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Standard Specification for Structural Steel for Bridges[1]

This standard is issued under the fixed designation A709/A709M; 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.

1. Scope*

1.1 This specification covers carbon and high-strength low-alloy steel structural shapes, plates, and bars, quenched and tempered alloy steel, and stainless steel for structural plates intended for use in bridges. Twelve grades are available in five yield strength levels as follows:

Grade U.S. [SI]	Yield Strength, ksi [MPa]
36 [250]	36 [250]
50 [345]	50 [345]
50S [345S]	50 [345]
QST 50 [QST 345]	50 [345]
QST 50S [QST 345S]	50 [345]
50W [345W]	50 [345]
HPS 50W [HPS 345W]	50 [345]
50CR [345CR]	50 [345]
QST 65 [QST450]	65 [450]
QST 70 [QST485]	70 [485]
HPS 70W [HPS 485W]	70 [485]
HPS 100W [HPS 690W]	100 [690]

1.1.1 Grades 36 [250], 50 [345], 50S [345S], 50W [345W], 50CR [345CR], QST 50 [QST 345], QST 50S [QST 345S], QST 65 [QST 450], and QST 70 [QST 485] are also included in Specifications A36/A36M, A572/A572M, A992/A992M, A588/A588M, A1010/A1010M (UNS S41003), and A913/A913M respectively. When the requirements of Table 11 or Table 12 or the supplementary requirements of this specification are specified, they exceed the requirements of Specifications A36/A36M, A572/A572M, A992/A992M, A588/A588M, A1010/A1010M (UNS S41003), and A913/A913M. Product availability is shown in Table 1.

1.1.2 Grades 50W [345W], 50CR [345CR], HPS 50W [HPS 345W], HPS 70W [HPS 485W], and HPS 100W [HPS 690W] have enhanced atmospheric corrosion resistance (see 13.1.2). Product availability is shown in Table 1.

1.2 Grade HPS 70W [HPS 485W] or HPS 100W [HPS 690W] shall not be substituted for Grades 36 [250], 50 [345], 50S [345S], 50W [345W], or HPS 50W [HPS 345W]. Grade 50W [345W], or HPS 50W [HPS 345W] shall not be substituted for Grades 36 [250], 50 [345] or 50S [345S] without agreement between the purchaser and the supplier.

1.3 When the steel is to be welded, it is presupposed that a welding procedure suitable for the grade of steel and intended use or service will be utilized. See Appendix X3 of Specification A6/A6M for information on weldability.

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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 A01.02 on Structural Steel for Bridges, Buildings, Rolling Stock and Ships.

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

TABLE 1 Tensile and Hardness Requirements[A]

NOTE 1—Where ". . ." appears in this table, there is no requirement.

Grade	Plate Thickness, in. [mm]	Structural Shape Flange or Leg Thickness, in. [mm]	Yield Point or Yield Strength,[B] ksi [MPa]	Tensile Strength, ksi [MPa]	Minimum Elongation, %				Reduction of Area[C,D] min, %
					Plates and Bars[C,E]		Shapes[E]		
					8 in. or 200 mm	2 in. or 50 mm	8 in. or 200 mm	2 in. or 50 mm	
36 [250]	to 4 [100], incl	to 3 in. [75 mm], incl	36 [250] min	58–80 [400–550]	20	23	20	21	...
		over 3 in. [75 mm]	36 [250] min	58 [400] min	...	...	20	19	...
50 [345]	to 4 [100], incl	all	50 [345] min	65 [450] min	18	21	18	21[F]	...
QST 50 [QST 345]	[G]	all	50 [345] min	65 [450] min	...	...	18	21[F]	...
50S [345S]	[G]	all	50–65 [345–450][H,I]	65 [450][H] min	...	...	18	21	...
QST 50S [QST 345S	[G]	all	50–65 [345–450]	65 [450] min	...	...	18	21	...
50W [345W] and HPS 50W [HPS 345W]	to 4 [100], incl	all	50 [345] min	70 [485] min	18	21	18	21[J]	...
50CR [345CR]	to 2 [50], incl	[G]	50 [345] min	70 [485] min	18	21	...	...	...
QST 65 [QST 450]	[G]	all	65 [450] min	80 [550] min	...	...	15	17	...
QST 70 [QST 485]	[G]	all	70 [485] min	90 [620] min	...	...	14	16	...
HPS 70W [HPS 485 W]	to 4 [100], incl	[G]	70 [485] min[B]	85–110 [585–760]	...	19[K]	...	...	...
HPS 100W [HPS 690W]	to 2½ [65], incl	[G]	100 [690] min[B]	110–130 [760–895]	...	18[K]	...	...	[L]
	over 2½ to 4 [65 to 100], incl[M]	[G]	90 [620] min[B]	100–130 [690–895]	...	16[K]	...	...	[L]

[A] See specimen orientation and preparation subsection in the Tension Tests section of Specification A6/A6M.
[B] Measured at 0.2 % offset or 0.5 % extension under load as described in Section 13 of Test Methods and Definitions A370.
[C] Elongation and reduction of area not required to be determined for floor plates.
[D] For plates wider than 24 in. [600 mm], the reduction of area requirement, where applicable, is reduced by five percentage points.
[E] For plates wider than 24 in. [600 mm], the elongation requirement is reduced by two percentage points. See elongation requirement adjustments in the Tension Tests section of Specification A6/A6M.
[F] Elongation in 2 in. or 50 mm: 19 % for shapes with flange thickness over 3 in. [75 mm].
[G] Not applicable.
[H] The yield to tensile ratio shall be 0.87 or less for shapes that are tested from the web location; for all other shapes, the requirement is 0.85.
[I] A maximum yield strength of 70 ksi [480 MPa] is permitted for structural shapes that are required to be tested from the web location.
[J] For wide flange shapes with flange thickness over 3 in. [75 mm], elongation in 2 in. or 50 mm of 18 % minimum applies.
[K] If measured on the Fig. 3 (Test Methods and Definitions A370) 1½-in. [40–mm] wide specimen, the elongation is determined in a 2-in. or 50-mm gage length that includes the fracture and shows the greatest elongation.
[L] 40 % minimum applies if measured on the Fig 3 (Test Methods and Definitions A370) 1½-in. [40-mm] wide specimen; 50 % minimum applies if measured on the Fig. 4 (Test Methods and Definitions A370) ½-in. [12.5-mm] round specimen.
[M] Not applicable to Fracture Critical Tension Components (see Table 12).

1.4 For structural products to be used as tension components requiring notch toughness testing, standardized requirements are provided in this standard, and they are based upon American Association of State Highway and Transportation Officials (AASHTO) requirements for both fracture critical and non-fracture critical members.

1.5 Supplementary requirements are available but shall apply only if specified in the purchase order.

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.

1.7 For structural products produced from coil and furnished without heat treatment or with stress relieving only, the additional requirements, including additional testing requirements and the reporting of additional test results, of Specification A6/A6M apply.

TABLE 2 Grade 36 [250] Chemical Requirements (Heat Analysis)

NOTE 1—Where ". . ." appears in this table there is no requirement. The heat analysis for manganese shall be determined and reported as described in the Heat Analysis section of Specification A6/A6M.

Product Thickness, in. [mm]	Shapes[A] All	Plates >15 in. [380 mm] Width[B]				Bars, Plates ≤15 in. [380 mm] Width[B]		
		To ¾ [20], incl	Over ¾ to 1½ [20 to 40], incl	Over 1½ to 2½ [40 to 65], incl	Over 2½ to 4 [65 to 100], incl	To ¾ [20], incl	Over ¾ to 1½ [20 to 40], incl	Over 1½ to 4 [40 to 100], incl
Carbon, max, %	0.26	0.25	0.25	0.26	0.27	0.26	0.27	0.28
Manganese, %	...	...	0.80–1.20	0.80–1.20	0.85–1.20	...	0.60–0.90	0.60–0.90
Phosphorus, max, %	0.04	0.030	0.030	0.030	0.030	0.04	0.04	0.04
Sulfur, max, %	0.05	0.030	0.030	0.030	0.030	0.05	0.05	0.05
Silicon, %	0.40 max	0.40 max	0.40 max	0.15–0.40	0.15–0.40	0.40 max	0.40 max	0.40 max
Copper, min, % when copper steel is specified	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

[A] Manganese content of 0.85 to 1.35 % and silicon content of 0.15 to 0.40 % is required for shapes with flange thickness over 3 in. [75 mm].
[B] For each reduction of 0.01 % below the specified carbon maximum, an increase of 0.06 % manganese above the specified maximum will be permitted up to a maximum of 1.35 %.

TABLE 3 Grade 50 [345] Chemical Requirements[A] (Heat Analysis)

Maximum Diameter, Thickness, or Distance Between Parallel Faces, in. [mm]	Carbon, max, %	Manganese,[B] max, %	Phosphorus,[C] max, %	Sulfur,[C] max, %	Silicon[D]		Columbium (Niobium),[E] Vanadium, and Nitrogen
					Plates to 1½-in. [40-mm] Thick, Shapes with flange or leg thickness to 3 in. [75 mm] inclusive, Sheet Piling, Bars, Zees, and Rolled Tees, max, %	Plates Over 1½-in. [40-mm] Thick and Shapes with flange thickness over 3 in. [75 mm], %	
4 [100]	0.23	1.35	0.030	0.030	0.40	0.15–0.40	See Table 4

[A] Copper when specified shall have a minimum content of 0.20 % by heat analysis (0.18 % by product analysis).
[B] Manganese, minimum by heat analysis of 0.80 % (0.75 % by product analysis) shall be required for all plates over ⅜ in. [10 mm] in thickness; a minimum of 0.50 % (0.45 % by product analysis) shall be required for plates ⅜ in. [10 mm] and less in thickness, and for all other products. ~~The manganese to carbon ratio shall not be less than 2 to 1.~~ For each reduction of 0.01 percentage point below the specified carbon maximum, an increase of 0.06 percentage point manganese above the specified maximum is permitted, up to a maximum of 1.60 %.
[C] A maximum phosphorus content of 0.04 % and a maximum sulfur content of 0.05 % are permitted for the following materials:
· Structural shapes
· Bars
· Plates with widths up to and including 15 in. [380 mm]
[D] Silicon content in excess of 0.40 % by heat analysis must be negotiated.
[E] Columbium and niobium are interchangeable names for the same element.

TABLE 4 Grade 50 [345] Alloy Content

Type[A]	Elements	Heat Analysis, %
1	Columbium (niobium)[B]	0.005–0.05[C]
2	Vanadium	0.01–0.15[D]
3	Columbium (niobium)[B]	0.005–0.05[C]
	Vanadium	0.01–0.15[D]
	Columbium (niobium)[B] plus vanadium	0.02–0.15[E]

[A] Alloy content shall be in accordance with Type 1, 2, or 3 and the contents of the applicable elements shall be reported on the test report.
[B] Columbium and niobium are interchangeable names for the same element.
[C] Product analysis limits = 0.004 to 0.06 %.
[D] Product analysis limits = 0.005 to 0.17 %.
[E] Product analysis limits = 0.01 to 0.16 %.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

TABLE 5 Grade 50CR [345CR] Chemical Requirements (Heat Analysis)

NOTE 1—Where ". . ." appears in this table there is no requirement.

Element	Composition, %
Carbon	0.030 max
Manganese	1.50 max
Phosphorus	0.040 max
Sulfur	0.010 max
Silicon	1.00 max
Nickel	1.50 max
Chromium	10.5 – 12.5
Molybdenum	. . .
Nitrogen	0.030 max

TABLE 6 Grade 50W [345 W] Chemical Requirements (Heat Analysis)

NOTE 1—Types A and B are equivalent to Specification A588/A588M, Grades A and B, respectively.

Element	Composition, %[A]	
	Type A	Type B
Carbon[B]	0.19 max	0.20 max
Manganese[B]	0.80–1.25	0.75–1.35
Phosphorus[C]	0.030 max	0.030 max
Sulfur[C]	0.030 max	0.030 max
Silicon	0.30–0.65	0.15–0.50
Nickel	0.40 max	0.50 max
Chromium	0.40–0.65	0.40–0.70
Copper	0.25–0.40	0.20–0.40
Vanadium	0.02–0.10	0.01–0.10

[A] Weldability data for these types have been qualified by FHWA for use in bridge construction.

[B] For each reduction of 0.01 percentage point below the specified maximum for carbon, an increase of 0.06 percentage point above the specified maximum for manganese is permitted, up to a maximum of 1.50 %.

[C] A maximum phosphorus content of 0.04 % and a maximum sulfur content of 0.05 % are permitted for the following materials:

- Structural shapes
- Bars
- Plates with widths up to and including 15 in. [380 mm]

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A6/A6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
A36/A36M Specification for Carbon Structural Steel
A370 Test Methods and Definitions for Mechanical Testing of Steel Products
A572/A572M Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
A588/A588M Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
A673/A673M Specification for Sampling Procedure for Impact Testing of Structural Steel
A913/A913M Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process (QST)
A992/A992M Specification for Structural Steel Shapes
A1010/A1010M Specification for Higher-Strength Martensitic Stainless Steel Plate, Sheet, and Strip
G101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels

[2] 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.

TABLE 7 Grades HPS 50W [HPS 345W] and HPS 70W [HPS 485 W], and HPS 100W [HPS 690W] Chemical Requirements (Heat Analysis)

NOTE 1—Where ". . ." appears in this table, there is no requirement.

Element	Composition, %	
	Grades HPS 50W [HPS 345W], HPS 70W [HPS 485W]	Grade HPS 100W [HPS 690W]
Carbon	0.11 max	0.08 max
Manganese		
2.5 in. [65 mm] and under	1.10–1.35	0.95–1.50
Over 2.5 in. [65 mm]	1.10–1.50	0.95–1.50
Phosphorus	0.020 max	0.015 max
Sulfur[A]	0.006 max	0.006 max
Silicon	0.30–0.50	0.15–0.35
Copper	0.25–0.40	0.90–1.20
Nickel	0.25–0.40	0.65–0.90
Chromium	0.45–0.70	0.40–0.65
Molybdenum	0.02–0.08	0.40–0.65
Vanadium	0.04–0.08	0.04–0.08
Columbium (niobium)[B]	. . .	0.01–0.03
Aluminum	0.010–0.040	0.020–0.050
Nitrogen	0.015 max	0.015 max

[A] The steel shall be calcium treated for sulfide shape control.
[B] Columbium and niobium are interchangeable names for the same element.

TABLE 8 Grade 50S [345S] Chemical Requirements (Heat Analysis)

Element	Composition, %
Carbon, max	0.23
Manganese	0.50 to 1.60[A]
Silicon, max	0.40
Vanadium, max	0.15[B]
Columbium (niobium),[C] max	0.05[B]
Phosphorus, max	0.035
Sulfur, max	0.045
Copper, max	0.60
Nickel, max	0.45
Chromium, max	0.35
Molybdenum, max	0.15

[A] Provided that the ratio of manganese to sulfur is not less than 20 to 1, the minimum limit for manganese for shapes with flange or leg thickness not exceeding 1 in. [25 mm] shall be 0.30 %.
[B] The sum of columbium (niobium) and vanadium shall not exceed 0.15 %.
[C] Columbium and niobium are interchangeable names for the same element.

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *fracture critical* ~~*member—*~~*member, n—*a main load-carrying tension member or tension component of a bending member whose failure would be expected to cause collapse of a structure or bridge without multiple, redundant load paths.

3.1.2 *main load-carrying* ~~*member—*~~*member, n—*a steel member designed to carry primary design loads, including dead, live, impact, and other loads.

3.1.3 *non-fracture critical* ~~*member—*~~*member, n—*a main load-carrying member whose failure would not be expected to cause collapse of a structure or bridge with multiple, redundant load paths.

3.1.4 *non-tension* ~~*component—*~~*component, n—*a steel member that is not in tension under any design loading.

3.1.5 *secondary* ~~*member—*~~*member, n—*a steel member used for aligning and bracing of main load-carrying members, or for attaching utilities, signs, or other items to them, but not to directly support primary design loads

TABLE 9 Grades QST 50 [QST 345], QST 50S [QST 345S], QST 65 [QST 450], and QST 70 [QST 485] Chemical Requirements (Heat Analysis)

NOTE 1—Boron shall not be intentionally added. See Specification A6/A6M, Section 7.1.2, for additional guidance regarding boron.

Element	Maximum Content in %		
	Grade QST 50 and QST 50S [QST 345] and [QST 345S]	Grade QST 65 [QST 450]	Grade QST 70Q [QST 485]
Carbon	0.12	0.12	0.12
Manganese	1.60	1.60	1.60
Phosphorus	0.030	0.030	0.030
Sulfur	0.030	0.030	0.030
Silicon	0.40	0.40	0.40
Copper	0.45	0.35	0.45
Nickel	0.25	0.25	0.25
Chromium	0.25	0.25	0.25
Molybdenum	0.07	0.07	0.07
Columbium (niobium)[A]	0.05	0.05	0.05
Vanadium	0.06	0.08	0.09

[A] Columbium and niobium are interchangeable names for the same element.

TABLE 10 Relationship Between Impact Testing Temperature Zones and Minimum Service Temperature

Zone	Minimum Service Temperature, °F [°C]
1	0 [–18]
2	below 0 to –30 [–18 to –34]
3	below –30 to –60 [–34 to –51]

3.1.6 *tension ~~component~~ component, n*—a part or element of a fracture critical or non-fracture critical member that is in tension under various design loadings.

4. Ordering Requirements

4.1 In addition to the items listed in the ordering information section of Specification A6/A6M, the following items should be considered if applicable:

4.1.1 Type of component (tension or non-tension, fracture critical or non-fracture critical) (see Section 10).

4.2 Impact testing temperature zone (see Table 10).

5. General Requirements for Delivery

5.1 Structural products furnished under this specification shall conform to the requirements of the current edition of Specification A6/A6M, for the specific structural product ordered, unless a conflict exists in which case this specification shall prevail.

5.2 Coils are excluded from qualification to this specification until they are processed into a finished structural product. Structural products produced from coil means structural products that have been cut to individual lengths from a coil. The processor directly controls, or is responsible for, the operations involved in the processing of a coil into a finished structural product. Such operations include decoiling, leveling or straightening, hot-forming or cold-forming (if applicable), cutting to length, testing, inspection, conditioning, heat treatment (if applicable), packaging, marking, loading for shipment, and certification.

NOTE 1—For structural products produced from coil and furnished without heat treatment or with stress relieving only, two test results are to be reported for each qualifying coil. Additional requirements regarding structural products produced from coil are described in Specification A6/A6M.

6. Materials and Manufacture

6.1 For all Grades, the steel shall be killed.

TABLE 11 Non-Fracture Critical Tension Component Impact Test Requirements

Grade	Thickness, in. [mm]	Minimum Average Energy, ft·lbf [J]		
		Zone 1	Zone 2	Zone 3
36T [250T][A]	to 4 [100] incl	15 [20] at 70°F [21°C]	15 [20] at 40°F [4°C]	15 [20] at 10°F [–12°C]
50T [345T][A, B]	to 2 [50] incl	15 [20] at 70°F [21°C]	15 [20] at 40°F [4°C]	15 [20] at 10°F [–12°C]
50ST [345ST][A, B]	over 2 to 4 [50 to 100] incl	20 [27] at 70°F [21°C]	20 [27] at 40°F [4°C]	20 [27] at 10°F [–12°C]
50WT [345WT][A, B]				
QST 50T [QST 345T][B, D]	to 2 [50] incl	15 [20] at 70°F [21°C]	15 [20] at 40°F [4°C]	15 [20] at 10°F [–12°C]
QST 50ST [QST 345ST][D]	over 2 to 4 [50 to 100] incl	20 [27] at 70°F [21°C]	20 [27] at 40°F [4°C]	20 [27] at 10°F [–12°C]
50CRT [345CRT][A, B]	to 2 [50] incl	15 [20] at 70°F [21°C]	15 [20] at 40°F [4°C]	15 [20] at 10°F [–12°C]
HPS 50WT [HPS 345WT][A, B]	to 4 [100] incl	20 [27] at 10°F [–12°C]	20 [27] at 10°F [–12°C]	20 [27] at 10°F [–12°C]
QST 65T [QST 450T][B, D]	to 2 [50] incl	20 [27] at 50°F [10°C]	20 [27] at 20°F [–7°C]	20 [27] at -10°F [–23°C]
	over 2 to 4 [50 to 100] incl	25 [34] at 50°F [10°C]	25 [34] at 20°F [–7°C]	25 [34] at -10°F [–23°C]
QST 70T [QST 485T][B, D]	to 2 [50] incl	20 [27] at 50°F [10°C]	20 [27] at 20°F [–7°C]	20 [27] at -10°F [–23°C]
	over 2 to 4 [50 to 100] incl	25 [34] at 50°F [10°C]	25 [34] at 20°F [–7°C]	25 [34] at -10°F [–23°C]
HPS 70WT [HPS 485WT][B, D]	to 4 [100] incl	25 [34] at –10°F [–23°C]	25 [34] at –10°F [–23°C]	25 [34] at –10°F [–23°C]
HPS 100WT [HPS 690WT][D]	to 2½ [65] incl	25 [34] at –30°F [–34°C]	25 [34] at –30°F [–34°C]	25 [34] at –30°F [–34°C]
	over 2½ to 4 [65 to 100] incl	35 [48] at –30°F [–34°C]	35 [48] at –30°F [–34°C]	35 [48] at –30°F [–34°C]

[A] The CVN-impact testing shall be at "H" frequency in accordance with Specification A673/A673M.

[B] If the yield point of the structural product exceeds the specified minimum value by 15 ksi [105Mpa] or more, the testing temperature for the minimum average energy required shall be reduced by 15°F [8°C] for each increment or fraction of 10 ksi [70 MPa] above the 15 ksi [105 Mpa] exceedance of the specified minimum value].The yield point is the value given in the test report. See examples in Table Footnote C.[C]

[C] If the yield point or yield strength for a 50 ksi [345 MPa] minimum yield strength steel is more than 65 ksi [450 MPa] but not more than 75 ksi [520 MPa], the test temperature reduction is 15°F [8°C]. If the yield point is more than 75 ksi [520 MPa] but not more than 85 ksi [585 MPa], the test temperature reduction is 30°F [17°C].

If the yield point or yield strength for a 65 ksi [450 MPa] minimum yield strength steel is more than 80 ksi [550 MPa] but not more than 90 ksi [620 MPa], the test temperature reduction is 15°F [8°C]. If the yield point is more than 90 ksi [620 MPa] but not more than 100 ksi [690 MPa], the test temperature reduction is 30°F [17°C].

If the yield point or yield strength for a 70 ksi [485 MPa] minimum yield strength steel is more than 85 ksi [585 MPa] but not more than 95 ksi [655 MPa], the test temperature reduction is 15°F [8°C]. If the yield point is more than 95 ksi [655 MPa] but not more than 105 ksi [725 MPa], the test temperature reduction is 30°F [17°C].

[D] The CVN-impact testing shall be at "P" frequency in accordance with Specification A673/A673M.

6.2 For Grades 50W [345W], QST 65 [QST 450], QST 70 [QST 485], HPS 50W [HPS 345W], and HPS 70W [HPS 485W], the steel shall be made to fine grain practice.

6.3 For Grade 50S [345S], the steelmaking practice used shall be one that produces steel having a nitrogen content not greater than 0.015 % and includes the addition of one or more nitrogen-binding elements, or one that produces steel having a nitrogen content of not greater than 0.012 % (with or without the addition of nitrogen-binding elements). The nitrogen content need not be reported, regardless of which steelmaking practice was used.

6.4 For Grades HPS 50W [HPS 345W], HPS 70W [HPS 485W], and HPS 100W [HPS 690W], the steel shall be made using a low-hydrogen practice, such as vacuum degassing during steel making; controlled soaking of the ingots, slabs; controlled slow cooling of the ingots, slabs, or plates, or a combination thereof.

6.5 For Grade HPS 100W [HPS 690W], the requirements for fine austenitic grain size in Specification A6/A6M shall be met.

6.6 Grades HPS 50W [HPS 345W] and HPS 70W [HPS 485W] shall be furnished in one of the following conditions: as-rolled, control-rolled, thermo-mechanical control processed (TMCP) with or without accelerated cooling, or quenched and tempered.

6.7 Grade 50CR [345CR] shall be furnished normalized and tempered or quenched and tempered.

6.8 For fracture critical base material only, weld repair of the base metal by the material manufacturer or supplier is not permitted.

6.9 For grades QST 50 [QST 345], QST 50S [QST 345S], QST 65 [QST 450], and QST 70 [QST 485], the shapes are produced