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Steel, Stainless Steel, and Nickel Base Alloy Castings for use in the Petroleum and Natural Gas Industry

Upstream Segment

**API SPECIFICATION 20A
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Table of Contents

1	Scope.....	1
1.1	Purpose.....	1
1.2	Applicability.....	1
1.3	Casting Specification Levels (CSL).....	1
2	Normative References	1
3	Terms, Definitions, and Abbreviations	2
3.1	Terms and Definitions	2
3.2	Abbreviations	4
4	Qualification	4
4.1	General.....	4
4.2	Qualification Casting	4
4.3	Qualification Test Coupon (QTC)	5
4.3.1	Size and Shape of Qualification Test Coupon (QTC)	5
4.4	Casting Qualification Testing	9
4.4.1	Examination Procedure.....	9
4.4.2	Visual Examination	10
4.4.3	Dimensional Inspection.....	10
4.4.4	Hardness Testing	10
4.4.5	Nondestructive Examination	10
4.4.6	Mechanical Testing.....	11
4.4.7	Microstructure Examination	11
4.4.8	Chemical Analysis	12
4.4.9	Additional Testing.....	12
4.5	Acceptance of the Qualification Casting	15
4.6	Records of Qualification.....	15
4.7	Limits of Casting Qualifications	16
4.7.1	CSL-1	16
4.7.2	CSL-2	16
4.7.3	CSL-3	16
4.7.4	CSL-4	17
5	Production Castings	17
5.1	General	17
5.2	Manufacturing Procedure Specification	17
5.3	Process Control Variables	17
5.3.1	General Variables.....	17
5.3.2	Heat Treatment Parameters	18
5.4	Sample Casting	19
5.4.1	General	19
5.4.2	Definition of a Sample Casting	19
5.4.3	Evaluation of Sample Castings	19
5.4.4	Sample Casting Acceptance.....	20
5.5	Design and Maintenance of Pattern Equipment	20
5.5.1	Design	20
5.5.2	Maintenance	21
5.5.3	Allowable Design Changes	21
5.6	Inspection, Quality Control, Marking, and Documentation	21
5.6.1	Calibration	21

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5.6.2	Furnace Calibration	21
5.6.3	Visual Inspection.....	21
5.6.4	Surface NDE	21
5.6.5	Volumetric NDE	22
5.6.6	Dimensional inspection.....	23
5.6.7	Repair welding.....	23
5.7	Limits on the Qualification of Production Castings	24
5.7.1	CSL-1	24
5.7.2	CSL-2	25
5.7.3	CSL-3	25
5.7.4	CSL-4	25
5.8	Traceability	26
5.9	Marking	26
5.10	Record Retention	27
5.11	Handling, Storage, and Shipping	27
Annex A	(informative) API Monogram Program	28
Annex B	(informative) Purchasing Guidelines	32

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Foreword

Users/owners may require a period of time to bring existing structures into conformance with new criteria. Due to the number of structures involved and the limited availability of qualified inspectors, the date of the first inspection for existing structures should remain flexible.

This standard shall become effective on the date of publication. The forms in annexes A through D are intended for free exchange between owners/operators of the equipment or users of API 4G.

Shall: As used in a publication, “shall” denotes a minimum requirement in order to conform to the publication.

Should: As used in a publication, “should” denotes a recommendation or that which is advised but not required in order to conform to the specification.

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Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

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1 Scope

1.1 Purpose

This API standard specifies requirements for the design, qualification, production, marking and documentation of steel and nickel base alloy castings used in the petroleum and natural gas industries when referenced by an applicable API equipment standard or otherwise specified as a requirement for compliance.

1.2 Applicability

This API standard applies to castings used in the manufacture of pressure containing, pressure controlling and primary load bearing components. Castings manufactured in accordance with this API Standard may be produced using any industry standard casting method.

1.3 Casting Specification Levels (CSL)

This API Standard establishes requirements for four casting specification levels (CSL). These four CSL designations define different levels of cast product technical, quality and qualification requirements.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASME¹ Boiler and Pressure Vessel Code (BPVC), Section VIII, Division 1, *Pressure Vessels*

ASME Boiler and Pressure Vessel Code (BPVC), Section IX, *Welding and Brazing Qualifications*

ASME B31.3, *Process Piping*

AWS D1.1, *Structural Welding Code—Steel*

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

ASTM A488/A488M, *Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel*

ASTM A609, *Standard Practice for Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof*

ASTM E10, *Standard Test Method for Brinell Hardness Test of Metallic Materials*

ASTM E18, *Standard Test Method for Rockwell Hardness Test of Metallic Materials*

¹ ASME International, 3 Park Avenue, New York, NY 10016-5990, USA, www.asme.org.

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ASTM E45, *Standard Test Method for Determining the Inclusion Content of Steel*

ASTM E94, *Standard Guide for Radiographic Examination*

ASTM E110, *Standard Test Method for Indentation Hardness of Metallic Materials by Portable Hardness Testers*

ASTM E112, *Standard Test Method for Determining Average Grain Size*

ASTM E125, *Standard Reference Photographs for Magnetic Particle Indications on Ferrous Castings*

ASTM E165, *Standard Practice for Liquid Penetrant Examination for General Industry*

ASTM E186, *Standard Reference Radiographs for Heavy-Walled (2 to 4½-in. (50.8 to 114-mm)) Steel Castings*

ASTM E280, *Standard Reference Radiographs for Heavy-Walled (4½ to 12-in. (114 to 305-mm)) Steel Castings*

ASTM E340, *Standard Test Method for Macroetching Metals and Alloys*

ASTM E407, *Standard Practice for Microetching Metals and Alloys*

ASTM E428, *Standard Practice for Fabrication and Control of Metal, Other than Aluminum, Reference Blocks Used in Ultrasonic Testing*

ASTM E446, *Standard Reference Radiographs for Steel Castings Up to 2 in. (50.8 mm) in Thickness*

ASTM E562, *Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count*

ASTM E709, *Standard Guide for Magnetic Particle Testing*

ASTM G48, *Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution*

NCSL Z540.3, *Requirements for the Calibration of Measuring and Test Equipment*

MSS-SP-55, *Quality Standard for Steel Castings for Valves, Flanges, Fittings and Other Piping Components – Visual Method for Evaluation of Surface Irregularities*

3 Terms, Definitions, and Abbreviations

For purposes of this standard, the following terms, definitions, and acronyms apply.

3.1 Terms and Definitions

3.1.1

acceptance criteria

Defined limits placed on characteristics of materials, processes, products or services.

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3.1.2 calibration

Comparison and adjustment to a standard of known accuracy.

3.1.3 casting process

General method for producing a casting, typically includes changes in the molding practice. These would include but are not limited to sand, centrifugal, investment, shell, permanent mold, die or lost foam casting.

3.1.4 equivalent round

A means of equating the thermal response in the center of parts having different geometries to that of a round bar having the same thermal response in the center.

3.1.5 grinding, cosmetic

Grinding meant to remove small surface discontinuities but not to exceed minimum wall conditions and to be blended or feathered with remaining surfaces.

3.1.6 heat cast

A term used to identify the material produced from a single melting operation.

NOTE Different heats of the same material can vary in chemical composition within prescribed limits. Stock from a single heat will have a consistent analysis and more uniform properties.

3.1.7 heat treatment

A sequence of controlled heating and cooling operations applied to a solid metal to impart desired properties.

3.1.8 linear indication

Surface NDE indication whose length is equal to or greater than three times its width.

3.1.9 melt practice

Procedure and equipment used to create a heat of metal. Includes the type of melting furnace used such as AIM, AOD and EAF.

3.1.10 pattern

The wood, metal, wax, foam or plastic replica of the final product to be made. Patterns usually include gating systems.

3.1.11 rigging

Gates, risers, loose pieces, etc., needed on the pattern to produce a sound casting.

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3.1.12

sample casting

A casting(s) made and tested as part of the initiation and development of the production method, i.e., the first casting(s) from a new pattern using the identical foundry practice, i.e., risering, gating, chilling, coring and molding as the production castings it is intended to represent.

3.1.13

thickness (T)

Maximum section thickness of the casting

3.1.14

traceability

The ability to verify the history, location or application of an item by means of documented recorded identification.

3.2 Abbreviations

AIM air induction melting

AOD argon oxygen de-carburization

EAF electric arc furnace

CSL casting specification level

MPS manufacturing procedure specification

NDE nondestructive examination

4 Qualification

4.1 General

This standard gives the requirements for four casting specification levels (CSL). The CSL's are numbered in increasing levels of severity from 1 to 4 in order to reflect increasing technical, quality and qualification criteria. The following subparagraphs describe the conditions which, when met, allow the casting to receive the appropriate CSL classification level.

4.2 Qualification Casting

4.2.1 A qualification casting shall be produced, tested, and evaluated by the casting supplier in order to establish qualification for a range of products listed in Table 8. Castings shall be produced in accordance with a Manufacturing Procedure Specification, as specified in 5.2. The material group of the qualification casting shall be in accordance with Table 1. Qualification castings are to be in their completed cast form, with the addition of any specified rough machining and full heat treatment to establish the final mechanical properties required of the finished product. Qualification castings shall be produced in accordance with the requirements of Table 3 and the acceptance criteria of Tables 5, 6 and 7. One or more qualification test coupons conforming to Figures 1 through 5, as appropriate, shall be poured at the same time and from the same heat as the qualification casting.

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4.2.2 A casting qualified to higher casting specification level is also qualified for lower casting specification levels (e.g. CSL-4 is qualified for CSL-3, CSL-2 and CSL-1).

4.2.3 Repair welding on the qualification casting shall comply with Table 2. Cosmetic grinding to remove defects is permitted, but cosmetic grinding shall be kept to a minimum. Excessive surface grinding may be cause for rejection of the qualification casting.

Table 1 — Material Groups

Material Group	Description	Typical Examples
Group A	Carbon steels	ASTM A216 ASTM A148 ASTM A352
Group B	Low alloy steels	ASTM A217 A487/A487M
Group C	Stainless steels other than duplex	ASTM A351
Group D	Corrosion resistant alloys/duplex	Duplex and super duplex stainless steels ASTM A890 ASTM A995
Group E	Corrosion resistant alloys/nickel base alloys	ASTM A494

Table 2 — Qualification Casting Weld Repair Limitations

CSL	% Surface Area	% Wall Thickness
CSL-1	No Limitation	No Limitation
CSL-2	25 %	25 %
CSL-3	20 %	20 %
CSL-4	10 %	10 %

4.3 Qualification Test Coupon (QTC)

4.3.1 Size and Shape of Qualification Test Coupon (QTC)

4.2.1.1 Determine the size of the qualification test coupon for a part using the equivalent-round method. Figure 1 and Figure 2 illustrate the basic models for determining the equivalent round of simple solid and hollow parts. Any of the shapes shown may be used for the qualification test coupon. Figure 4 describes the steps for determining the governing equivalent-round for more complex sections. Determine the equivalent round of a part using the actual dimensions of the part in the “as-heat-treated” condition. The equivalent round of the qualification test coupon shall be equal to or greater than the equivalent-round dimensions of the part it qualifies, except that the equivalent round is not required to exceed 125

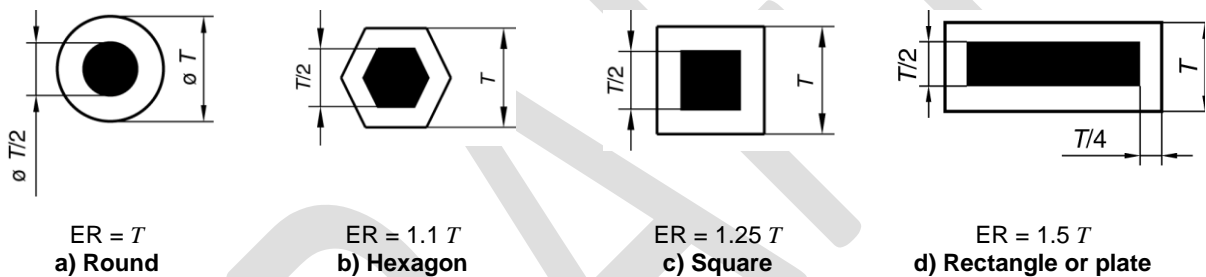
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mm (5 in.). Figure 3 and Figure 5 illustrate the procedure for determining the required dimensions of a keel block.

4.2.1.2 Qualification test coupons shall either be integral with the components they represent, separate from the components or be taken from sacrificed production part(s). In all cases, test coupons shall be from the same heat as the components they qualify and shall be heat-treated together with the components.

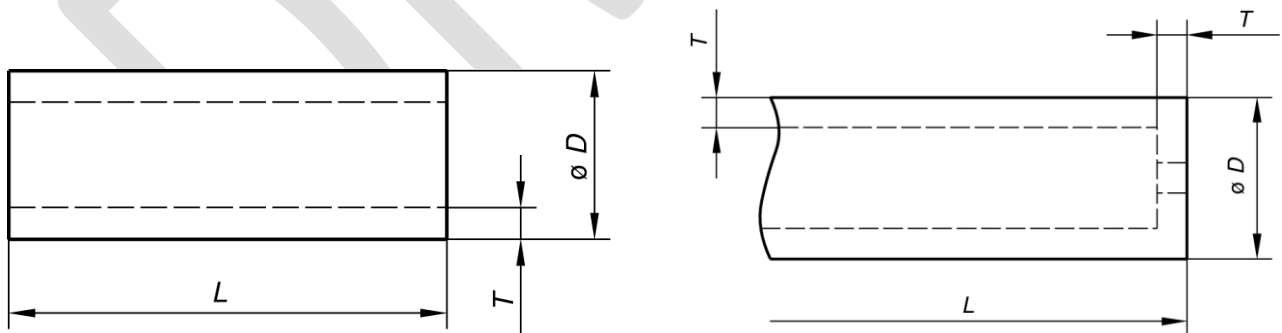
4.2.1.3 Test specimens shall be removed from integral or separate qualification test coupons so that their longitudinal centerline axis is entirely within the centre core 1/4-thickness envelope for a solid test coupon, or within 3 mm (1/8 in.) of the mid-thickness of the thickest section of a hollow test coupon. The gauge length of a tensile specimen or the notch of an impact specimen shall be at least 1/4-thickness from the ends of the test coupon.

4.2.1.4 Test specimens taken from sacrificed production parts shall be removed from the centre core 1/4-thickness envelope location of the thickest section of the part.



NOTE If L is less than T , consider section as a plate of thickness L .

Figure 1 — Equivalent round models — Solids of length L



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$$ER = 2 T$$

$$ER = 2.5 T \text{ if } D \text{ is less than or equal to } 63.5 \text{ mm (2.5 in.)}$$

$$ER = 3.5 T \text{ if } D \text{ is greater than } 63.5 \text{ mm (2.5 in.)}$$

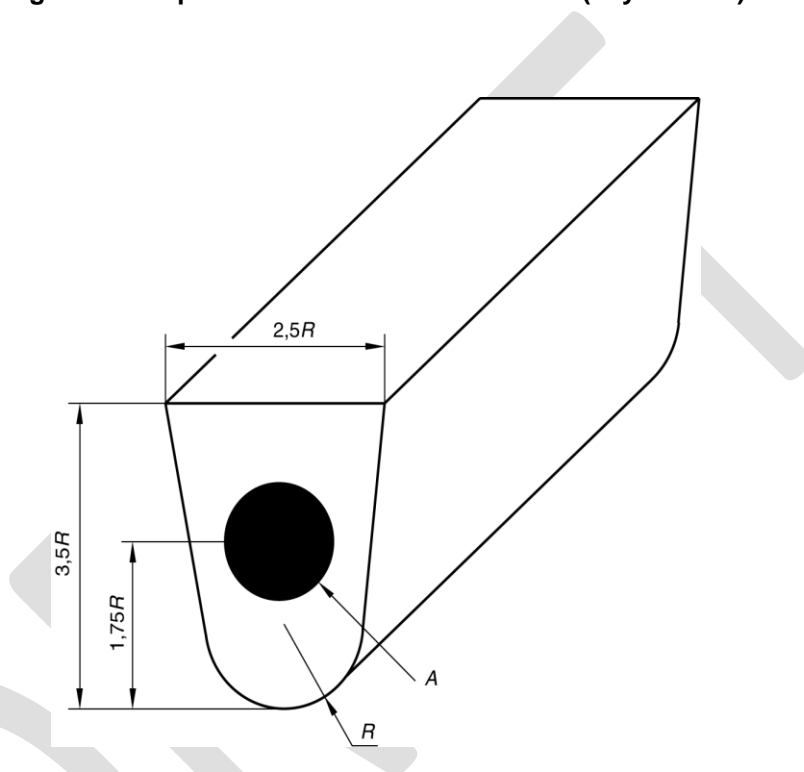
NOTE If L is less than D , consider as a plate of thickness T . If L is less than T , consider as a plate of thickness L .

NOTE Use maximum thickness, T , in the calculation.

a) Open at Both Ends

b) Restricted or Closed at One or Both Ends

Figure 2 — Equivalent round models — Tube (any section)



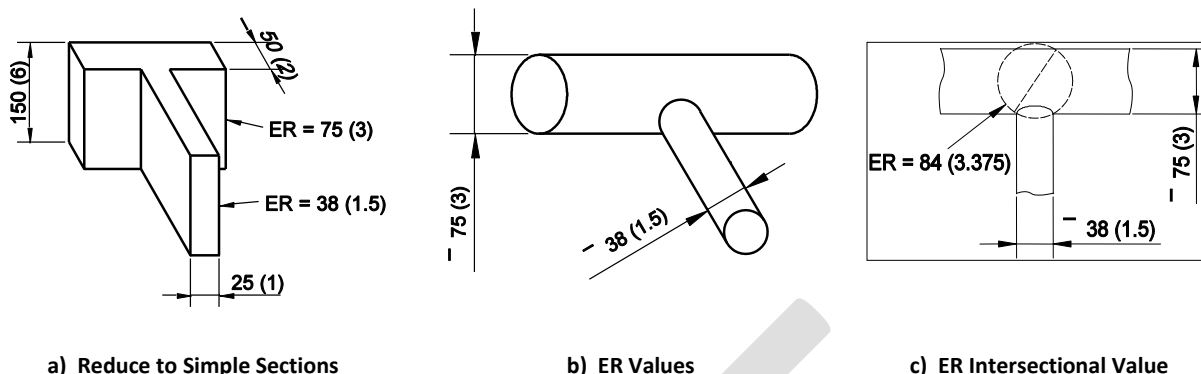
$$ER = 2.3 R$$

NOTE Shaded area, A, indicates 1/4 T envelope for test specimen removal.

Figure 3 — Equivalent Round Models — Keel Block Configuration

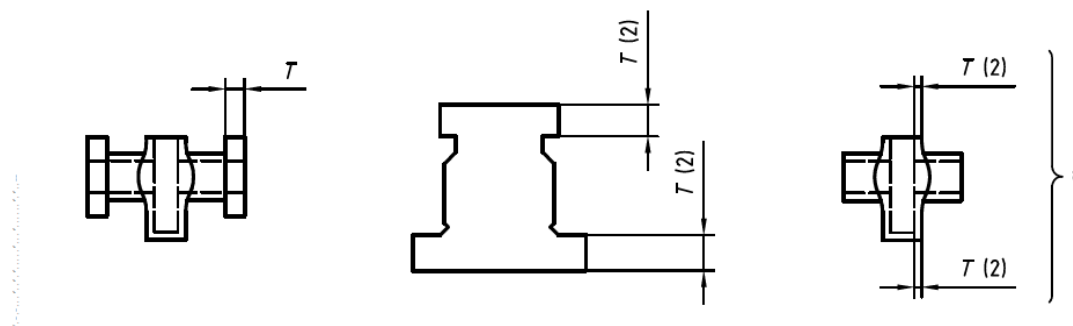
Dimensions in millimeters (inches)

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NOTE The following steps should be used in determining the governing equivalent-round (ER), for complex sections:

- Reduce the component to simple sections a).
- Convert each simple section to an equivalent-round b).
- Calculate the diagonal through the circle that would circumscribe the intersection of the ER values c).
- Use the maximum ER value, whether for a single section or an intersection as the ER of the complex section.



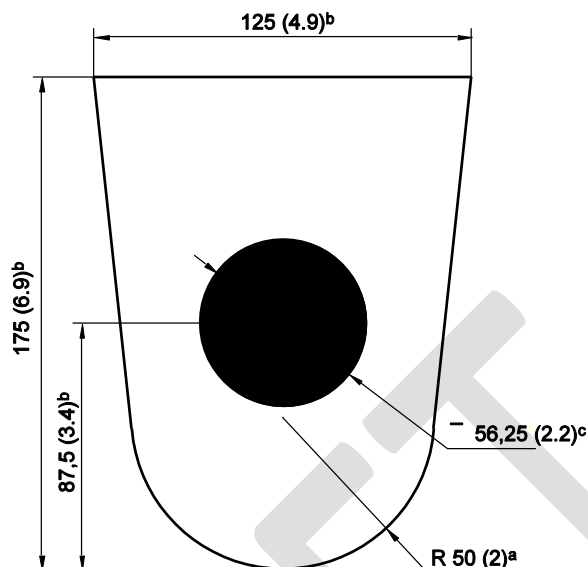
a Bodies with screwed and open ends.

When all internal and external surfaces during heat treatment are within 13 mm (1/2 in.) of the final surfaces, $ER = 1 \frac{1}{4} T$. When all internal and external surfaces during heat treatment are not within 13 mm (1/2 in.) of the final surfaces, $ER = 2 T$. On multi-flanged components, T shall be the thickness of the thickest flange.

Where T is the thickness when the component is heat-treated as in $T(2)$, use the larger of the two indicated dimensions

Figure 4 — Equivalent-round models — Complex shapes

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To develop a keel block for ER = 115 mm (4.5 inches), see footnotes below:

- ^a Noting from Figure 3 that $ER = 2.3 R$, then $R = ER/2.3 = 50 \text{ mm (2 in.)}$.
- ^b Construct keel block as illustrated in Figure C using multiples of R .
- ^c Diameter D .

Figure 5 — Example of Development of Keel Block Dimensions

4.4 Casting Qualification Testing

4.4.1 Examination Procedure

The examinations described in this section shall be performed when specified in Table 3.

Table 3 — Examination/Testing Requirements for Qualification Casting

CSL	Mechanical	Micro-Structure	Visual	Dimensional	Hardness	Surface NDE	Volumetric NDE	Sacrificial Casting	Corrosion Testing
CSL-1	4.3.6	—	4.3.2	4.3.3	—	—	—	—	—
CSL-2	4.3.6	—	4.3.2	4.3.3	4.3.4	4.3.5.1 4.3.5.2	—	—	—
CSL-3	4.3.6	4.3.7 Gr. A & B	4.3.2	4.3.3	4.3.4	4.3.5.1 4.3.5.2	4.3.5.3	—	4.3.8.2 Group D
CSL-4	4.3.6	4.3.7 Gr. A & B	4.3.2	4.3.3	4.3.4	4.3.5.1 4.3.5.2	4.3.5.3	4.3.8.1	4.3.8.2 Group D

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4.4.2 Visual Examination

All surfaces of the qualification casting shall be visually inspected in accordance with MSS-SP-55. No internal chills or permanent metal chaplets are allowed. Chaplets or core supports made of molding media are allowed. In the instance where these molding media chaplets are used, the hole remaining in the casting wall will need to be welded. Photographs shall be taken of the qualification casting in the “as-received” condition to document surface finish and general appearance. Acceptance criteria shall be in accordance with Table 5. Results shall be documented.

4.4.3 Dimensional Inspection

The casting supplier shall specify and verify critical dimensions. Acceptance criteria for critical dimensions shall be as required by the casting supplier’s written specification. Results shall be documented.

4.4.4 Hardness Testing

Brinell and/or Rockwell hardness testing in accordance with ASTM E10, ASTM E110, or ASTM E18 shall be performed on external surfaces to ensure the casting is within the specified limits for the finished product. The casting supplier shall specify in the MPS the number and location for the tests. Results shall be documented.

4.4.5 Nondestructive Examination

4.4.5.1 Magnetic Particle Examination

All accessible surfaces of each Group A and Group B ferromagnetic casting shall be magnetic particle inspected per ASTM E709. The acceptance criteria shall be as specified in Table 6. Results shall be recorded.

4.4.5.2 Liquid Penetrant Examination

All accessible surfaces of each non-ferromagnetic casting shall be liquid penetrant inspected in accordance with ASTM E165. The acceptance criteria shall be as specified in Table 6. Results shall be recorded.

4.4.5.3 Volumetric Examination

4.4.5.3.1 General

As far as practical, the entire volume of each part shall be volumetrically inspected (radiography or ultrasonic) after heat treatment for mechanical properties and prior to machining operations that limit effective interpretation of the results of the examination.

For quench-and-tempered products, the volumetric inspection shall be performed after heat treatment for mechanical properties exclusive of stress-relief treatments or re-tempering to reduce hardness.

4.4.5.3.2 Test Method: Radiographic Examination

Radiographic examinations shall be performed in accordance with procedures specified in ASTM E94, to a minimum equivalent sensitivity of 2 % and a 2-2T quality level. Both X-ray and gamma-ray radiation sources are acceptable within the inherent thickness range limitation of each. Real-time imaging and recording/enhancement methods may be used if the casting supplier has documented proof that these

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methods result in a minimum equivalent sensitivity of 2 % and a 2-2T quality level. Wire-type image quality indicators are acceptable for use in accordance with ASTM E747. Acceptance criteria shall be in accordance with Table 7.

NOTE The first number of the quality level designation refers to the image quality indicator or penetrameter thickness expressed as a percentage of the specimen thickness; the second number refers to the diameter of the image quality indicator hole that it is necessary to be able to see on the radiograph, expressed as a multiple of penetrameter thickness,

4.4.5.3.3 Test Method: Ultrasonic Examination

Ultrasonic examination of castings shall be performed in accordance with the flat-bottom hole procedures specified in ASTM A609 (except immersion method may be used) and ASTM E428.

For calibration, the distance amplitude curve (DAC) shall be based on 1,6 mm (1/16 in.) flat-bottom hole for metal thicknesses through 38 mm (1 ½ in.), on 3,2 mm (1/8 in.) flat-bottom hole for metal thicknesses from 38 mm (1 ½ in.) through 150 mm (6 in.), and on 6,4 mm (1/4 in.) flat-bottom hole for metal thicknesses exceeding 150 mm (6 in.). Acceptance shall be in accordance with Table 7.

4.4.5.3.4 Test Results

All volumetric test results shall be recorded.

4.4.6 Mechanical Testing

The mechanical tests required by this standard shall be performed on qualification test coupons representing the heat and heat treatment lot used in the manufacture of the casting. Tests shall be performed in accordance with the requirements of ASTM A370, or equivalent national standards, using material in the final heat-treated condition. For the purposes of material qualification testing, stress relief following welding is not considered heat treatment, provided that the PWHT temperature is below that which changes the heat-treated condition of the base material. Material qualification tests may be performed before the stress-relieving process, provided that the stress-relieving temperature is below that which changes the heat-treatment condition.

- a) Tensile test specimens shall be removed from qualification test coupon and tested in accordance with ASTM A370. The results shall be reported.
- b) When required by the material specification selected for the qualification casting, Charpy (CVN) impact specimens shall be removed from the qualification test coupon and tested in accordance with ASTM A370. The results shall be reported. At the option of the casting supplier, Charpy (CVN) tests may be performed on material not requiring impact testing.

4.4.7 Microstructure Examination

4.4.7.1 Prepare a micro-specimen from the grip end of one of the tensile specimens.

4.4.7.2 Provide a photomicrograph of the as-polished specimen at 100X showing average and worst-case field (any type).

4.4.7.3 Etch the specimen using the appropriate reagent. The structure shall be free from casting defects, inclusions, and must be homogenous. Photograph typical microstructure and report it. Any

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unusual anomalies such as intermetallic and/or heavy precipitates in the grain boundaries shall be photographed and reported. Results shall be documented.

4.4.7.4 For Group A, Group B and Group C materials, steel cleanliness shall be determined in accordance with ASTM E45 as shown in Table 4. Photomicrographs shall be taken at 100X magnification showing average and worst-case field views. Results shall be documented.

Table 4 — Modified JK Inclusion Rating Limits

Inclusion Type	Thin	Heavy
Type A sulfide	2	1 ½
Type B sulfide	2	1 ½
Type C silicate	2	1 ½
Type D oxide	2	1 ½

4.4.7.5 Grain size shall be determined in accordance with ASTM E112 for the sample following etching with a suitable reagent. Photomicrographs of grain size shall be taken.

4.4.8 Chemical Analysis

4.4.8.1 The casting supplier shall specify the nominal chemical composition, including composition tolerances, of the material used for the qualification casting.

4.4.8.2 Material composition shall be determined on a heat basis (or on a remelt-ingot basis for remelt-grade materials) in accordance with a nationally or internationally recognized standard.

4.4.9 Additional Testing

4.4.9.1 General

The additional testing in this section is mandatory and shall be performed in addition to the requirements of sections 4.4.1 through 4.4.8.

4.4.9.2 Sacrificial Casting – CSL-4

- Section the casting into four (4) roughly sized equal quadrants.
- Visually inspect all surfaces of each quadrant for cracks, voids, porosity, or other anomalies. Photograph all anomalies of each surface.
- Liquid penetrant examine the cut surface of each quadrant per ASTM E165 and report results.
- Macro-etch one quadrant in accordance with ASTM E340 (an appropriate etchant shall be used) to show the grain structure and internal quality. The surface closest to the centerline shall be used. Photographs shall be taken with a scale visible to provide size reference. Any indications noted shall be clearly marked for later evaluation.

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- e) A set of hardness traverses shall be made across the cut surface of one quadrant taken 90 degrees to each other. The hardness and specific locations shall be recorded. A photograph shall also be taken.

4.4.9.3 Group D - Duplex Material Testing

4.4.9.3.1 General

4.4.9.3.1.1 The qualification test coupon (QTC), after the final heat treatment cycle, shall be corrosion tested in accordance with ASTM G48, Method A.

4.4.9.3.1.2 If the QTC is a solid block, one ASTM G48 sample shall be taken from the center of the block.

4.4.9.3.1.3 If the QTC has a hole, two ASTM G48 samples shall be taken. One shall be taken adjacent to the inside surface and one from the center of the thickest cross-section. The specimen surface shall be parallel to the internal surface.

4.4.9.3.1.4 Sides of the test specimen shall be ground to a 120-grit finish (or better) with the edges rounded.

4.4.9.3.1.5 Test temperature shall be $25 \pm 1^\circ\text{C}$ and the exposure time 24 hours.

4.4.9.3.1.6 The acceptance criteria shall be that the test material shall show no evidence of pitting after 24 hours immersion in the test solution when examined with a low power magnification (20X) and the maximum weight loss shall be less than 1 g/m².

4.4.9.3.2 Microstructure Controls

The micrographic examination shall be carried out on a sample taken from the qualification test coupon at the same location as specimens taken for mechanical testing.

4.4.9.3.3 Ferrite Content

The ferrite content shall be conducted in accordance with ASTM E562. The ferrite content shall be in the range of 35 % – 65 % (volume fraction). Samples shall be electrolytically etched in either NaOH or KOH, and in such a manner as to provide maximum contrast for austenite and ferrite phase discrimination. A minimum of 15 fields and 16 points per field shall be used.

4.4.9.3.4 Metallographic Examination

Samples shall be etched using ASTM E407 etchant number 98 ($\text{K}_3\text{Fe}(\text{CN})_4$ with KOH or NaOH). Samples cross-section shall be examined at the mid-wall location. Sample cross-section shall be examined at a minimum of 500X magnification. Intermetallic phases or precipitates are allowed up to a maximum of 0.2 %.

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Table 5 — Visual Inspection Acceptance Criteria

Reference photographs in MSS-SP-55 shall be used to determine acceptability of castings
Type 1 - Unacceptable
Type 2 - 12 - A and B are Acceptable All others are Unacceptable

Table 6 — Surface Examination Acceptance Criteria

Relevant Indication	Those indications whose major dimension is greater than 1/16 inch.				
Non-Relevant Indication	Inherent indications not associated with a surface rupture (i.e., magnetic permeability, non-metallic stringers).				
Linear Indication	Any indication in which the length is equal to or greater than three times its width.				
Rounded Indication	Any indication which is circular or elliptical with its length less than three times the width.				
Magnetic Particle	<u>Acceptance Criteria</u>				
	Indications greater than the following shall be unacceptable:				
	Reference: ASTM E125				
	Defect Type	Indication	Wall Thickness	E-125 Degree	Figure Number
	I	Linear	All	3/16"	—
	II	Shrinkage	All	2	II-2
	III	Inclusions	All	2	III-3
Liquid Penetrant	IV	Chills & Chaplets	All	None	—
	V	Porosity	All	1	V-1
	<u>Acceptance Criteria</u>				
	a) No linear relevant indications greater than 3/16 in.				
	b) No rounded relevant indications greater than 3/16 in.				
	Four or more rounded relevant indications greater than 1/16 in. in a line separated by less than 1/16 in., edge to edge, are unacceptable.				

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Table 7 — Volumetric Examination Acceptance Criteria

	ASTM E186: Standard reference radiographs for heavy walled (2 to 4-1/2 inch) steel casting.																
RT Acceptance Criteria:	ASTM E280: Standard reference radiographs for heavy walled (4-1/2 in. to 12 in.) steel castings.																
	ASTM E446: Standard reference radiographs for steel casting up to 2 inches in thickness.																
	Maximum defect classification as follows: <table> <tr> <th>Type Defect</th><th>Maximum Defect Class</th></tr> <tr> <td>A</td><td>2</td></tr> <tr> <td>B</td><td>2</td></tr> <tr> <td>C</td><td>2 All Types)</td></tr> <tr> <td>D</td><td>None Acceptable</td></tr> <tr> <td>E</td><td>None Acceptable</td></tr> <tr> <td>F</td><td>None Acceptable</td></tr> <tr> <td>G</td><td>None Acceptable</td></tr> </table>	Type Defect	Maximum Defect Class	A	2	B	2	C	2 All Types)	D	None Acceptable	E	None Acceptable	F	None Acceptable	G	None Acceptable
Type Defect	Maximum Defect Class																
A	2																
B	2																
C	2 All Types)																
D	None Acceptable																
E	None Acceptable																
F	None Acceptable																
G	None Acceptable																
UT Acceptance Criteria:	Distant amplitude curve (DAC) shall be based on the following: <table> <tr> <th>Wall Thickness (T)</th><th>DAC</th></tr> <tr> <td>T to 1.5 in. inclusive</td><td>1/16 in.</td></tr> <tr> <td>T from 1.5 in. to 6 in. inclusive</td><td>1/8 in.</td></tr> <tr> <td>T over 6 in.</td><td>¼ in.</td></tr> </table> <p>a) No single indication greater than reference DAC.</p> <p>b) Two or more indications exceeding 50 % DAC within ½ in. of each other in any direction are unacceptable.</p>	Wall Thickness (T)	DAC	T to 1.5 in. inclusive	1/16 in.	T from 1.5 in. to 6 in. inclusive	1/8 in.	T over 6 in.	¼ in.								
Wall Thickness (T)	DAC																
T to 1.5 in. inclusive	1/16 in.																
T from 1.5 in. to 6 in. inclusive	1/8 in.																
T over 6 in.	¼ in.																

4.5 Acceptance of the Qualification Casting

4.5.1 Results of the examinations specified in Table 3 shall comply with the acceptance criteria specified in the Tables 5, 6, 7 and the casting supplier's written specification. Results shall be documented.

4.5.2 Qualification castings failing to meet the acceptance criteria shall be cause for re-evaluation of foundry practice and the casting design. Requalification is required. Results shall be documented.

4.6 Records of Qualification

The following records are required to document qualification of the casting.

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- a) Heat number, material specification, actual chemistry with minimum and maximum tolerances, cleanliness, if applicable.
- b) Casting parameters such as molding media, wash type if applicable, melt practice, ladle refining if applicable, tap temperature, pouring temperature.
- c) Heat Treatment Parameters such as specification, ramp rate, temperature, time at temperature, cooling rate and/or cooling media, time to quench if applicable, heat treat equipment used, actual heat treatment chart.
- d) Test records: records of the examinations, mechanical testing, metallographic evaluations, as described in 6.1.

4.7 Limits of Casting Qualifications

4.7.1 CSL-1

4.7.1.1 A change in material group as shown in Table 1 from the casting that was previously qualified requires requalification.

Table 8 — As-cast Weight/Thickness Range Classes

CSL Level	As-cast Thickness (inch) and Weight (pound)							
	<2	≥2	<6	≥6	<8	≥8	<10	≥10
	<500	<500	≥500<2500	≥500<2500	≥2500<10,000	≥2500<10,000	≥10,000	≥10,000
CSL-1	1-1	1-1	1-1	1-1	1-1	1-1	1-1	1-1
CSL-2	2-1	2-1	2-1	2-1	2-1	2-2	2-2	2-2
CSL-3	3-1	3-1	3-2	3-2	3-3	3-3	3-4	3-4
CSL-4	Weight and thickness not applicable for CSL 4							

4.7.2 CSL-2

4.7.2.1 Qualification requirements specified for CSL-1 are required for CSL-2.

4.7.2.2 A change in the as-cast thickness and weight range class as shown in Table 8 from the casting that was previously qualified requires requalification.

4.7.3 CSL-3

4.7.3.1 Qualification requirements specified for CSL-2 are required for CSL-3.

4.7.3.2 When metal refining steps, such as AOD or ladle refining, are used to produce the qualification casting, the elimination of any of these steps from the melting/casting practice shall require requalification.

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4.7.4 CSL-4

4.7.4.1 Qualification requirements specified for CSL-3 are required for CSL-4.

4.7.4.2 A change in the specific material specification/grade from the casting that was previously qualified requires requalification of the casting.

Table 9 — Limits of CSL Qualification Summary

Requirement	Ref.	CSL 1	CSL 2	CSL 3	CSL-4
ASTM keel block	Fig. 3 Fig. 5	X	X	—	—
Equivalent round or Integral test specimen	Fig. 4 Fig. 5	—	—	X	—
Sacrificial casting	4.4.9.2	—	—	—	X
Change in material group	4.7.1.1	X	X	X	X
As-cast thickness and weight range class	4.7.2.2	—	X	X	X
Change in melt practice	4.7.3.2	—	—	X	X
Material specification/grade	4.7.4.2	—	—	—	X
NOTE This table provides a matrix of requirements and may not include all requirements and should be used as a reference only.					

5 Production Castings

5.1 General

Castings, including sample castings, shall be produced in accordance with the manufacturing procedure specification specified in 5.2.

5.2 Manufacturing Procedure Specification

The casting supplier shall prepare a manufacturing procedure specification (MPS) to include, as minimum, allowable levels for all casting parameters including the process control variables listed in 5.3.1 and the heat treatment parameters listed in 5.3.2. As part of the MPS, pattern equipment shall be shown with detailed rigging.

5.3 Process Control Variables

5.3.1 General Variables

The following are general process control variables for the production of qualified castings:

- a) acceptable pattern equipment for production;

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- b) acceptable core equipment for production;
- c) acceptable sand control;
- d) mold/core equipment maintenance;
- e) rigging design documented;
- f) molding parameters defined, such as sand and wash type, dipping sequence for investment;
- g) melt practice;
- h) cleaning room practices;
- i) weld repair, if required, including PWHT;
- j) NDE and inspection procedures;
- k) material traceability system;
- l) qualification test coupon per heat;
- m) chemical analysis;
- n) mechanical properties;
- o) hardness test.

5.3.2 Heat Treatment Parameters

The following are heat treat parameters, as applicable:

- a) furnace loading diagram and orientation of production parts;
- b) normalizing temperature and time, if applicable;
- c) casting configuration and dimensions at time of heat treatment;
- d) austenitizing temperature and time;
- e) quenching medium and type of agitation (water/polymer, forced, horizontal; or vertical quench, ID/OD, etc.);
- f) tempering temperature and time;
- g) loading temperature;
- h) heating rate;
- i) holding temperature;

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- j) holding time;
- k) cooling medium;
- l) time to quench;
- m) furnace chart(s).

5.4 Sample Casting

5.4.1 General

Prior to the production of castings, the casting supplier shall produce a sample casting(s) and obtain approval from the purchaser. The casting supplier shall perform all required tests and examinations and certify that the sample casting(s) meets the requirements of this standard.

At the discretion of the purchaser, the first production run of castings may be considered the sample. In this case, at least one of the castings shall be processed as a sample by the casting vendor.

5.4.2 Definition of a Sample Casting

A casting shall be deemed a "sample" when one or more of the following events take place:

- a) first use of a pattern on a new order;
- b) a pattern is re-rigged;
- c) a new pattern is made;
- d) a pattern is revised;
- e) a change in processing (i.e., core making, sand control, melt practice);
- f) a pattern is sent to another foundry;
- g) rejection of a sample;
- h) upon identification of a recurring defect in a casting released for production.

5.4.3 Evaluation of Sample Castings

5.4.3.1 Dimensional inspection shall be performed in accordance with the purchaser's drawings.

5.4.3.2 Visual examination shall be performed in accordance with the purchaser's specification, if provided. No internal chills or permanent metal chaplets are allowed. Chaplets or core supports made of molding media are allowed as agreed upon between the supplier and purchaser. In the instance where these molding media chaplets are used, the hole remaining in the casting wall would need to be welded. If the purchaser does not provide requirements for visual examination, visual examination shall be performed as specified in 4.4.2.

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5.4.3.3 Magnetic particle examination of ferromagnetic castings shall be performed in accordance with the purchaser's specification, if provided. If the purchaser does not provide requirements for magnetic particle examination, magnetic particle examination shall be performed as specified in 4.4.5.1.

5.4.3.4 Liquid penetrant particle examination of non-ferromagnetic castings shall be performed in accordance with the purchaser's specification, if provided. If the purchaser does not provide requirements for liquid penetrant examination, liquid penetrant examination shall be performed as specified in 4.4.5.2.

5.4.3.5 Volumetric examination shall be performed in accordance with the purchaser's specification, if provided. If the purchaser does not provide requirements for volumetric examination, the examination shall be performed as specified in 4.4.5.3.

5.4.3.6 Brinell and/or Rockwell hardness testing shall be performed in accordance with ASTM E10, ASTM E110 or ASTM E18. Hardness test locations shall be as specified in the purchaser's specification. If the purchaser does not provide hardness test locations, testing shall be as specified in 4.4.4.

5.4.3.7 Mechanical testing shall be performed as specified in 4.4.6.

5.4.3.8 Chemical analysis shall be performed as specified in 4.4.8.

5.4.4 Sample Casting Acceptance

Upon completion of all required examinations and tests, results shall be sent to the purchaser for approval. Subsequent castings shall not be made until the sample is approved by the purchaser.

5.5 Design and Maintenance of Pattern Equipment

5.5.1 Design

Design of patterns and cores used to produce castings in accordance with this standard shall include documentation of those designs. This documentation shall include, as applicable

- design requirements,
- assumptions,
- analysis methods,
- comparison with previous designs or operating history of similar products,
- calculations,
- manufacturing drawings and specifications,
- design reviews and/or,
- physical testing results (such as design validation testing).

Design documentation shall be reviewed by a qualified person other than the person who created the original design. Design documents and data, shall be maintained for 5 years after the date of last manufacture of that product.

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5.5.2 Maintenance

Maintenance of patterns and related equipment shall be conducted in accordance with documented procedures. Records of maintenance shall be kept.

5.5.3 Allowable Design Changes

Design changes shall be documented and reviewed by the casting supplier against the design documents to determine if the change is a substantive change.

All substantive design changes shall be documented reviewed and approved by a qualified person before their implementation and shall continue to meet the applicable requirements of this standard. When required by purchase order, all substantive design changes shall be approved by the purchaser.

5.6 Inspection, Quality Control, Marking, and Documentation

5.6.1 Calibration

Inspection, measuring and testing equipment used for acceptance shall be identified, inspected, calibrated, and adjusted at specific intervals in accordance with NCSL Z540.3 and this standard. Calibration standards shall be traceable to the applicable national or international standards agency and shall be no less stringent than the requirements included herein. Inspection, measuring and testing equipment shall be used only within the calibrated range. Calibration intervals shall be established based on repeatability and degree of usage.

5.6.2 Furnace Calibration

Furnaces shall be calibrated yearly in accordance with documented procedures. Records of furnace calibration shall be maintained.

5.6.3 Visual Inspection

All production castings shall be visually inspected in accordance with MSS-SP-55 for cracks, voids, blisters, laps and other anomalies. If the purchaser does not provide acceptance criteria for visual examination, Table 5 shall be used. Results shall be documented.

5.6.4 Surface NDE

5.6.4.1 CSL-2 and CSL-3

The casting supplier shall randomly select one casting from each production run of each weight/thickness class (Table 8) and material group (Table 1) for surface examination. Surface examination shall be performed in accordance with the methods specified in 4.4.5.1 or 4.4.5.2, as appropriate for material. Acceptance criteria shall be in accordance with Table 6.

5.6.4.2 CSL-4

Each CSL-4 casting shall be surface-examined in accordance with the methods specified in 4.4.5.1 or 4.4.5.2, as appropriate for material. Acceptance criteria shall be in accordance with Table 6.

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5.6.4.3 Failure to Meet Acceptance Criteria

Failure of the casting to meet the applicable acceptance criteria will require a “hold” to be placed on the production lot and a surface examination performed on two additional sample castings selected at random from the same production run of castings. If the two additional castings fail, the purchaser and the casting supplier shall specifically agree on the disposition of the production lot.

5.6.5 Volumetric NDE

5.6.5.1 CSL-2 and 3

The casting supplier shall randomly select one casting from each production run of each weight/thickness class (Table 8) and material group (Table 1) for volumetric examination. Volumetric examination shall be performed in accordance with the methods specified in 4.4.5.3. Acceptance criteria shall be in accordance with Table 7 for ultrasonic examination and the radiographic quality levels as listed in Tables 10, 11 and 12.

5.6.5.2 CSL-4

Each CSL-4 casting shall be volumetrically examined in accordance with the methods specified in 4.4.5.3. Acceptance criteria shall be in accordance with Table 7 for ultrasonic examination and the radiographic quality levels as listed in Tables 10, 11 and 12.

5.6.5.3 Failure to Meet Acceptance Criteria

Failure of the casting to meet the applicable quality level will require a “hold” to be placed on the production lot and a radiographic examination performed on two additional sample castings selected at random from the same production run of castings. If the two additional castings fail, the purchaser and the casting supplier shall specifically agree on the disposition of the production lot.

Table 10 — Wall Thickness up to 2 in., in Accordance with ASTM E446

Discontinuity Type	Category	Acceptable Comparative Plate	
		CSL-2 and CSL-3	CSL-4
Gas	A	A3	A2
Sand	B	B4	B3
Shrink, Type 1	C	CA3	CA2
Shrink, Type 2	C	CB4	CB3
Shrink, Type 3	C	CC4	CC3
Shrink, Type 4	C	CD4	CD3
Hot tears and cracks	D and E	None	None
Inserts (chills & chaplets)	F	None	None

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Table 11 — Wall Thicknesses from 2 in. – 4.5 in., in Accordance with ASTM E186

Discontinuity Type	Category	Acceptable Comparative Plate	
		CSL-2 and CSL-3	CSL-4
Gas	A	A4	A3
Sand	B	B4	B3
Shrink, Type 1	C	CA4	CA3
Shrink, Type 2	C	CB4	CB3
Shrink, Type 3	C	CC4	CC3
Crack	D	None	None
Hot tear	E	None	None
Inserts	F	None	None

Table 12 — Wall Thicknesses from 4.5 in. to 12 in., in Accordance with ASTM E280

Discontinuity Type	Category	Acceptable Comparative Plate	
		CSL-2 and CSL-3	CSL-4
Gas	A	A4	A3
Sand	B	B4	B3
Shrink, Type 1	C	CA4	CA3
Shrink, Type 2	C	CB4	CB3
Shrink, Type 3	C	CC4	CC3
Crack	D	None	None
Hot tear	E	None	None
Inserts	F	None	None

5.6.6 Dimensional inspection

Dimensional inspection shall be performed on products produced to this standard. Sampling shall be in accordance with ISO 2859-1, Level II, 1.5 AQL. The casting supplier shall verify critical dimensions. Critical dimensions and acceptance criteria shall be as required by the purchaser's specification.

5.6.7 Repair welding

5.6.7.1 Where defect removal results in a wall thickness below an acceptable value, the resultant cavity may be repaired by welding, provided that all of the following requirements are satisfied.

- a) Welding shall be performed using weld procedures qualified in accordance with:

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- CSL-1 and CSL-2 – ASME B31.3, ASME BPVC, Section IX, AWS D1.1, ASTM A488 or equivalent standards;
 - CSL-3 – ASME BPVC, Section IX;
 - CSL-4 – No welding permitted.
- b) Welding shall only be performed by welders or welding operators qualified in accordance with standards listed in item a).
- c) Welding consumables shall conform to the consumable-manufacturer's specifications. The casting supplier shall have a written procedure for the storage and control of welding consumables.
- d) Materials of low-hydrogen type shall be stored and used as recommended by the welding consumable manufacturer to retain their original low-hydrogen properties.
- e) Weld repairs shall be heat treated in accordance with the postweld heat treatment requirements of the ASME BPVC, Section VIII, Division 1.
- f) Postweld heat treatment (solution treatment) of repair welds in austenitic stainless steels is neither required nor prohibited except when required by the material specification.
- g) The area shall be re-examined by the NDE method that originally disclosed the defect. The re-examination by magnetic particle or liquid penetrant methods of a repaired area originally disclosed by magnetic particle or liquid penetrant examination shall be performed after postweld heat treatment when postweld heat treatment is performed. The re-examination by radiography or ultrasonic methods of a repaired area originally disclosed by radiography or ultrasonic examination may be performed either before or after postweld heat treatment. The acceptance standards shall be as in the original examination.
- h) Weld repairs made as a result of radiographic examination shall be radiographed after welding. The acceptance standards for porosity and slag inclusion in welds shall be in accordance with the ASME BPVC, Section VIII, Division 1, UW-51.

5.6.7.2 Weld repair shall be documented.

5.7 Limits on the Qualification of Production Castings

5.7.1 CSL-1

5.7.1.1 A change in material group as shown in Table 1 from the qualification casting requires requalification.

5.7.1.2 Requalification is required when the pattern of the production casting is revised or a new pattern made.

5.7.1.3 Requalification is required when the pattern of the production casting is re-rigged including padding and external chills.

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5.7.2 CSL-2

5.7.2.1 Qualification requirements specified for CSL-1 are required for CSL-2.

5.7.2.2 A change in the as-cast thickness and weight range class as shown in Table 8 from the qualification casting requires requalification.

5.7.2.3 Requalification is required when the general casting process is changed from the qualification casting process, such as changing from an investment casting to a sand casting

5.7.3 CSL-3

5.7.3.1 Qualification requirements specified for CSL-2 are required for CSL-3.

5.7.3.2 Requalification is required when within a Material Group (Table 1), there is a change in the material type where a specified element's tolerance changes by 15 %. For example, if a qualification casting is made from ASTM A352 LCC with a 0.50 maximum nickel and a production casting is to be made from ASTM A352 LC3 with a 3.0 % – 4.0 % nickel, requalification is required.

5.7.3.3 When metal refining steps, such as AOD or ladle refining, are used to produce the qualification casting, the elimination of any of these steps from the melting/casting practice used for production castings shall require requalification.

5.7.4 CSL-4

5.7.4.1 Qualification requirements specified for CSL-3 are required for CSL-4

5.7.4.2 A change in the specific material specification/grade from the qualification casting requires requalification.

Table 13 — Limits of CSL Production Casting Summary

Requirement	Ref.	CSL 1	CSL 2	CSL 3	CSL-4
ASTM keel block	Fig. 3 Fig. 5	X	X	—	—
Equivalent round or Integral test specimen	Fig. 4 Fig. 5	—	—	X	—
Sacrificial casting	4.4.9.2	—	—	—	X
Change in material group	5.7.1.1	X	X	X	X
Revision or new pattern	5.7.1.2	X	X	X	X
Pattern is re-rigged	5.7.1.3	X	X	X	X
Change in risers or padding	5.7.1.3	X	X	X	X
Change in external chills	5.7.1.3	X	X	X	X
As-cast thickness and weight range class	5.7.2.2	—	X	X	X
Casting process	5.7.2.3	—	X	X	X

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Chemistry tolerance greater than 15 %	5.7.3.2	—	—	X	X
Change in melt practice	5.7.3.3	—	—	X	X
Material specification/grade	5.7.4.2	—	—	—	X
NOTE This table provides a matrix of requirements and may not include all requirements and should be used as a reference only.					

5.8 Traceability

5.8.1 Full traceability of castings shall be maintained with respect to material heat, manufacturing procedure specification, and heat treatment loads.

5.8.2 Casting qualification records shall be traceable to the Manufacturing Procedure Specification (MPS).

5.8.3 Castings produced to this specification shall be traceable to the applicable casting qualification record.

5.9 Marking

5.9.1 Each casting shall be marked with the following:

- “API Spec 20A”;
- date of manufacture (month and year);
- heat or heat treat lot number;
- traceability number;
- material group;
- weight/thickness range;
- qualification record;

5.9.2 The above marking shall be applied using low-stress (dot, vibration, or rounded V) stamps. Conventional sharp V-stamping is acceptable in low-stress areas, such as raised pads designed for stamping. Sharp V-stamping is not permitted in high stress areas unless subsequently stress-relieved at 590 °C (1100 °F) minimum.

5.9.3 The following marking may be applied by stamping or by cast-on lettering. Cast lettering shall be placed on the drag side of the pattern. All cast marking shall be of a size in relationship to the size of the casting. In all cases the largest size lettering possible must be utilized.

5.9.4 If cast markings are not 100 % legible, they shall be ground smooth and reapplied by welding or low stress steel stamping. Any welding performed to replace or repair cast marking shall comply with 5.6.7.

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- casting supplier's name or mark
- pattern number
- material grade

5.10 Record Retention

The casting supplier shall establish and maintain documented procedures to control all documents and data required by this standard. Records required by this standard shall be maintained for 10 years from date of manufacture. Documents and data may be in any type of media (hard copy or electronic) and shall be:

- maintained to demonstrate conformance to specified requirements;
- legible;
- retained and readily retrievable;
- stored in an environment to prevent damage, deterioration, or loss;
- available and auditable by the user/purchaser.

5.11 Handling, Storage, and Shipping

Castings shall be packaged for storage or transit in accordance with the written specifications of the casting supplier.

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Annex A **(informative)**

API Monogram Program

A.1 Scope

The API Monogram Program allows an API Licensee to apply the API Monogram to products. The API Monogram Program delivers significant value to the international oil and gas industry by linking the verification of an organization's quality management system with the demonstrated ability to meet specific product specification requirements. The use of the Monogram on products constitutes a representation and warranty by the Licensee to purchasers of the products that, on the date indicated, the products were produced in accordance with a verified quality management system and in accordance with an API product specification.

When used in conjunction with the requirements of the API License Agreement, API Q1, in its entirety, defines the requirements for those organizations who wish to voluntarily obtain an API license to provide API monogrammed products in accordance with an API product specification.

API Monogram Program licenses are issued only after an on-site audit has verified that the Licensee conforms to the requirements described in API Q1 in total, and the requirements of an API product specification. Customers/users are requested to report to API all problems with API monogrammed products. The effectiveness of the API Monogram Program can be strengthened by customers/users reporting problems encountered with API monogrammed products. A nonconformance may be reported using the API Nonconformance Reporting System available at <http://compositelist.api.org/ncr.asp>. API solicits information on new product that is found to be nonconforming with API-specified requirements, as well as field failures (or malfunctions), which are judged to be caused by either specification deficiencies or nonconformities with API-specified requirements.

This annex sets forth the API Monogram Program requirements necessary for a supplier to consistently produce products in accordance with API-specified requirements. For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, NW, Washington, DC 20005 or call 202-962-4791 or by email at certification@api.org.

A.2 References

In addition to the referenced standards listed earlier in this document, this annex references the following standard:

API Specification Q1.

For Licensees under the Monogram Program, the latest version of this document shall be used. The requirements identified therein are mandatory.

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A.3 API Monogram Program: Licensee Responsibilities

A.3.1 Maintaining a License to use the API Monogram

For all organizations desiring to acquire and maintain a license to use the API Monogram, conformance with the following shall be required at all times:

- a) the quality management system requirements of API Q1;
- b) the API Monogram Program requirements of API Q1, Annex A;
- c) the requirements contained in the API product specification(s) for which the organization desires to be licensed;
- d) the requirements contained in the API Monogram Program License Agreement.

A.3.2 Monogrammed Product Conformance with API Q1

When an API-licensed organization is providing an API monogrammed product, conformance with API-specified requirements, described in API Q1, including Annex A, is required.

A.3.3 Application of the API Monogram

Each Licensee shall control the application of the API Monogram in accordance with the following.

- a) Each Licensee shall develop and maintain an API Monogram marking procedure that documents the marking/monogramming requirements specified by the API product specification to be used for application of the API Monogram by the Licensee. The marking procedure shall define the location(s) where the Licensee shall apply the API Monogram and require that the Licensee's license number and date of manufacture be marked on monogrammed products in conjunction with the API Monogram. At a minimum, the date of manufacture shall be two digits representing the month and two digits representing the year (e.g. 05-07 for May 2007) unless otherwise stipulated in the applicable API product specification. Where there are no API product specification marking requirements, the Licensee shall define the location(s) where this information is applied.
- b) The API Monogram may be applied at any time appropriate during the production process but shall be removed in accordance with the Licensee's API Monogram marking procedure if the product is subsequently found to be nonconforming with API-specified requirements. Products that do not conform to API-specified requirements shall not bear the API Monogram.
- c) Only an API Licensee may apply the API Monogram and its license number to API monogramable products. For certain manufacturing processes or types of products, alternative API Monogram marking procedures may be acceptable. The current API requirements for Monogram marking are detailed in the API Policy Document, Monogram Marking Requirements, available on the API Monogram Program website at <http://www.api.org/certifications/monogram/>.
- d) The API Monogram shall be applied at the licensed facility.
- e) The authority responsible for applying and removing the API Monogram shall be defined in the Licensee's API Monogram marking procedure.

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A.3.4 Records

Records required by API product specifications shall be retained for a minimum of five years or for the period of time specified within the product specification if greater than five years. Records specified to demonstrate achievement of the effective operation of the quality system shall be maintained for a minimum of five years.

A.3.5 Quality Program Changes

Any proposed change to the Licensee's quality program to a degree requiring changes to the quality manual shall be submitted to API for acceptance prior to incorporation into the Licensee's quality program.

A.3.6 Use of the API Monogram in Advertising

Licensee shall not use the API Monogram on letterheads or in any advertising (including company-sponsored web sites) without an express statement of fact describing the scope of Licensee's authorization (license number). The Licensee should contact API for guidance on the use of the API Monogram other than on products.

A.4 Marking Requirements for Products

A.4.1 General

These marking requirements apply only to those API Licensees wishing to mark their products with the API Monogram.

A.4.2 Product Specification Identification

Manufacturers shall mark equipment with the information identified in 5.9, as a minimum, including "API Spec 20A."

A.4.3 Units

As a minimum, equipment should be marked with U.S. customary (USC) units. Use of dual units [metric (SI) units and USC units] is acceptable.

A.4.4 License Number

The API Monogram license number shall not be used unless it is marked in conjunction with the API Monogram.

A.5 API Monogram Program: API Responsibilities

The API shall maintain records of reported problems encountered with API monogrammed products. Documented cases of nonconformity with API-specified requirements may be reason for an audit of the Licensee involved (also known as audit for "cause").

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Documented cases of specification deficiencies shall be reported, without reference to Licensees, customers or users, to API Subcommittee 18 (Quality) and to the applicable API Standards Subcommittee for corrective actions.

DRAFT

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Annex B
(informative)

Purchasing Guidelines

TBD

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Bibliography

- [1] ASTM A703, *Standard Specification for Steel Castings, General Requirements, for Pressure-Containing Parts*
- [2] ASTM E747, *Standard Practice for Design, Manufacture and Material Grouping Classification of Wire Image Quality Indicators (IQI) Used for Radiology*
- [3] ASTM A352, *Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service*
- [4] ISO 2859-1, *Sampling Procedures for Inspection by Attributes -- Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*