.020 0.020 0.10 max 0.20-0.30 0.20-0.30 0.001-0.003 0.001-0.003 0.001-0.003 0.015-0.035 | F3VCb 0.10-0.15 0.30-0.60 0.30-0.60 0.020 0.10 max 0.25 max 2.7-3.3 0.90-1.10 0.25 max 2.7-3.3 0.90-1.10 0.20-0.30 0.015-0.070 0.015 max 0.25 max | F22V 0.11-0.15 0.11-0.15 0.30-0.60 0.015 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.025 max 0.00-2.50 0.00-2.50 0.00-2.50 0.00-2.50 0.00-2.50 0.00-2.50 0.00-2.50 0.00-2.50 0.00-2.50 0.00-2.50 0.00-2.50 0.00-2.50 0.00-2.50 0.00-2.50 0.00-2.50 0.00-1.10 0.25-0.35 0.07 max 0.0020 max 0.0020 max 0.0030 max 0.20 max | | | |
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^A TWhe pre ellipsent Grade F 5As (0.25%, maximum carbon..) aprpevious to 1955 was assr igned theidens tification symbol F5. Iden, tification symbol F5has beren ass igs ned to th re 0.15%, maxquiremument, e arbon grade to bhe co elemensist need nt weith ASTM specifier be ationsalyzed for nother p roducts such as pipe, tubing,

¹ Boolting, welding, fittings, etc.
^B AThe ppiresent Grade F 5A (0.25 %, maximum carbon) previous to 1955 was assigned the identification symbol F5. Identification symbol F5 h-has been assigned to the 0.15 %, maximum, carbon grade to be consistent with ASTM specifications for other products such as pipe, tubing, bolysting, welding, fittings, etc.

^D For Grade F 22V, rare earth metals (REM) may be added in place of calcium subject to agreement between the producer and the purchaser. In that case the total amount of REM shall be determined and reported.