



Designation: **A757/A757M—15 A757/A757M – 22**

Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure- Containing and Other Applications, for Low-Temperature Service¹

This standard is issued under the fixed designation A757/A757M; 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 covers carbon and alloy steel castings for pressure-containing and other applications intended primarily for petroleum and gas pipelines in areas subject to low-ambient temperatures. Castings shall be heat treated by normalizing and tempering or liquid quenching and tempering. All classes are weldable under proper conditions. Hardenability of some grades may limit usable section size.

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

1.2.1 Unless the order specifies an “M” designation, the material shall be furnished to inch-pound units.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate ~~safety~~ safety, health, and ~~health~~ environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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.*

2. Referenced Documents

2.1 ASTM Standards:²

[A488/A488M Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel](#)

[A703/A703M Specification for Steel Castings, General Requirements, for Pressure-Containing Parts](#)

[A985/A985M Specification for Steel Investment Castings General Requirements, for Pressure-Containing Parts](#)

[A1067/A1067M Specification for Test Coupons for Steel Castings](#)

2.2 *American Society of Mechanical Engineers:*³

[ASME Boiler and Pressure Vessel Code](#)

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 A01.18 on Castings.

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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.

³ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.

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

2.3 *Manufacturers Standardization Society of the Valve and Fittings Industry Standards:*⁴

[MSS SP-55 Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components—Visual Components—Visual Method for Evaluation of Surface Irregularities](#)

3. Terminology

3.1 ~~Definitions:~~*Definitions of Terms Specific to This Standard:*

~~3.1.1 Definitions in Specification **A703/A703M** are applicable to this specification.~~

~~3.1.1 *nominal thickness, T, n*—for quenched and tempered castings with a thickness exceeding 2 in. [50 mm], the maximum thickness of the pressure-containing wall of the casting exclusive of padding added for directional solidification, flanges, appendages, and sections designated by the designer as noncritical.~~

~~3.1.2 Definition of nominal thickness, T, applies to quenched and tempered castings with a thickness exceeding 2 in. [50 mm]. Nominal thickness, T, is the maximum thickness of the pressure-containing wall of the casting exclusive of padding added for directional solidification, flanges, appendages, and sections designated by the designer as noncritical.~~

4. General Conditions for Delivery

4.1 Except for investment castings, castings furnished to this specification shall be in accordance with the requirements of Specification **A703/A703M**, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification **A703/A703M** constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification **A703/A703M**, this specification shall prevail.

4.2 Steel investment castings furnished to this specification shall conform to the requirements of Specification **A985/A985M**, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification **A985/A985M** constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification **A985/A985M**, **A985/A985M** shall prevail.

5. Ordering Information

5.1 Orders for material to this specification should include the following, as required, to describe the material adequately:

5.1.1 Quantity,

5.1.2 ASTM designation and date of issue,

5.1.3 Grade designation (~~designation~~, **Table 1**);

5.1.4 Class (if applicable),

5.1.5 Description of casting by part, pattern, or drawing number. (~~Dimensional~~ number (dimensional tolerances and machined surfaces should be indicated on the casting ~~drawing~~ drawing)),

5.1.6 Options in the specification,

5.1.7 Whether the castings are to be produced using investment casting process, and

5.1.8 Supplementary requirements desired, if any, including standards of acceptance.

6. Materials and Manufacture

6.1 *Melting Process*—The steel shall be made by the electric furnace process or other primary processes approved by the purchaser. The primary melting may incorporate separate degassing or refining and may be followed by secondary melting.

⁴ Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602, <http://www.mss-hq.com>.

TABLE 1 Chemical Requirements (Maximum Composition Requirements^A Percent^B Unless Range is Given)

Grade ^C Element, %	A+Q Grade ^C Type											A2Q
	Type A1Q C	Carbon A2Q C-Mn	Carbon-B2N, B2Q Manga-2.5Ni nese	2B3N, 1/2 Nickel B3Q 3.5Ni	3B4N, B4Q 1/2 Nickel 4.5Ni	4C1Q 1/2 Nickel Ni-Mo	Nickel D1N, D1Q Molybdenum Cr-Mo	Chromium E1Q Ni-Cr-Mo	Nickel E2N, E2Q Chromium Ni- Cr-Mo Molybdenum	Nickel Chromium Molybdenum	E3N Martensitic Chromium Cr-N Nickel	
Carbon	0.30	0.25 ^A	0.25	0.15	0.15	0.25	0.20	0.22	0.20	0.06		
Carbon	0.30	0.25 ^D	0.25	0.15	0.15	0.25	0.20	0.22	0.20	0.06		
Manganese	1.00	1.20 ^A	0.50/0.80	0.50/0.80	0.50/0.80	1.20	0.40/0.80	0.50/0.80	0.40/0.70	1.00		
Manganese	1.00	1.20 ^D	0.50-0.80	0.50-0.80	0.50-0.80	1.20	0.40-0.80	0.50-0.80	0.40-0.70	1.00		
Phosphorus	0.025 ^E	0.025 ^E	0.025 ^E	0.025 ^E	0.025 ^E	0.025 ^E	0.025 ^E	0.025 ^F	0.020 ^F	0.030 ^G		
Sulfur	0.025 ^E	0.025 ^E	0.025 ^E	0.025 ^E	0.025 ^E	0.025 ^E	0.025 ^E	0.025 ^F	0.020 ^F	0.030 ^G		
Silicon	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	1.00		
Nickel	—	—	2.0/3.0	3.0/4.0	4.0/5.0	1.5/2.0	—	2.5/3.5	2.75/3.90	3.5/4.5		
Nickel	0.50 ^E	0.50 ^E	2.0-3.0	3.0-4.0	4.0-5.0	1.5-2.0	0.50 ^E	2.5-3.5	2.75-3.90	3.5-4.5		
Chromium	—	—	—	—	—	—	2.0/2.75	1.35/1.85	1.50/2.0	11.5/14.0		
Molybdenum	—	—	—	—	—	0.15/0.30	0.90/1.20	0.35/0.60	0.40/0.60	0.40/1.0		
Specified Residual — Elements:												
Vanadium	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	—		
Copper	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50		
Nickel	0.50	0.50	—	—	—	—	0.50	—	—	—		
Chromium	0.40	0.40	0.40	0.40	0.40	0.40	—	—	—	—		
Chromium	0.40 ^E	0.40 ^E	0.40 ^E	0.40 ^E	0.40 ^E	0.40 ^E	2.0-2.75	1.35-1.85	1.50-2.0	11.5-14.0		
Molybdenum	0.25	0.25	0.25	0.25	0.25	—	—	—	—	—		
Molybdenum	0.25 ^E	0.25 ^E	0.25 ^E	0.25 ^E	0.25 ^E	0.15-0.30	0.90-1.20	0.35-0.60	0.40-0.60	0.40-1.0		
Tungsten	—	—	—	—	—	—	0.10	—	0.10	0.10		
Copper	0.50 ^E	0.50 ^E	0.50 ^E	0.50 ^E	0.50 ^E	0.50 ^E	0.50 ^E	0.50 ^F	0.50 ^F	0.50 ^G		
Vanadium	0.03 ^E	0.03 ^E	0.03 ^E	0.03 ^E	0.03 ^E	0.03 ^E	0.03 ^E	0.03 ^F	0.03 ^F	...		
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.70	0.70	0.50		
— residuals (maxi- mum %) ^E												
Tungsten	0.10 ^E	...	0.10 ^F	0.10 ^G		

^A All values are maximums unless a range is provided.

^B Where ellipses (...) appear in this table, there is no requirement and the element need not be analyzed for or reported.

^C "Q" in the grade name indicates that the casting has been quenched and tempered. "N" in the grade name indicates that the casting has been normalized and tempered.

^D For each 0.01 % of reduction in carbon below the maximum specified, an increase of 0.04 % manganese over the maximum specified will be permitted up to 1.40 %.

^E Total residuals includes The total content of these elements shall not exceed 1.00 % including phosphorus and sulfur.

^F The total content of these elements shall not exceed 0.70 % including phosphorus and sulfur.

^G The total content of these elements shall not exceed 0.50 % including phosphorus and sulfur.

6.2 Heat Treatment:

6.2.1 All castings shall be heat treated by either normalizing and tempering or quenching and tempering. Tempering temperature shall be 1100°F [595°C] 1100°F [595°C] minimum, except grades B4N and B4Q, which shall be tempered at 1050°F [565°C] 1050°F [565°C] minimum.

6.2.2 E3N castings shall be heat treated by heating to 1850°F [1010°C] 1850°F [1010°C] minimum, and air cooling to 200°F [95°C] ~~maximum~~ 200°F [95°C] or cooler before any optional intermediate temper, but shall cool to 100°F [40°C] ~~maximum~~ be cooled to 100°F [40°C] or cooler before the final temper, which shall be between 1050 and 1150°F [565 and 620°C] 620°C].

6.2.3 Furnace temperatures for heat treating shall be controlled by ~~pyrometers, thermocouples,~~

6.2.4 Castings shall be allowed to cool below the transformation range directly after pouring and solidification before they are reheated for normalizing or liquid quenching.

7. Chemical Composition

7.1 The steel shall be in accordance with the requirements as to chemical composition prescribed in Table 1.



TABLE 2 Tensile Requirements

Grade	Heat Treatment ^{A,B}	Tensile Strength, ^C min, ksi [MPa]	Yield Strength (0.2 % offset), min, ksi [MPa]	Elongation in 2 in. [50 mm], min, %	Reduction of Area, min, %
A1Q	QT	65 [450]	35 [240]	24	35
A2Q	QT	70 [485]	40 [275]	22	35
B2N, B2Q	NT/QT ^D	70 [485]	40 [275]	24	35
B3N, B3Q	NT/QT	70 [485]	40 [275]	24	35
B4N, B4Q	NT/QT	70 [485]	40 [275]	24	35
C1Q	QT	75 [515]	55 [380]	22	35
D1N1, D1Q1	NT/QT	85 [585]	55 [380]	20	35
—	—	115 [795]	—	—	—
D1N2, D1Q2	NT/QT	95 [655]	75 [515]	18	35
—	—	125 [860]	—	—	—
D1N3, D1Q3	NT/QT	105 [725]	85 [585]	15	30
—	—	135 [930]	—	—	—
E1Q	QT	90 [620]	65 [450]	22	40
E2N1, E2Q1	NT/QT	90 [620]	70 [485]	18	35
—	—	120 [825]	—	—	—
E2N2, E2Q2	NT/QT	105 [725]	85 [585]	15	30
—	—	135 [930]	—	—	—
E2N3, E2Q3	NT/QT	115 [795]	100 [690]	13	30
—	—	145 [1000]	—	—	—
E3N	NT	110 [760]	80 [550]	15	35

TABLE 2 Tensile Requirements^A

Grade ^B	Class	Heat Treatment ^{C,D,E}	Tensile Strength, ksi [MPa]	Yield Strength (0.2 % offset), ksi [MPa]	Elongation in 2 in. [50 mm], %	Reduction of Area, %
A1Q	...	QT	65 [450]	35 [240]	24	35
A2Q	...	QT	70 [485]	40 [275]	22	35
B2N, B2Q	...	NT, QT ^E	70 [485]	40 [275]	24	35
B3N, B3Q	...	NT, QT	70 [485]	40 [275]	24	35
B4N, B4Q	...	NT, QT	70 [485]	40 [275]	24	35
C1Q	...	QT	75 [515]	55 [380]	22	35
D1N, D1Q	1	NT, QT	85–115 [585–795]	55 [380]	20	35
D1N, D1Q	2	NT, QT	95–125 [655–860]	75 [515]	18	35
D1N, D1Q	3	NT, QT	105–135 [725–930]	85 [585]	15	30
E1Q	...	QT	90 [620]	65 [450]	22	40
E2N, E2Q	1	NT, QT	90–120 [620–825]	70 [485]	18	35
E2N, E2Q	2	NT, QT	105–135 [725–930]	85 [585]	15	30
E2N, E2Q	3	NT, QT	115–145 [795–1000]	100 [690]	13	30
E3N	...	NT	110 [760]	80 [550]	15	35

^A All values are minimums unless a range is provided.

^B "Q" in the grade name indicates the casting has been quenched and tempered. "N" in the grade name indicates the casting has been normalized and tempered.

^C QT = Quenched and tempered.

^D NT = Normalized and tempered.

^E Minimum ksi (MPa), unless range is given.

^F NT, NT/QT, QT indicates that either a normalized and tempered or quenched and tempered heat treatment may be used.

8. Tensile Requirements

8.1 Steel used for the castings shall conform to the requirements as to the tensile properties prescribed in Table 2.

9. Impact Requirements

9.1 Impact properties shall be determined on each heat by testing a set of three Charpy V-notch specimens. The bar from which the impact specimens are machined shall be prepared in accordance with Section 12. The longitudinal axis of the Charpy specimens shall be parallel to the longitudinal axis of the tensile bar.

9.2 Test temperature and absorbed energy requirements for the grade shall be as specified in Table 3. Impact properties at temperatures other than specified in Table 3 shall be agreed upon between the manufacturer and the purchaser and Supplementary Requirement S8 shall be specified. The average energy value of three specimens shall not be less than the minimum average specified, with only one value permitted below the minimum average specified and this value not permitted to fall below the minimum specified for a single specimen. Supplementary Requirement S52 may be specified if lateral expansion or percent shear area, or both, are desired by the purchaser.

TABLE 3 Charpy V-Notch Energy Requirements for Standard Size (10 mm by 10 mm) Specimens^A

Grade	Heat Treatment ^{B,C}	Effective Section Size, max, in. [mm]	Test Temperature	Energy value, ft·lbf [J]; min value for two specimens and min average of three specimens	Energy Value, ft·lbf [J]; min for single specimen	°F	[°C]
A1Q	QT	1¼ [32]	-50	[-46]	13 [17]	10 [14]	
A2Q	QT	3 [75]	-50	[-46]	15 [20]	12 [16]	
B2N, B2Q	NT/QT ^D	5 [125]	-100	[-73]	15 [20]	12 [16]	
B3N, B3Q	NT/QT	1¼ [32]	-150	[-101]	15 [20]	12 [16]	
B4N, B4Q	NT/QT	1¼ [32]	-175	[-115]	15 [20]	12 [16]	
C1Q	QT	5 [125]	-50	[-46]	15 [20]	12 [16]	
D1N1, D-1Q1	NT/QT	E	E	E	E	E	
D1N2, D-1Q2	NT/QT	E	E	E	E	E	
D1N3, D-1Q3	NT/QT	E	E	E	E	E	
E1Q	QT	E	-100	[-73]	30 [41]	25 [34]	
E2N1, E-2Q1	NT/QT	5 [125]	-100	[-73]	30 [41]	25 [34]	
E2N2, E-2Q2	NT/QT	1¼ [32]	-100	[-73]	20 [27]	15 [20]	
E2N3, E-2Q3	NT/QT	1¼ [32]	-100	[-73]	15 [20]	12 [16]	
E3N	NT	1¼ [32]	-100	[-73]	20 [27]	15 [20]	

TABLE 3 Charpy V-Notch Energy Requirements for Standard Size (10 mm by 10 mm) Specimens^A

Grade ^B	Class	Heat Treatment ^{C,D,E}	Maximum Effective Section Size, in. [mm]	Minimum Energy Value for Two Specimens and Minimum Average of Three Specimens, ft·lbf [J]	Minimum Energy Value for Single Specimen, ft·lbf [J]	Test Temperature °F [°C]
A1Q	...	QT	1¼ [32]	13 [17]	10 [14]	-50 [-46]
A2Q	...	QT	3 [75]	15 [20]	12 [16]	-50 [-46]
B2N, B2Q	...	NT, QT	5 [125]	15 [20]	12 [16]	-100 [-73]
B3N, B3Q	...	NT, QT	1¼ [32]	15 [20]	12 [16]	-150 [-101]
B4N, B4Q	...	NT, QT	1¼ [32]	15 [20]	12 [16]	-175 [-115]
C1Q	...	QT	5 [125]	15 [20]	12 [16]	-50 [-46]
D1N, D1Q	1	NT, QT	F	F	F	F
D1N, D1Q	2	NT, QT	F	F	F	F
D1N, D1Q	3	NT, QT	F	F	F	F
E1Q	...	QT	F	30 [41]	25 [34]	-100 [-73]
E2N, E2Q	1	NT, QT	5 [125]	30 [41]	25 [34]	-100 [-73]
E2N, E2Q	2	NT, QT	1¼ [32]	20 [27]	15 [20]	-100 [-73]
E2N, E2Q	3	NT, QT	1¼ [32]	15 [20]	12 [16]	-100 [-73]
E3N	...	NT	1¼ [32]	20 [27]	15 [20]	-100 [-73]

^A Hardenability and residual elements (primarily P & S levels) in some of the grades may limit the maximum section size in which these impact values can be obtained.
^B "Q" in the grade name indicates the casting has been quenched and tempered. "N" in the grade name indicates the casting has been normalized and tempered.
^C QT = Quenched and tempered.
^D NT = Normalized and tempered.
^E NT, QT, NT-QT indicates that either a normalized and tempered or quenched and tempered heat treatment may be used.
^F Requirements shall be subject to agreement between the manufacturer and the purchaser.

9.3 Impact properties shall also be determined on both the heat-affected zone of the base metal and the weld metal of the welding procedure qualification test. Test temperature, energy absorption, specimen type, and test method shall be the same as specified for the base material.

9.3.1 *Coupons Representing the Weld Deposits*—Impact specimens shall be located so that the longitudinal axis of the specimen is at least one fourth of the thickness of the weld test plate, *t*, from the surface of the test assembly and is transverse to the longitudinal axis of the weld with the area of the notch located in the weld metal. The length of the notch of the Charpy specimen shall be normal to the surface of the weld (see Fig. 1)–Fig. 1).

9.3.2 *Coupons Representing the Heat-Affected Zone:*

9.3.2.1 Impact specimens in test plate thicknesses greater than 5/8 in. [16 mm] shall be from coupons removed from a location as near as practical to a point midway between the surface and center thickness. Heat-affected zone coupons for impact specimens shall be taken transverse to the weld and etched to define the heat-affected zone. The notch shall be cut normal to the material surface in the heat-affected zone to include as much heat-affected zone as possible in the resulting fracture (see Fig. 2)–Fig. 2).

9.3.2.2 Where the material thickness permits, the axis of a specimen may be inclined to allow the root of the notch to align parallel to the fusion line (see Fig. 2)–Fig. 2).

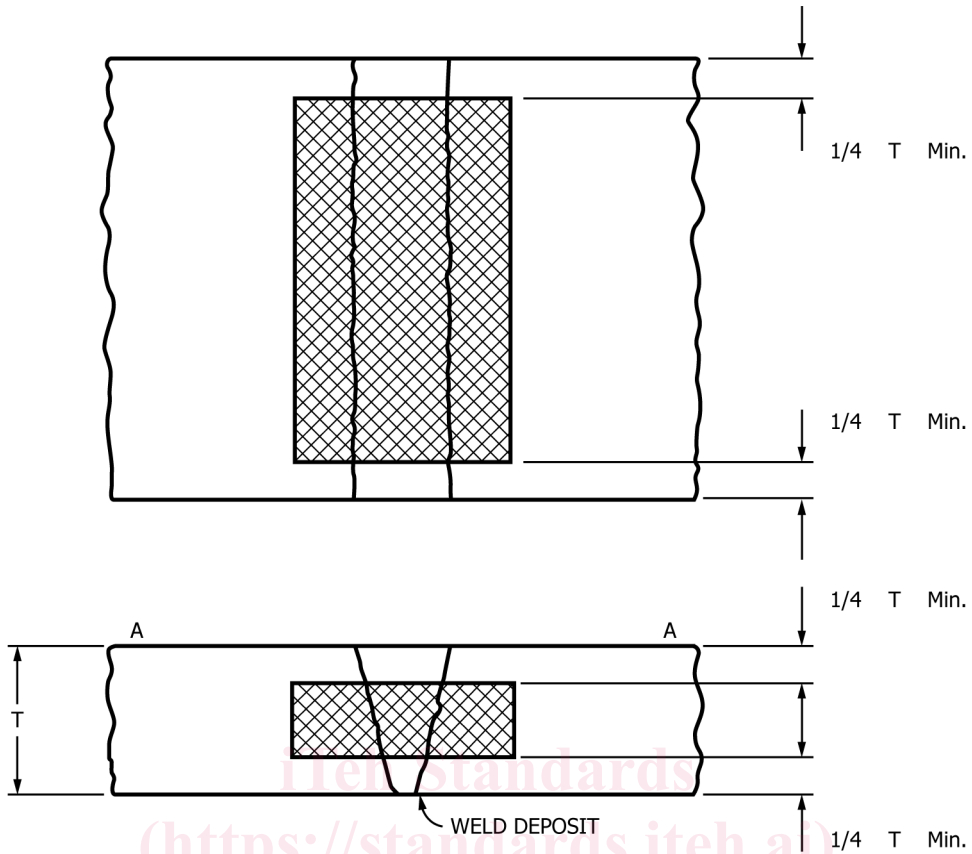


FIG. 1 Charpy V-Notch Specimen Must Be Within Cross-Hatched Zone With with Notch in the Weld Metal Perpendicular to Surface A-A

Document Preview

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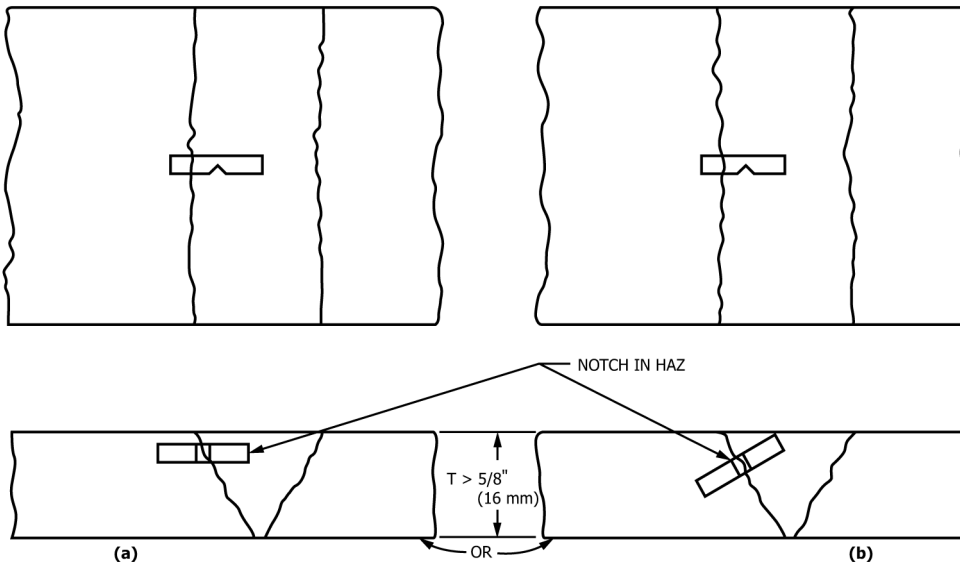


FIG. 2 Location of Notch in Charpy Specimens Shall Be in HAZ Midway Between Center and Surface

9.4 Test temperature and impact values for section thickness in excess of those specified in Table 3 may be agreed upon between

the manufacturer and the purchaser, in which case, Supplementary Requirement S8S54 shall be specified. Castings shall be marked with this test temperature in accordance with 14.1.

10. Workmanship, Finish, and Appearance

10.1 Castings shall conform to the shapes, tolerances, and sizes indicated by patterns or drawings submitted by the purchaser.

10.2 The castings shall not be peened, plugged, or impregnated to stop leaks or disguise rejectable indications.

11. Quality

11.1 The surface of the casting shall be examined visually and shall be free of adhering sand, scale, cracks, and hot tears. Other surface discontinuities shall meet the visual acceptance standards specified in the order. Visual Method MSS SP-55 or other visual standards may be used to define acceptable surface discontinuities and finish. Unacceptable visual surface discontinuities shall be removed and their removal verified by visual examination of the resultant cavities. When methods involving high temperatures are used in the removal of discontinuities, the casting shall be preheated to at least the minimum temperatures in Table 4.

TABLE 4 Minimum Preheat Temperatures

Grade	Minimum Preheat Temperature	
	°F	°C
A1Q	-50	[-10]
A2Q	-50	[-10]
B2N, B 2Q	300	[150]
B3N, B 3Q	300	[150]
B4N, B 4Q	300	[150]
C1Q	300	[150]
D1N, D 1Q	400	[200]
E1Q	300	[150]
E2N, E 2Q	400	[200]
E3N	-50	[-10]

TABLE 4 Minimum Preheat Temperatures

Grade ^A	Minimum Preheat Temperature, °F [°C]
A1Q	50 [10]
A2Q	50 [10]
B2N, B2Q	300 [150]
B3N, B3Q	300 [150]
B4N, B4Q	300 [150]
C1Q	300 [150]
D1N, D1Q	400 [200]
E1Q	300 [150]
E2N, E2Q	400 [200]
E3N	50 [10]

^A "Q" in the grade name indicates the casting has been quenched and tempered.
 "N" in the grade name indicates the casting has been normalized and tempered.

11.2 When additional inspection is desired, Supplementary Requirements S4, S5, and S10 may be ordered.

12. Test Coupons and Specimen Location

12.1 Test blocks may be cast integrally with the casting or as separate blocks. Test coupons shall be heat treated in production furnaces to the same procedure as the castings they represent.

12.2 *Normalized and Tempered Castings*—Test blocks shall be similar to those shown in Fig. 1 in Specification A1067/A1067M.

12.3 *Quenched and Tempered Castings* $T \leq 2$ in. [50 mm]—Requirements in 12.2 apply.

12.4 *Quenched and Tempered Castings* $T > 2$ in. [350 mm]—Requirements of 12.2 may be applied when agreed upon between the manufacturer and the purchaser, in place of 12.4.1 – 12.4.4, one of which otherwise shall apply.